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International Agreement Report

RELAP5 Assessment Using LSTF Test Data SB-CL-18

Prepared by
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Office of Nuclear Regulatory Research
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NOTICE

ICAP

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Abstract

5 % cold leg break test, run SB-CL-18, conducted at the Large Scale Test Facility (LSTF) was analyzed using the RELAP5/MOD2 Cycle 36.04 and the RELAP5/MOD3 Version 5m5 codes.

The test SB-CL-18 was conducted with the main objective being the investigation of the thermal-hydraulic mechanisms responsible for the early core uncovery, including the manometric effect due to an asymmetric coolant holdup in the steam generator upflow and downflow side.

The present analysis, carried out with the RELAP5/MOD2 and MOD3 codes, demonstrates the code's capability to predict, with sufficient accuracy, the main phenomena occuring in the depressurization transient, both from a qualitative and quantitative point of view. Nevertheless, several differences regarding the evolution of phenomena and affecting the timing order have to be pointed out in the base calculations.

The sensitivity study on the break flow and the nodalization study in the components of the steam generator U-tubes and the cross-over legs were also carried out. The RELAP5/MOD3 calculation with the nodalization change resulted in good predictions of the major thermal-hydraulic phenomena and their timing order.

Executive Summary

The LSTF test SB-CL-18 has been analyzed using the RELAP5/MOD2 and MOD3 codes to assess the code's ability for a 5 % cold leg break LOCA, to improve common understanding of PWR thermal-haydraulic response during such a transient and to identify areas for desirable model improvements based on comparisons between data and predictions.

The main goal of the calculation is the assessment of the simulation capability of the code for the following phenomena occurring during the small break LOCA experimental test;

- top-down drain of coolant in primary system
- stratified two-phase flow in horizontal legs
- loop seal clearing and concurrently temporary core liquid depression, with influenced residual liquid holdup in steam generator primary side, leading to core heatup
- quick core level recovery after loop seal clearing
- vessel inventory boil-off leading to second core uncovery
- core reflooding due to accumulator injection.

The calculated overall trend agreed well with the test data. However, several differences regarding the evolution of phenomena and affecting the timing order have to be point out.

In the base calculation with the RELAP5/MOD2, one can observe three fundamental disagreements between calculated and experimental transient

sequences. The first is the underestimation of the calculated two-phase break flow rate (between 100 and 200 seconds) leading to an insufficient mass discharge from the primary system and therefore from the pressure vessel. A sensitivity study on the break flow rate using break flow options, i.e., abrupt area change and smooth area change, and break cischarge coefficients of two-phase flow, was carried out. However the results did not give sufficient improvement on predicting the break flow rate. The second and the most important inaccuracy is that the code strongly overestimates the liquid holdup in the upflow side of the steam generator U-tubes, giving rise to a plug effect hindering the loop seal downflow side level decreasing and delaying the loop seal clearance. The third discrepancy of the calculation in comparison with the experiment is that the higher vapor-phase break flow rate after 160 seconds results in a fast primary mass loss and therefore in an anticipated earlier accumulator injection.

In the base calculation with the RELAP5/MOD3, the first and the third disagreements described above were still observed. The liquid holdup in the upflow side of the steam generator U-tubes was predicted well with the experiment, however the complete loop seal clearing was not occurred throughout the transient. This discrepancy was cleared by the nodalization changes in the steam generator U-tubes and the cross-over legs and the calculated results were in good agreement with the experiment in the evolution of the major thermal-hydraulic phenomena and their timing order.

Acknowledgement

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1. Introduction

The International Code Assessment and Application Program (ICAP) has been conducted by fourteen nations and multinational organizations under the auspices of the USNRC[1]. For the pressurized water reactor analysis, the USNRC selected two best estimate (BE) codes: RELAP5/MOD2 and TRAC/PF1/MOD1[2]. The goal of the program is to assess the prediction capabilities of the current BE thermal hydraulic codes utilizing the available facility test and plant data. At present the ICAP activities in Korea help to quantify uncertainties in the codes so that the codes may be used for regulatory purposes.

This report is a part of the Korean contribution to the ICAP. The RELAP5/MOD2[3] Cycle 36.04 and the RELAP5/MOD3[4] Version 5m5 were used in the present calculations simulating the test SB-CL-18 of the Large Scale Test Facility (LSTF) [5].

The Rig of Safety Assessment No. 4 (ROSA-IV) Program, launched by the Japan Atomic Energy Research Institute (JAERI) in 1980 immediately after the Three Mile Island Unit 2 accident, comprises three major tasks: (1) conducting integral effect tests on PWR small break loss of coolant accidents (SBLOCAs) and transients using the LSTF, (2) conducting separate effects tests using the Two-Phase Flow Test Facility (TPTF), and (3) developing and verifying an advanced thermal-hydraulic code for the analysis of SBLOCAs and transients.

The test SB-CL-18[6], as one of the Integral Effect Test (IET), was simulated 5 % cold leg break (loop without pressurizer) test and conducted with the main objective being the investigation of the thermal-hydraulic mechanisms responsible for the early core uncovery, including the manometric effect due to an asymmetric coolant holdup in the steam generator (SG) upflow and downflow side.

The main goal of the calculation is the assessment of the simulation capability of the code for the following phenomena occuring during the small break LOCA experimental test;

- top-down drain of coolant in primary system
- stratified two-phase flow in horizontal legs
- loop seal clearing and concurrently temporary core liquid depression, with influenced residual liquid holdup in SG primary side, leading to core heatup
- quick core level recovery after loop seal clearing
- vessel inventory boil-off leading to second core uncovery
- core reflooding due to accumulator injection.

The report describes the results of the calculation performed by the RELAP5/MOD2 and MOD3 codes and shows the comparisons with the major variables obtained in the experiment. A brief description of the LSTF and SB-CL-18 test is provided in Section 2, and Section 3 describes the features of the RELAP5 code and modelling to be assessed. Section 4 discusses the results of the base calculations with the RELAP5/MOD2 and MOD3. The motivations for the sensitivity and nodalization studies and their results are included in Section 5. The code efficiency is evaluated in Section 6 through run statistics. The conclusions drawn from this study are given in Section 7.

2. Facility and Test Description

2.1 Facility Description

The LSTF [5] is a 1/48 volumetrically scaled model of a Westinghouse type 3423 MWt four loop Pressurized Water Reactor (PWR). The LSTF has the same major component elevations as the reference PWR to simulate the natural circulation phenomena and large loop pipes (hot and cold legs of 207 mm in diameter) to simulate the two-phase flow regimes and significant phenomena in an actual plant. Fig. 1 and Table 1 show the structure and major dimensions of the LSTF, respectively. The facility is designed to be operated at the same high pressures and temperatures as the reference PWR.

The LSTF facility simulates the major components of the PWR primary system (e.g., pressure vessel, steam generators) and the reactor protection system (e.g., emergency core cooling system, ECCS) that have an impact on the plant behaviour during SBLOCAs and operational transients. Equipment controls allow the test operators to either follow procedures defined in standard plant manual or to follow variations of standard procedures.

Other systems, such as the secondary and various auxiliary systems, are capable of achieving pretest steady-state conditions and simulating the primary to secondary interactions. These systems include feedwater, condensate and steam systems together with component service systems such as the cooling water, water purification etc.

The fuel assembly dimensions [7], i.e. the fuel rod and the guide thimble diameter, pitch and length, and the ratio of number of fuel rods to number of guide thimbles are designed to be the same as the 17 x 17 fuel assembly of the reference PWR to preserve the heat transfer characteristics of the core. The total number of rod is scaled by 1/48 and is 1064 for the electrically heated and 104 for the unheated rods.

The downcomer, lower plenum and upper plenum design, including the scaled internal structures, maintains, to a practicable extent, the volume and flow resistances typical of the reference PWR.

Three core bypasses, consisting of the downcomer to hot leg leakage, an unintentional leakage between the downcomer and the upper plenum, and the spray nozzle connecting the downcomer to the upper head, are also simulated.

The most important design scaling compromise is the 10 MW maximum core power limitation, 14 % of the scaled reference PWR rated power. The steady state condition is therefore restricted to a core mass flow rate that is 14 % of the scaled value, to simulate the reference PWR temperature distribution in the primary loop.

The steam generators are designed in accordance with the facility scaling requirements, also in consideration that the rated 10 MWt LSTF power capability sets the steady-state flow conditions at 14 % of the scaled reference PWR SG-flow.

The four primary loops of the reference PWRs are represented by two equal-volume loops. The hot and cold legs were sized to conserve the volume scaling and the ratio of the length to the square root of the pipe diameter, $L/\sqrt{D}$ for the reference PWR, in expectation that the flow regime transitions in the primary loops can be simulated appropriately by taking this scaling approach.

A simulated containment system is available to collect and contain the effuent from simulated breaks. The simulated containment system is designed to ensure that the break flow will always be choked.

2.2 Test Description

The test SB-CL-18 was simulated 5 % cold leg horizontal break and the break point is located in the B-loop (loop without pressurizer) cold leg, between the reactor coolant pump and the reactor pressure vessel, with horizontal nozzle orientation. The test procedures were designed to minimize the effects of LSTF scaling compromises on the transients during the test.

After the break occurs at time zero, the primary system depressurizes quickly. During the first few seconds from the time of break onwards, the pump's speed is intentionally increased to simulate the post-scram hot leg temperature decay in PWR. At a pressurizer pressure of 12.97 MPa the reactor scrams. Since the loss of offsite power concurrent with the reactor scram is assumed, the primary coolant pumps are tripped to begin coastdown and the core power begins to decrease along the programmed decay curve. The power decay used in the test gives a slower decrease than the ANS standard.

The major operational setpoints and ECCS conditions are summarized in Table 2. To simplify the transient it is assumed that the SG auxiliary feedwater system as well as the high pressure charging system and the High Pressure Safety Injection (HPSI) system fail. As a result of the station blackout, concurrent with the auxiliary feedwater failure, the SG secondary side is isolated, allowing, in any case, the steam discharge through the relief valves (cycling between opening and closure). The Accumulator (ACC) system and the Low Pressure Safety Injection (LPSI) system are specified to initiate coolant injection into the primary system at pressures of 4.51 and 1.29 MPa, respectively.

3. Code and Modelling Description

3.1 Code Description

The RELAP5/MOD2 code has been developed for best-estimate transient simulation of PWRs and associated systems. The code is based on a non-homogeneous and non-equilibrium model for one dimensional, two-phase system that is solved by a fast, partially implicit numerical scheme to permit economical evaluation of system transients. Recently, the RELAP5/MOD3 code development program has been initiated to develop a code version suitable for the analysis of all transients and postulated accidents in PWR systems including both large and small break LOCAs as well as the full range of operational transients. Although the emphasis of the RELAP5/MOD3 development is on large break LOCA, improvements to existing code models, based on the results of assessments against small break LOCA and operational transient test data, are also being made. Table 3 is a list of the phenomena and code models,improved from the RELAP5/MOD2, that are being addressed by the RELAP5/MOD3 code program.

The RELAP5/MOD2 Cycle 36.04 and the RELAP5/MOD3 Version 5m5 were used in this assessment.

3.2 Modelling Description

The nodalization used to simulate the LSTF facility of the ROSA-IV program with the RELAP5 code is shown in Fig. 2. The model is based on 162 volumes connected by 169 junctions and 166 heat structures.

In the reactor vessel element (volumes 100 to 156) the volumes corresponding to the downcomer, the lower plenum, the core, the upper plenum, the upper head and the guide timble channel are defined. In the schematization of the upper part of the LSTF downcomer (volumes 100 and 104), care was taken to correctly simulate the steady-state mass flow rates in the connections with the hot legs (bypasses), the upper plenum (unintentional leak path) and the upper head (spray nozzles) to obtain the requested values, i.e. 0.1 %,0.085 % and 0.3 % of the core inlet flow rate, respectively. The core is modelled by one channel arranged in 6 hydraulic volumes, in which only one series of heat structures is adopted to simulate the fuel assembly (i.e. a flat radial core power profile is assumed). The reason for this choice resides in the attempt to perform the simplest modelling of the LSTF facility as possible.

A pipe connection (volume 156) between the upper head and the upper plenum of the pressure vessel is introduced in the scheme to simulate the guide thimble channel path existing in the facility. The two loops of the LSTF system are represented by the I-loop (volumes 400 to 499, intact loop) and the B-loop (volumes 200 to 299, broken loop) in an almost symmetrical way. In fact, each of the two loops present the hot leg, the SG inlet and outlet plena, the SG U-tube channel, the loop seal, the reactor coolant pump, the cold leg. In addition, the pressurizer is connected to the I-loop hot leg by means of the surge line element and the break system is connected to the B-loop cold leg.

In the volumes representing the pressurizer vessel, an additional heat structure is introduced to simulate the effects of the proportional and back-up heaters.

The two steam generator secondary sides (volumes 300 to 399 and 500 to 599) are simulated using an identical schematization. They can be subdivided into the downcomer, the boiling section, the steam separator and the steam dome. The steam and feedwater lines are simulated by using Time Dependent Junctions (i.e. with imposed flow rates) because they must be excluded during the transient phase of the calculation. In fact, in the experimental test, the two mentioned lines are closed in coincidence with the reactor scram signal, few seconds after break opening, to isolate the SG secondary side. Relief and safety valves are also connected to the SG steam dome using valve components in which the operational setpoints and conditions are specified to be the same as the experiment.

The requested volume distributions for the primary and secondary system, including the "active dead volumes" distribution, is taken into account for the determination of the piping cross sectional areas, that result in small area differences between analogous pipes belonging to the two different loops.

The nodalization of the SG secondary side (volumes 328, 332, 528, 532 and 800 to 820) is simulated for the present case, however it could have been reduced to be simpler.

The steam generators as well as the pressurizer are provided with two systems devoted to the control of the pressure and the liquid level during the steady-state period (200 sec.) and to maintain them at the specified initial values.

The physical boundaries of the entire system, i.e., the reactor containment and the relief and safety discharge tanks, are reproduced by means of Time Dependent Volumes with constant internal conditions during the calculation.

To allow the accumulator injection to start correspondingly to the cold leg pressure specified in the experiment, a valve is arranged on each of the accumulator surge lines.

The choked flow option is specified in the valve simulating the break and to avoid the code calculating mass flow rates to be inconsistent with the experimental data, the subcooled and two-phase discharge coefficient are chosen as close as 1.0 and 1.05, respectively.

4. Base Calculations

During a small break loss of coolant accident,the primary coolant inventory loss will continue until the break flow rate decreases sufficiently, due to break uncovery or primary depressurization, to allow the emergency core cooling system to make up the coolant loss. Such coolant inventory depletion will involve concurrent liquid level depressions in the downflow side of the cross-over leg , for each loop, and in the vessel riser section (upper plenum and core). Meanwhile, the upflow side of the cross-over leg, cold leg and downcomer will remain liquid filled up to the break elevation. The core level depressions will continue until the level of the downflow side in the cross-over leg reaches the bottom of the legs and thus allows the vapor to clear the liquid seal in the cross-over legs toward the break. When this liquid clearing (loop seal clearing) initiates, the core liquid level starts to recover. This occurs because the vapor can now reach to the downcomer and allows a manometric flow of the downcomer liquid inventory into the core region[8].

In the present study both the RELAP5/MOD2 and MOD3 codes were used for the base calculations and their results are shown in the figures from 3 to 44. In all figures, the results with the RELAP5/MOD2 and with the RELAP5/MOD3 are represented as "Calculated 1 " and "Calculated 2 ," respectively.

The major initial conditions, as shown in Table 4, and the sequence of events, summarized in Table 5, are compared with the experiment. The input listing for the base calculation with the RELAP%/MOD3 is attached in Appendix.

4.1 RELAP5/MOD2

The calculated results for the principal events are compared with the experimental values in Table 5. All the main primary phenomena observed during the experiment were reproduced by the code.

i) Primary and Secondary Pressures Response

Figures 3 to 5 show the primary and secondary pressure in comparison with the experimental values. The code predicts well the secondary pressure trend, whereas, despite a good qualitative agreement, it highlights some differences in the behavior of the primary depressurization in the region between 200 and 600 seconds.

The primary pressure depressurization became slower after flashing started in the primary loop hot side. The primary pressure remained higher than the secondary pressure until after the loop seals cleared completely.

In this respect one should point out the strong delay at which the loop seal clearance occur in comparison with the experiment as shown in Figs. 6 to 9. This occurrence results in a delayed beginning of the linear primary pressure decrease, happening moreover with a higher depressurization rate. The mentioned faster pressure decreasing allows an earlier intervention of the accumulator system as shown in Figs. 10 and 11.

ii) Break Flow Rate

Figs. 12 and 13 show that the break flow rate is first overpredicted by about 30 % for subcooled liquid discharge and is underpredicted as approaching saturation condition. In the region between 50 and 150 seconds, the two-phase break flow rate is definitely underestimated by the code, in such a way that the time integrated mass inventory, escaping from the break in that period, is about one half of the experimental value. The underprediction of liquid and low-quality two-phase break flow rates resulted in a delay of loop seal clearing relative to the experimental result. Loop seal clearing occurred at 195 seconds (vs. 140 seconds in the experiment). Both loop seal cleared at the same time as was the case in the experiment.

iii) SG U-tube differential Pressure

Figures 6 to 9 show the differential pressures in SG U-tubes, upflow and downflow side. The agreement between measured and calculated data is acceptable concerning the downflow side, but the code predicts too strong liquid holdup in the upflow side of the SG U-tubes. This SG liquid holdup was overpredicted tending to enhance the core level depression during loop seal clearing. While considerable amount of liquid remained in the upflow side of the SG U-Tube and SG inlet plenum at the time of loop seal clearing, the hot legs underneath were nearly empty after 130 seconds.

The SG U-tube differential pressure as shown in Fig. 14 increased until it took a maximum of 18 kPa at about 140 seconds. This increase resulted from a redistribution of liquid due to the hydrostatic pressure balance throughout the primary system during flow coastdown. During the flow coastdown, the pressure distribution in the primary loops changed since frictional pressure losses (mainly at the pumps) decreases and the core void fractions increased. At 120 seconds, the vertical legs in the cold side loop was liquid filled whereas the hot side loop contained much void as shown in Figs 15, 16 and 17. Thus, due to the manometric balance between the hot side loop and the cold side loop, including the SGs, more liquid was retained in the SG upflow side than in the downflow side. The calculation overpredicted the peak SG differential pressure, that was reached at the end of two-phase natural circulation.

The SG liquid holdup persisted after loop seal clearing in this calculation. The differential pressure in the SG inlet plenum became zero at 300 seconds (vs. 300 seconds in the experiment) as shown in Figs. 18 and 19. Also the differential pressure in the upflow side of the SG U-tube increased after loop seal clearing while such an increase was not seen or less significant in the experiment. Thus, the liquid level recovery into the upper plenum and hot legs after loop seal clearing was underpredicted or not predicted at all as shown in Fig. 20. Consequently, the second core level drop initiated 320 seconds (vs. 400 seconds in the experiment), i.e., immediately after the level recovery following loop seal clearing.

iv) Core Thermal-Hydraulic Responses

The differential pressures in the core and the upper plenum are presented in Fig. 21 in which the code achieves a good simulation of the core level depression. One can observe, however, that the first core uncovery and consequent recovery is delayed about 50 seconds, whereas the second core level depression is anticipated earlier about 60 seconds. The reason for this behavior resides in the simultaneous occurrence of several effects. The duration of the first core heatup, associated with loop seal clearing, was overpredicted because of the underprediction of the core liquid level. The reason for the early second core uncovery must be given to the faster linear depressurization predicted by the calculation after loop seal clearing, causing the anticipated vessel mass inventory boil-off.

The core level was depressed manometrically, concurrently with the level drop in cross-over legs, and took a minimum immediately before the loop seal clearing started. This minimum core level was lower than the cross-over leg liquid level which was at the bottom of the leg.

The core inlet flow almost stopped after 150 seconds as shown in Fig. 22. After this, the core was covered by nearly stagnant two-phase mixture until core uncovery started at about 170 seconds.

Figs. 23 and 24 show rod surface temperature at the average-power bundles. The core liquid level depression resulted in rod temperature excursions starting from about 150 seconds. The peak cladding temperature was about 750 K (vs. 680 K in the experiment) for the average-powered bundles. After the loop seal clearing, the core liquid level recovered quickly and heater rods were quenched as shown in Fig. 20. The core differential pressure was generally underpredicted. This was the case even when the core was covered by two-phase mixture. This occurred due to an overprediction of core interfacial drag; a well-known deficiency of the RELAP5/MOD2 interfacial drag models.

v) Transient Behavior of Other Variables

The transient behavior of the other variables are shown in Figs. 25 to 44. The variables, such as flow rates, liquid densities, and fluid temperatures in the primary loops, etc., were in good agreement with the experiment. However large fluction of the fluid temperatures in the cold legs of the primary loops was occurred after the accumulator injection.

4.2 Base Calculation with RELAP5/MOD3

The modifications to the RELAP5/MOD2 input deck to accommodate the RELAP5/MOD3 are as follows:

- Countercurrent and Flow Limiting (CCFL) options added at the inlet to the steam generator U-tubes and the 40 degree bend in the hot leg
- Junctions in the core region modified for new interphase drag package (flow area and hydraulic diameters)
- Heat structure cards added for new Critical Heat Flux (CHF) calculation

The calculated results for the principal variables are compared with the experimental values in Table 5.

The trend in the break flow rate is almost same as that with the RELAP5/MOD2. Therefore, in the region between 50 and 150 seconds the two-phase break flow rate is still underestimated as shown in Figs. 12 and 13. Nevertheless, the integrated break flow shows nearly identical to the experiment. Therefore it may be considered that there exists some errors in measuring break flow rate. And the break flow rate with high void fraction was overpredicted after 200 seconds as shown in Fig. 13. The primary pressure decreases nearly same as test data up 250 seconds, however the faster decrease in the pressure after 250 seconds allows an earlier intervention of the accumulator injection as shown in Fig. 10.

It is shown in the figures 6 to 9 that the strong liquid holdup in the SG upflow side is not occurred unlikely the case with the RELAP5/MOD2. This improvement may be obtained from the implementation of the new interphase drag model in the RELAP5/MOD3. The calculation overpredicted the peak SG differential pressure, that was reached at the end of two-phase natural circulation as shown in Fig. 14.

The significant difference is found in the loop seal clearing phenomena as shown in Figs. 15 and 16. The loop seal clearing was started at 150 seconds, however, was not cleared completely through the transient.

The liquid level and the differential pressure in the heated core length are shown in Figs. 20 and 21, respectively. The first core uncovery is occurred at 100 seconds which is earlier than the experiment of 120 seconds and the duration of the first core heatup is nearly same as the experiment even though the core level depression was overpredicted. The second core level drop initiated 165 seconds (vs. 400 seconds in the experiment), i.e., immediately after the level recovery following the loop seal clearing as shown in Fig. 20.

The transient behavior of the other variables are shown in Figs. 22 to 44. The variables, such as flow rates, liquid densities, and fluid temperatures in the primary loops, etc., were in good agreement with the experiment. However large fluctions of the fluid temperatures and liquid densities in the cold legs of the primary loops were occurred after the accumulator injection.

The major areas of the differences between the RELAP5/MOD2 and the RELAP5/MOD3 are the primary system pressure response, the differential pressure in the upper plenum, core heatup prediction, core liquid level depression, and the drainage of steam generator inlet plena. These differences may be due to modifications to interphase drag model which affected the liquid holdup in the upper plenum and void distributions in the primary loops. Both calculations predicted trend well, however each differed in prediction of the magnitude and timing of occurrences. In the RELAP5/MOD3 calculations the amount of liquid holdup in the upflow side of the SG U-tubes predicted well, however the complete loop seal clearing was not occurred throughout the transient, which was occurred in the experiment.

5. Sensitivity and Nodalization Studies

The base calculations agreed well with the test data. However the break flow rates and the timing order of the principal phenomena have to be pointed out.

5.1 Break Flows

From the discussions in the previous chapters, it was found that the break flow was overestimated about 30 % at the initiation of the transient and was underpredicted in the region between 50 and 150 seconds. Thus it may be necessary to predict the thermal-hydraulic transient phenomena more accurately by considering the break flow options, i.e., abrupt area change and smooth area change, and break discharge coefficients for the single- and two-phase flows.

In the present calculation with the RELAP5/MOD2, several values of the two phase break discharge coefficients with both abrupt and smooth area change options. For single phase flow, a discharge coefficient was fixed to be 1.0 here.

Figs. 45 to 50 show the effect of two phase break discharge coefficient with both area change options. With the abrupt area change option, the break flow rate was still underestimated in the region between 50 and 150 seconds and the little differences were found for different discharge coefficients. With the smooth area change option, similar underprediction of break flow was obtained, however it matched better with the experiment in the single phase region, particularly in the region between 50 and 100 seconds.

5.2 Nodalization

In the calculation with the RELAP5/MOD3 the complete loop seal clearing was not occurred, therefore the nodalization study may be necessary to evaluate the effectiveness of the nodalization and to quantify their effects on the loop seal behavior, particularly on the loops from steam generator inlet to reactor coolant pump inlet via the cross-over cold legs. In this calculation with the RELAP5/MOD3 the volumes, stated above, were divided twice than the base case to show the effect of loop seal clearing and related phenomena. This model is based on 204 volumes connected by 211 junctions and 216 heat structures.

The calculated results for the principal variables are compared with the experiment and the base calculation with the RELAP5/MOD3 results in Table 4. The base calculation and the calculation with nodalization change are represented as "Calculated 2" and "Calculated 3 ", respectively, in Figs. 51 to 70.

The calculated results of the break flow rate, the primary and secondary pressures show almost same trend as those with the RELAP5/MOD3 as shown in Figs. 51 and 55. In Figs. 56 to 57 the differential pressure of the cross-over leg predicts much better than the base calculation with the RELAP5/MOD3 which did not show the complete loop seal clearing. The liquid in the downflow side of the cross-over leg is empted after the loop seal clearing, however some liquid in the upflow side of the cross-over leg existed throughout the transient.

The timing order of the first core uncovery and the duration of the core heatup is predicted remarkably well with the experiment, however the liquid level depression is still underpredicted and the quick second core level depression was also occurred as shown in Figs. 58 and 59.

6. Run Statistics

CDC 170-875 Series with NOS Version 2.6.1 for calculation using RELAP5/MOD2 Code and CRAY2S/4-128 for calculation using RELAP5/MOD3 Code were used.

Fig. 71 shows the required CPU time vs the transient time in the base calculations. The size of the time step was chosen to be 10E-6 and 10E-1 seconds at the minimum and the maximum time step, respectively, for both base calculations. During the RELAP5/MOD3 calculation the water property errors were occurred about at 100, 190, and 320 seconds. Therefore, restart calculation with reduced time step of 0.05 seconds were applied for the next 30 seconds to overcome this. The computational efficiency is summarized in Table 7 from the major edit for base calculations and can be calculated as follows.

Calculation	Computer Time (CPU),sec	Number of Time Step (DT),	Number of Volume (N)	Grind Time, CPU/(N*DT)
RELAP5/MOD2	2351.7	6376	162	0.002276
RELAP5/MOD3	1865.2	15338	162	0.001153

7. Conclusions

The LSTF test SB-CL-18, 5 % cold leg break LOCA, was analyzed using the RELAP5/MOD2 and MOD3 codes. Four major calculations were carried out; two base calculations with the RELAP5/MOD2 and MOD3, one sensitivity calculation with the RELAP5/MOD2 using the break flow options, and one nodalization study with the RELAP5/MOD3 in the areas of the SG U-tubes and the cross-over legs.

The present activity demonstrates the code's capability to predict, with sufficient accuracy, the main phenomena occurring in the depressurization transient, both from a qualitative and quantitative point of view. In the base cases, several differences regarding the evolution of such phenomena and affecting their timing order have to be pointed out.

In the base calculation with the RELAP5/MOD2, one can observe three fundamental disagreements between calculated and experimental transient sequences. The first is the underestimation of the calculated two-phase break flow rate (between 100 and 200 seconds) leading to an insufficient mass discharge from the primary system and therefore from the pressure vessel. A sensitivity study on the break flow rate using break flow options was carried out. However the results did not give sufficient improvement on predicting the break flow rate. The second and the most important inaccuracy is that the code strongly overestimates the liquid holdup in the upflow side of the SG U-tubes, giving rise to a plug effect hindering the loop seal downflow side level decreasing and delaying the loop seal clearance. The third discrepancy of the calculation in comparison with the experiment is that the higher vapor-phase break flow rate (after 160 seconds) results in a fast primary mass loss and therefore in an ancitipated earlier accumulator injection.

In the base calculation with the RELAP5/MOD3, the first and the third disagreements described above were still observed. The liquid holdup in the upflow side of the steam generator U-tubes was predicted well with the experiment, however the complete loop seal clearing was not occurred throughout the transient. This discrepancy was cleared by the nodalization changes in the steam generator U-tubes and the cross-over legs and the calculated results were in good agreement with the experiment in the evolution of the major thermal-hydraulic phenomena and their timing order.

References

1. Guidelines and Procedures for the International Code Assessment and Applications Program, NUREG-1271, April 1987.
2. U.S. Regulatory Commision Compendium of ECCS Research for Realistic LOCA Analysis, NUREG-1230, May 1987.
3. Ransom, V.H. et al.,"REALP5/MOD2 Code Manual, Volume 1: System Models and Numerical Methods, Volume 2: User Guides and Input Requirements," NUREG/CR-4312,EGG 2390,1987.
4. "Appendix A RELAP5 Input Data Requirements," EG&G Idaho Inc.,1990.
5. "ROSA-IV Large Scale Test Facility (LSTF) System Description," The ROSA-IV Group, JAERI-M/84-237.
6. "ROSA-IV/LSTF 5% Cold Leg Break LOCA Experiment Run SB-CL-18 Data Report," H. Kumamaru et al., JAERI-M/89-027.
7. "Supplimental Description of ROSA-IV/LSTF with No. 1 Simulated Fuel-Rod Assembly," The ROSA-IV Group, JAERI-M/89-113.
8. Kukida, Y. et al.,"Manometric Core Liquid Level Depression During a Small- Break Loss-of-Coolant Accident in a Westinghouse-Type Pressurized Water Reactor," Seminar Series Thermal Fluid Sciences, 1988.

Tables and Figures

Table 1. Major Design Characteristics of LSTF and PWR

		LSTF	PWR	PWR/LSTF
Pressure	(MPa)	16	16	1
Temperature	(K)	598	598	1
No. of fuel rods		1064	50952	48
Core height	(m)	3.66	3.66	1
Fluid volume, V	(m)	7.23	347	48
Core power, P	(MW)	10	3423(t)	342
P/V	(MW/m)	1.4	9.9	7.1
Core inlet flow	(t/s)	0.0488	16.7	342
Downcomer gap	(m)	0.053	0.260	4.91
Hot leg, D	(m)	0.207	0.737	3.56
L	(m)	3.69	6.99	1.89
$L/\sqrt{D}$	(m½)	8.15	8.15	1.0
$\pi \frac{1}{4} D^2 L$	(m)	0.124	2.98	24.0
No. of loops		2	4	2
No. of tubes in steam generator		141	3382	24
Length of steam generator tube (average)	(m)	20.2	20.2	1.0

Table 2. Specified Operational Setpoints and Conditions for Run SB-CL-18

Reactor scram signal	12.97 MPa
Initiation of RC pump coastdown	with reactor scram
Safety injection (SI) signal	12.27 MPa
Hish pressure charging	not actuated
Safety injection	not actuated
Accumulator injection	4.51 MPa
Low pressure injection	1.29 MPa
Main feedwater termination	with reactor scram
Turbine throttle valve closure	with reactor scram
Auxiliary feedwater	not actuated
Pressurizer Sparay Valve Bypass Flow Rate	0.011 kg/s
Pressurizer Proportional-Heater off	1 m (PR Liquid Level)
Pressurizer Back-up-heater off	1 m (PR Liquid Level)
Pressurizer Relief Valve Orifice	6.83 mm
Pressurizer Relief Valve on/off	16.20/16.07 MPa
Pressurizer Safety Valve Orifice	14.5 mm
Pressurizer Safety Valve on/off	17.26/17.06 MPa
Downcomer-to-Hot-Leg Leakage	0.049 kg/s/loop
Steam Generator Relief Valve Orifice	19.4 mm
Steam Generator Relief Valve on/off	8.03/7.82 MPa
Steam Generator Safety Valve Orifice	26.6 mm
Steam Generator Safety Valve on/of	8.68/7.69 MPa

Table 3. RELAP5/MOD3 Model Improvements

- Counter Current And Flow Limiting
- Interfacial Friction in Bubbly/Slug Flow Regime
- Vapor Pullthrough, Liquid Entrainment in Horizontal Pipes
- Critical Heat Flux
- Interfacial Condensation on Subcooled ECCS Liquid in Horizontal Pipes
- Horizontal Stratification Inception Criterion
- Reflood Heat Transfer
- Vertical Stratification
- Metal-Water Reaction
- Fuel Rod Ballooning and Rupture Model
- Radiation Heat Transfer Model
- Non-Condensible Gas Modelling
- Downcomer Penetration and ECCS Bypass
- Upper Plenum De-entrainment

Table 4. Comparison of Initial Conditions

Parameter	Units	Measured	Calc. 1	Calc. 2
PRIMARY LOOP				
CORE DIFFERENTIAL TEMPERATURE = (HOT-LEG TEMPERATURE) - (COLD-LEG TEMPERATURE)	K	36	35.7	35.0
HOT-LEG PRESSURE	MPa	15.5	15.6	15.5
HOT-LEG TEMPERATURE	K	599	600	599.5
MASS FLOW RATE PER LOOP	kg/s	24.35	24.34	
DOWNCOMER-TO-HOT LEG BYPASS FLOW RATE	kg/s	0.066	0.029	0.029
DOWNCOMER-TO-UPPER PLENUM LEAK FLOW RATE	kg/s	0.041	0.015	0.018
DOWNCOMER-TO-UPPER HEAD BYPASS FLOW RATE	kg/s	0.146	0.041	0.023
PUMP DIFFERENTIAL PRESSURE	kPa	4	2.9	3.0
PUMP ROTATIONAL SPEED	Hz	12.81	12.26	12.71
PRESSURE VESSEL				
CORE POWER	MW	10	10	10
MAXIMUM LINEAR HEAT GENERATION RATE	kW/m		3.926	
CORE DIFFERENTIAL PRESSURE	MPa		0.0277	0.0278
UPPER HEAD TEMPERATURE (TOP/BOTTOM)	K	595	594.8	594.8
LOWER PLENUM TEMPERATURE (MID/BOTTOM)	K		567.3	567.3
PRESSUREIZER				
PRESSURE	MPa	15.5	15.56	15.56
LIQUID LEVEL	m	2.7	2.63	2.63
LIQUID VOLUME	m3		0.734	0.733
VAPOR VOLUME	m3		0.413	0.414
TEMPERATURE (BOTTOM)	K		618.2	618.2
PRIMARY SYSTEM TOTAL MASS INVENTORY	kg	5764	5511.7	5511.3
PRIMARY SYSTEM TOTAL VOLUME	m3	8.106	8.191	8.191

+ Calc. 1 : REALP5/MOD2
  Calc. 2 : RELAP5/MOD3

(Table 4 continued)

Parameter	Units	Measured	Calc. 1	Calc. 2
SECONDARY SYSTEM				
SG STEAM DOME PRESSURE	MPa	7.3	7.31	7.31
STEAM FLOW RATE	kg/s	2.7	2.89	2.89
FEEDWATER FLOW RATE	kg/s	2.7	2.89	2.89
FEEDWATER TEMPERATURE	K	494	495	495
DOWNCOMER FLOW RATE	kg/s		16.587	
DOWNCOMER WATER LEVEL (FLOW TOP OF TUBE SHEET)	m	10.8	9.09	9.58
SECONDARY SIDE TOTAL MASS INBENTORY FOR EACH SG (LIQUID/VAPOR)	kg		2570	2570
SECONDARY SIDE TOTAL VOLUME FOR EACH SG	m3	7.003(A) 7.030(B)	6.95(A) 6.95(A)	6.95(A) 6.95(B)
EMERGENCY CORE COOLING SYSTEM				
HOT-ACCUMULATOR PRESSURE	MPa	4.51	4.51	4.51
HOT-ACCUMULATOR LIQUID TEMPERATURE	K	320	320	320
HOT-ACCUMULATOR LIQUID VOLUME	m3	4.189	4.189	4.189
HOT-ACCUMULATOR GAS VOLUME	m3	0.611	0.611	0.611
COLD-ACCUMULATOR PRESSURE	MPa	4.51	4.51	4.51
COLD-ACCUMULATOR LIQUID TEMPERATURE	K	320	320	320
COLD-ACCUMULATOR LIQUID VOLUME	m3	4.676	4.676	4.676
COLD-ACCUMULATOR GAS VOLUME	m3	0.124	0.124	0.124

Table 5. Chronology of Main Events

(unit :second)

	Measures	Cal. 1	Calc. 2	Calc. 3
BREAK VALVE OPENED	0	0	0	0
SCRAM SETPOINT REACHED	9	14	12	12
SAFETY INJECTION SIGNAL GENERATED	9	14	12	12
STEAM LINE VALVE CLOSED	14	19	17	17
SG FEEDWATER TRIPPED	16	19	17	17
STEAM LINE RELIEF VALVE STARTED				
OPEN/CLOSE CYCLING (A/B)		37/36	23/22	23/22
FIRST CORE UNCOVERY STARTED	120	170	100	120
LOOP SEAL CLEARING OCCURRED (A/B)	140/140	195/195	135/135	150/150
PRIMARY/SECONDARY PRESSURE				
REVERSAL OCCURRED	180	210	180	170
REACTOR COOLANT PUMP STOPPED	265	285	285	285
SECOND CORE UNCOVERY STARTED	420	360	300	340
ACCUMULATOR INJECTION STARTED	455	420	365	370
FINAL CORE REFLOODING STARTED	460	430	370	380
FINAL CORE REFLOODING COMPLETE	540	665	430	430
(ANALYSIS TERMINATED)		900	900	(650)

+ Calc. 1 : RELAP5/MOD2
  Calc. 2 : RELAP5/MOD3
  Calc. 3 : RELAP5/MOD3 (Nodalization Change)

Table 6. Run Statistics Data in Base Case

i) RELAP/MOD2

Transient time (sec)	CPU Time (sec)	Attempted ADV	Repeated ADV
0	1.39	0	0
100	213.72	630	12
200	340.30	978	55
300	730.98	2032	309
400	951.71	2711	340
500	1232.42	3556	431
600	1602.27	4638	551
700	1892.98	5545	556
800	2085.98	6161	563
900	2351.73	6970	594

ii) RELAP/MOD3

Transient time (sec)	CPU Time (sec)	Attempted ADV	Repeated ADV
0	1.3	0	0
100	98.1	830	75
130	427.9	3830	175
190	480.0	4261	283
220*	1123.3	10261	0
320	1245.6	11323	155
420*	1370.6	12375	114
520	1505.3	13534	218
620	1645.2	14738	369
720	1754.9	15689	489
820	1865.2	16639	593
900			

* Restart calculations with reduced time step size to overcome "water property error"

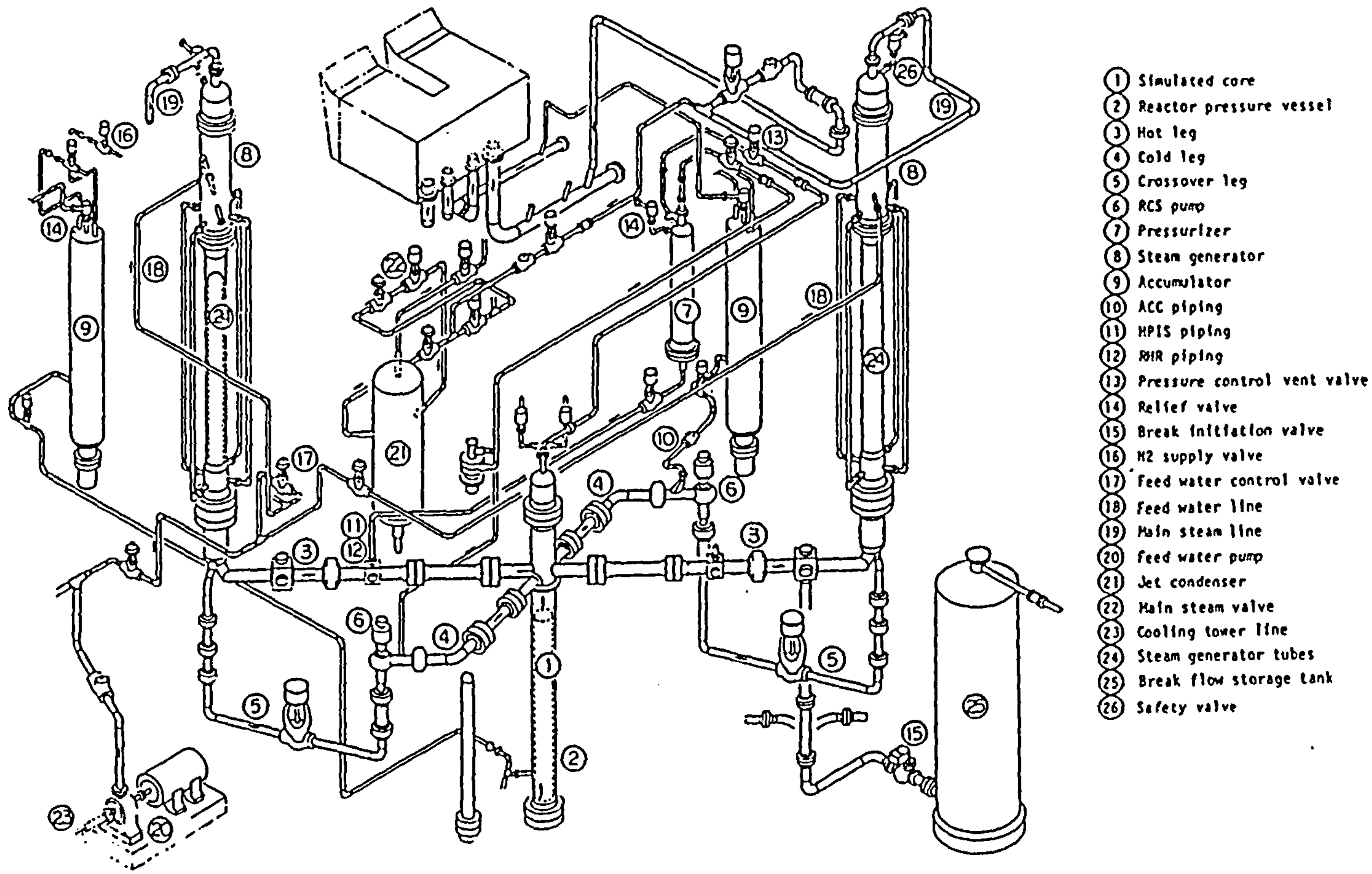

Fig. 1 General Structure of Large Scale Test Facility (LSTF)

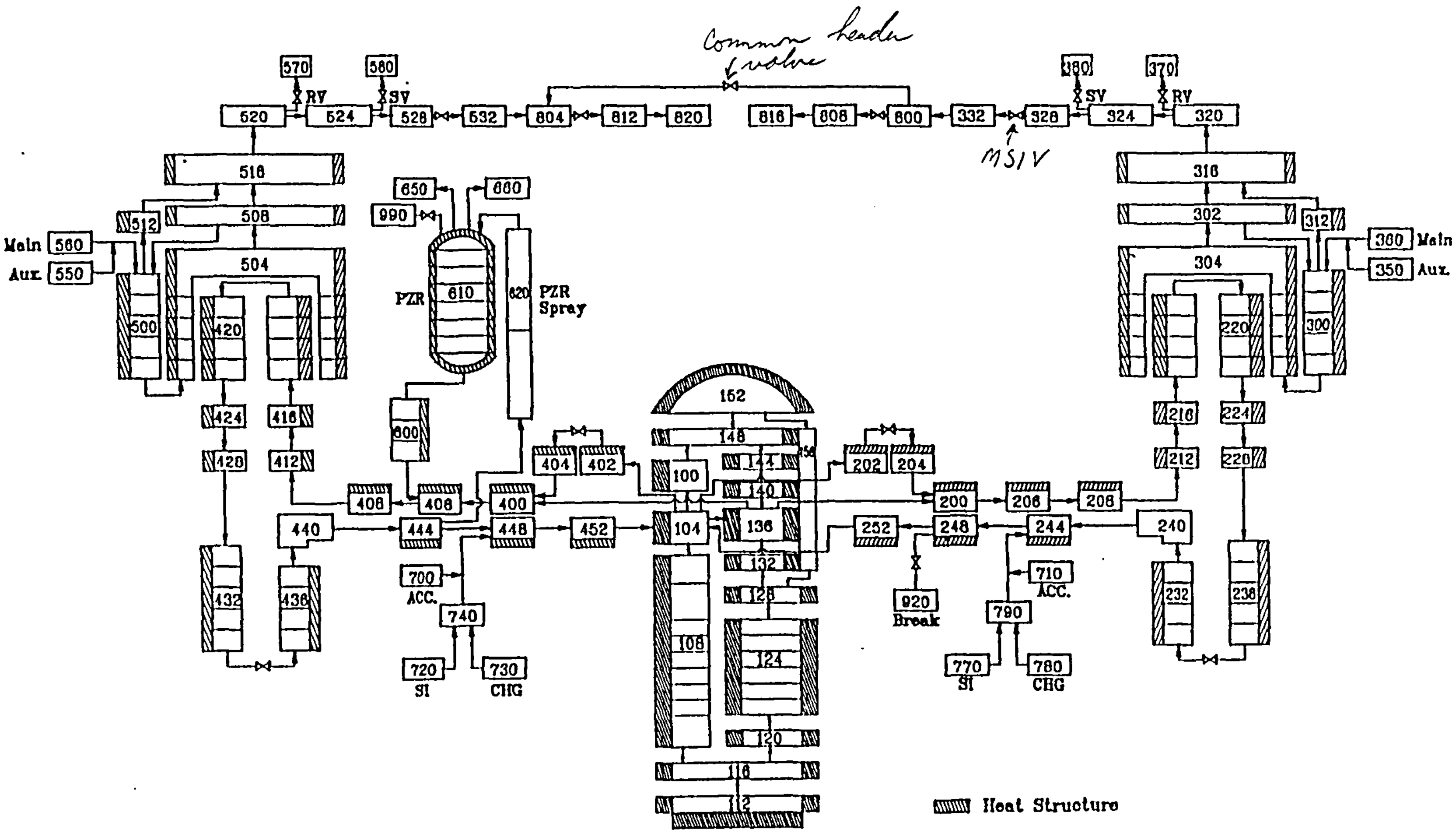

Fig. 2 Nodalization of ROSA-IV LSTF for RELAP5/MOD2 Code

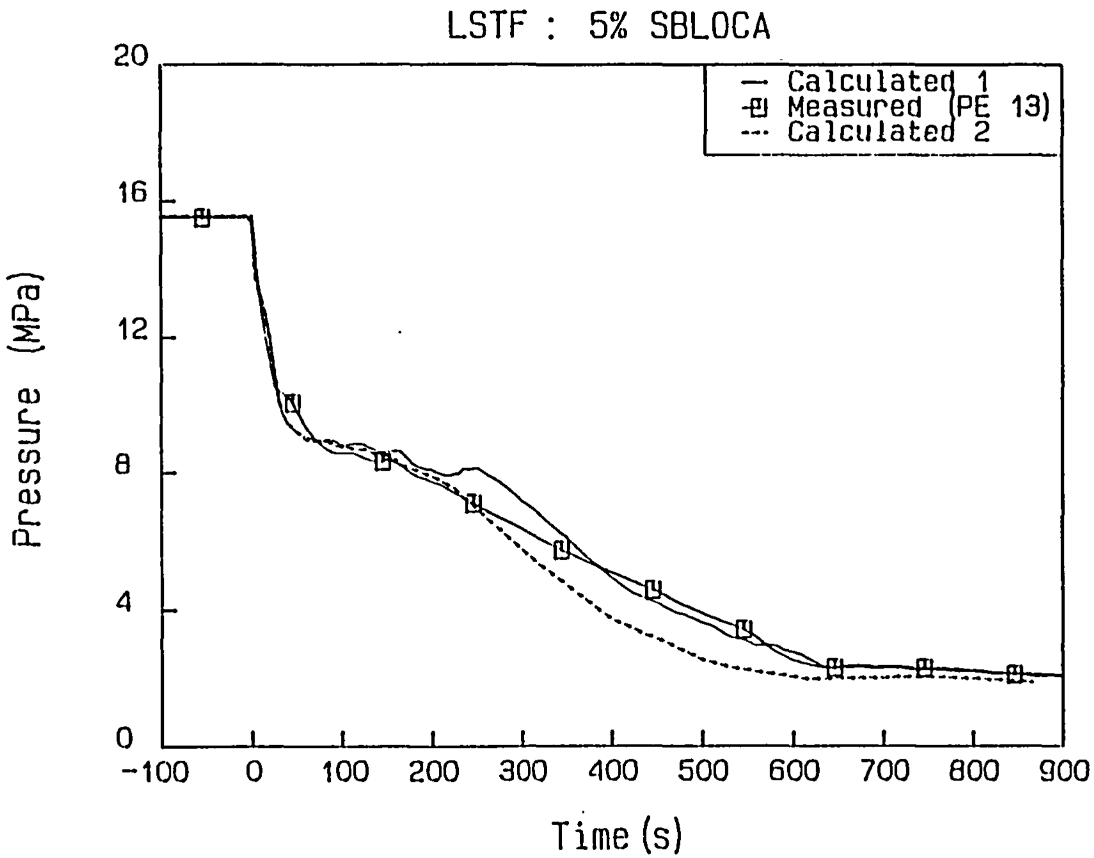

Fig.3 Pressurizer Pressure

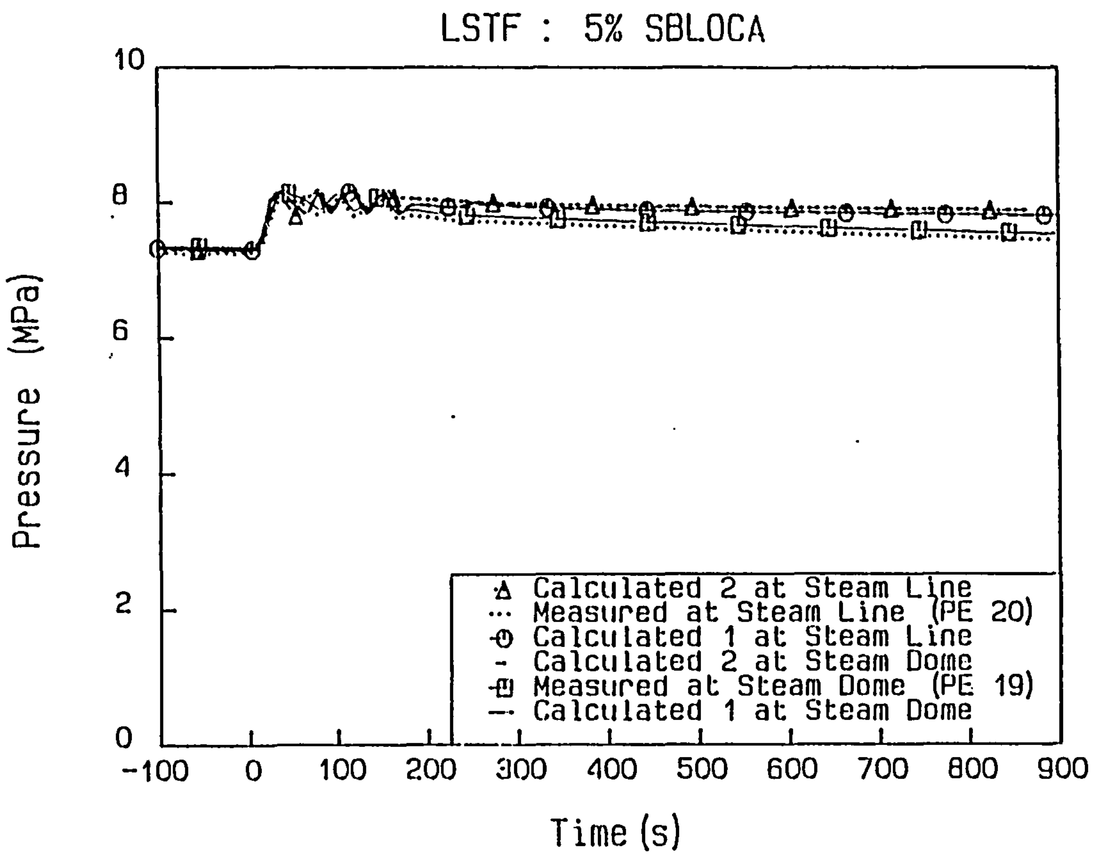

Fig. 4 SG-I Steam Dome / Line Pressures

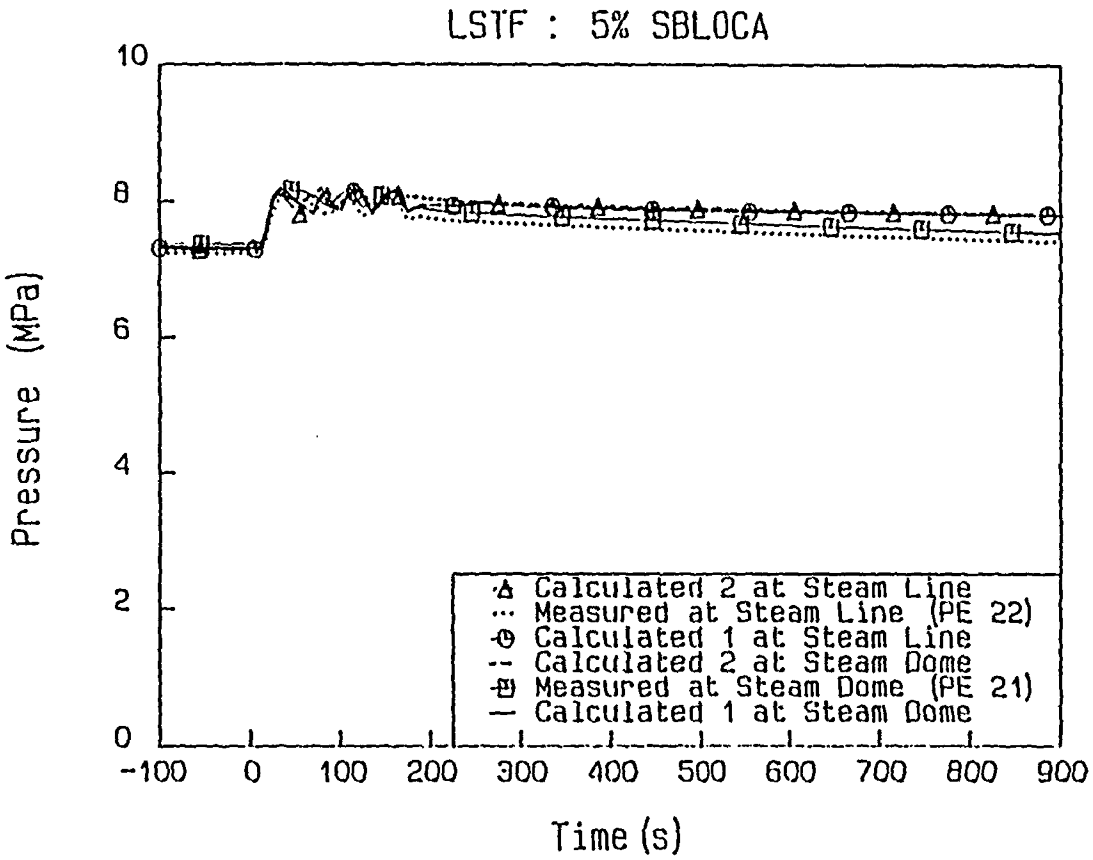

Fig. 5 SG-B Steam Dome / Line Pressures

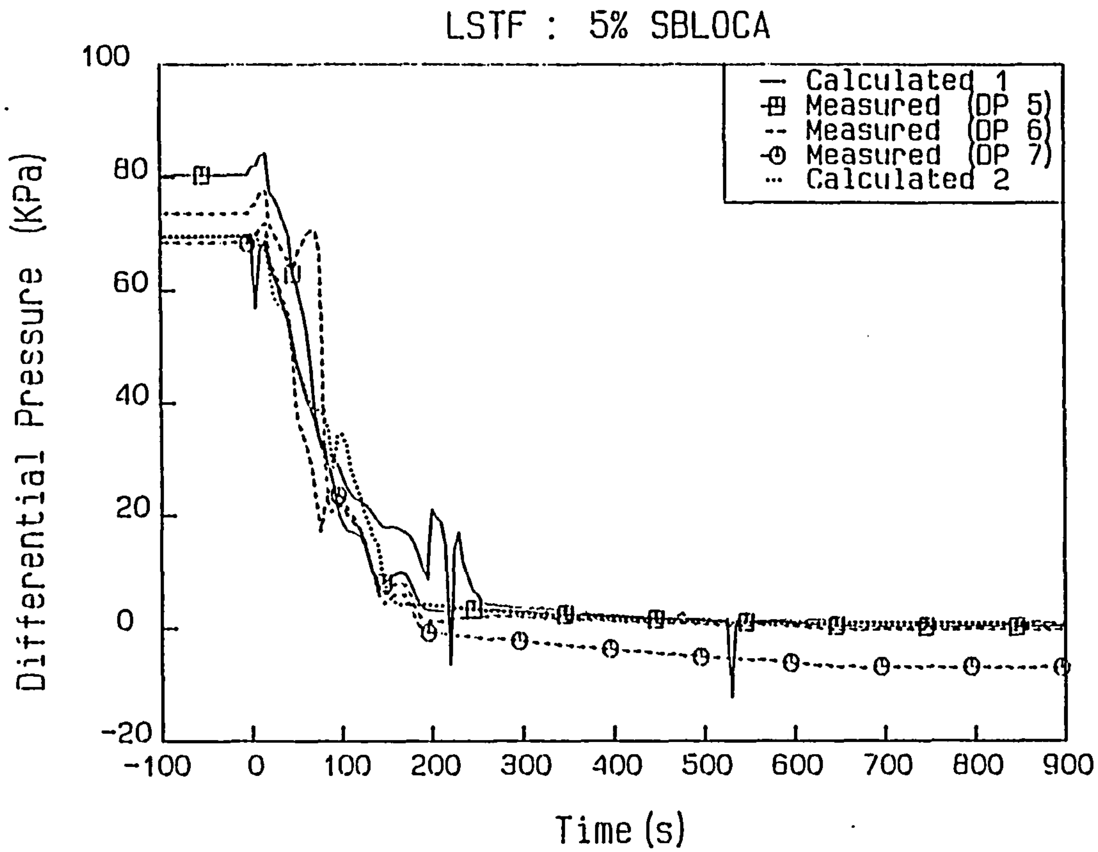

Fig. 6 SG-I Inlet - Tube Top Differential Pressure

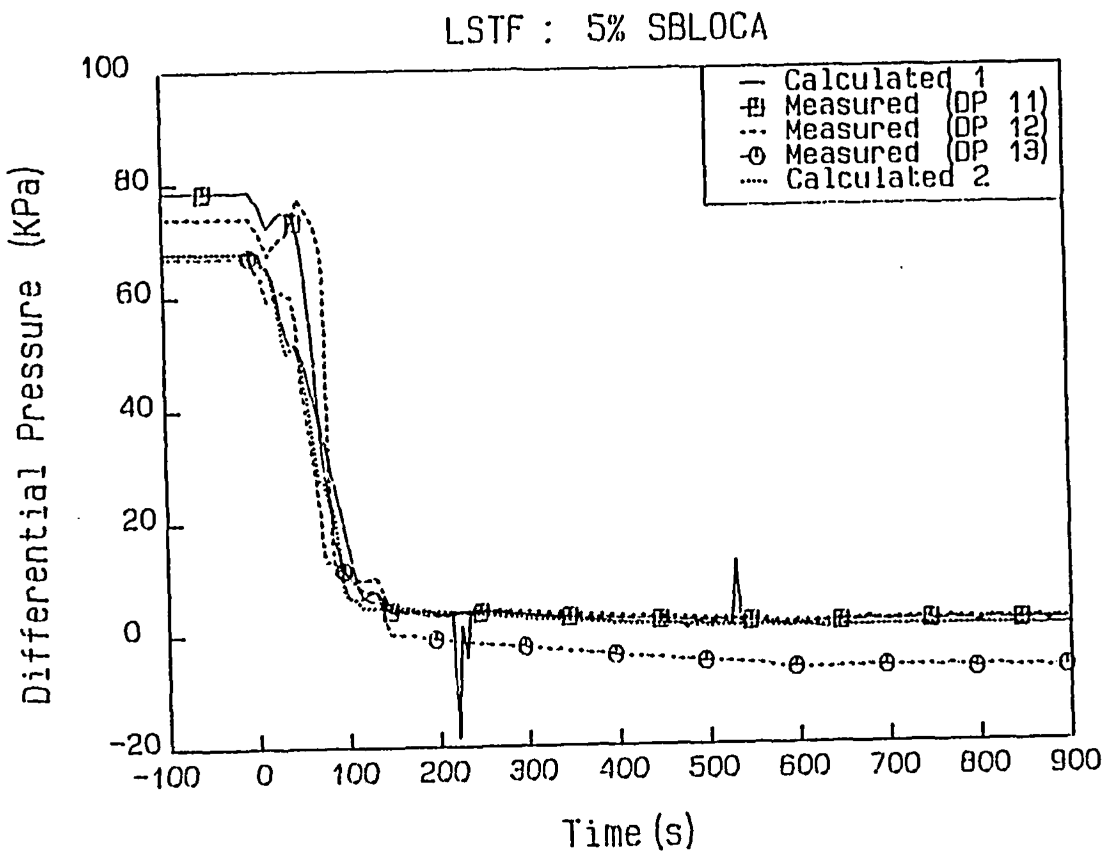

Fig. 7 SG-I Outlet - Tube Top Differential Pressure

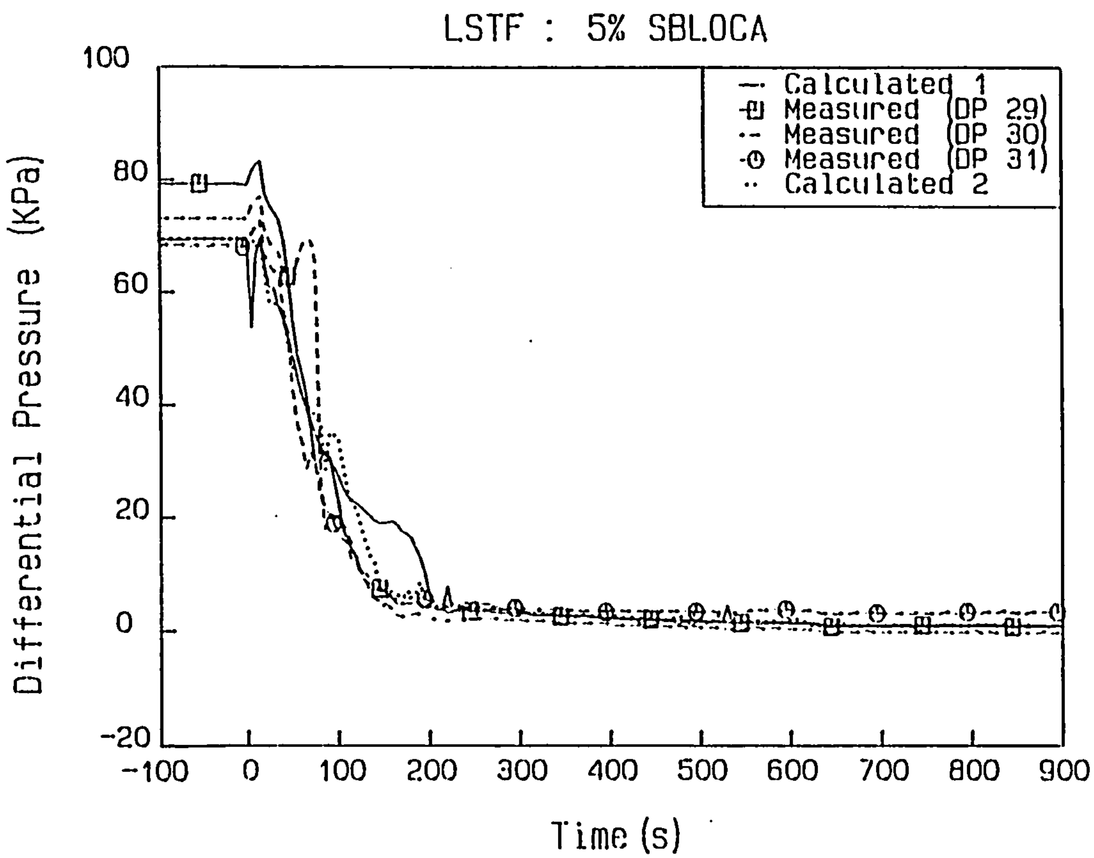

Fig. 8 SG-B Inlet - Tube Top Differential Pressure

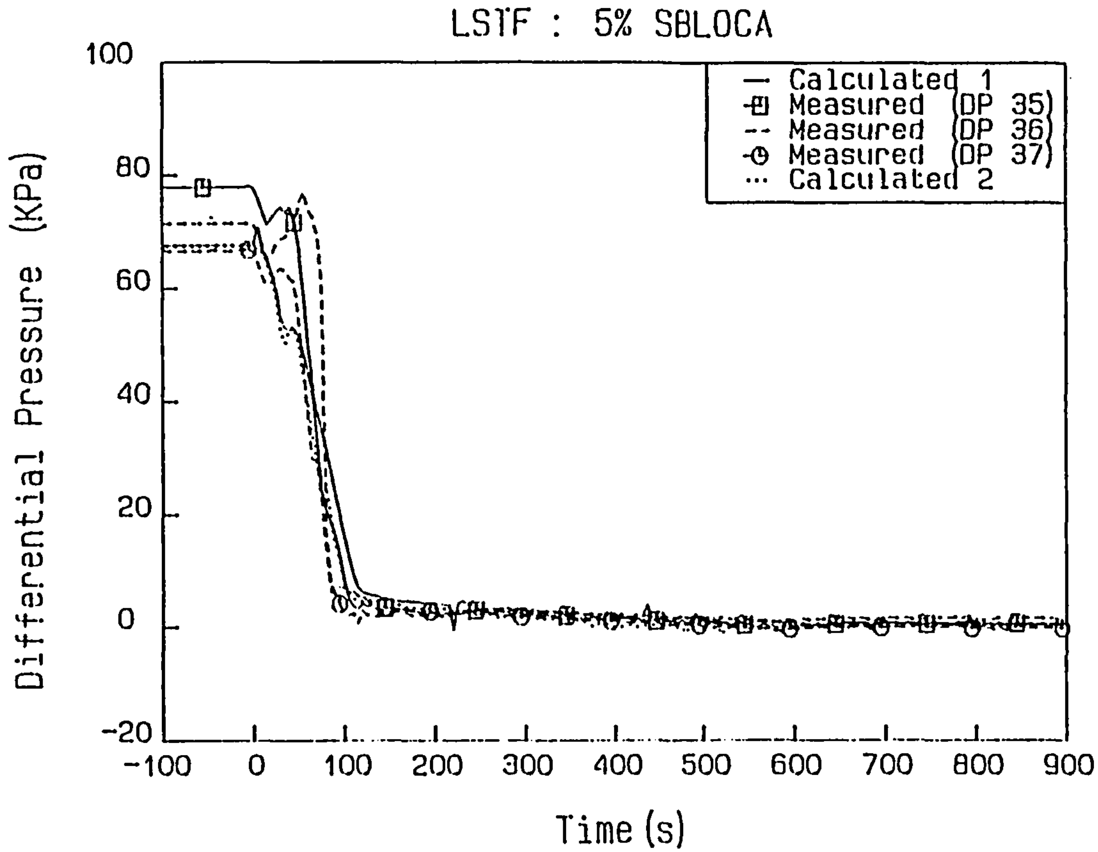

Fig. 9 SG-B Outlet - Tube Top Differential Pressure

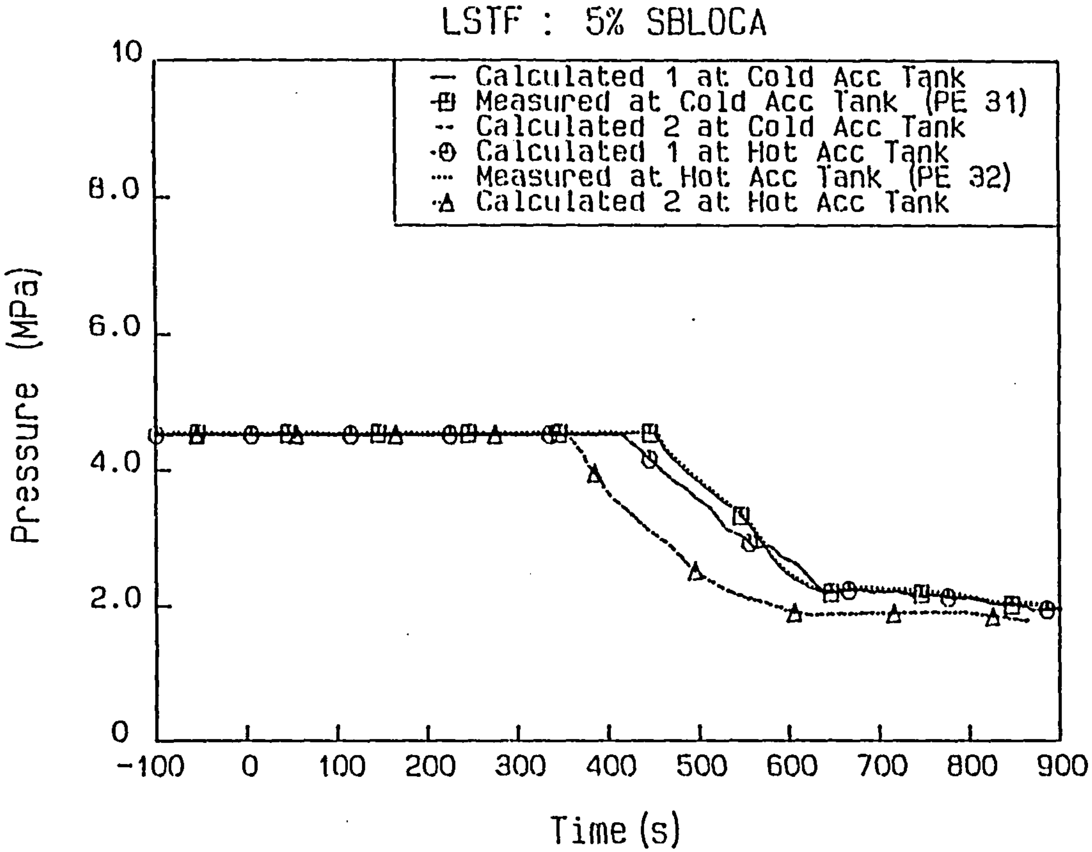

Fig. 10 Cold Acc Tank/Hot Acc tank Pressures

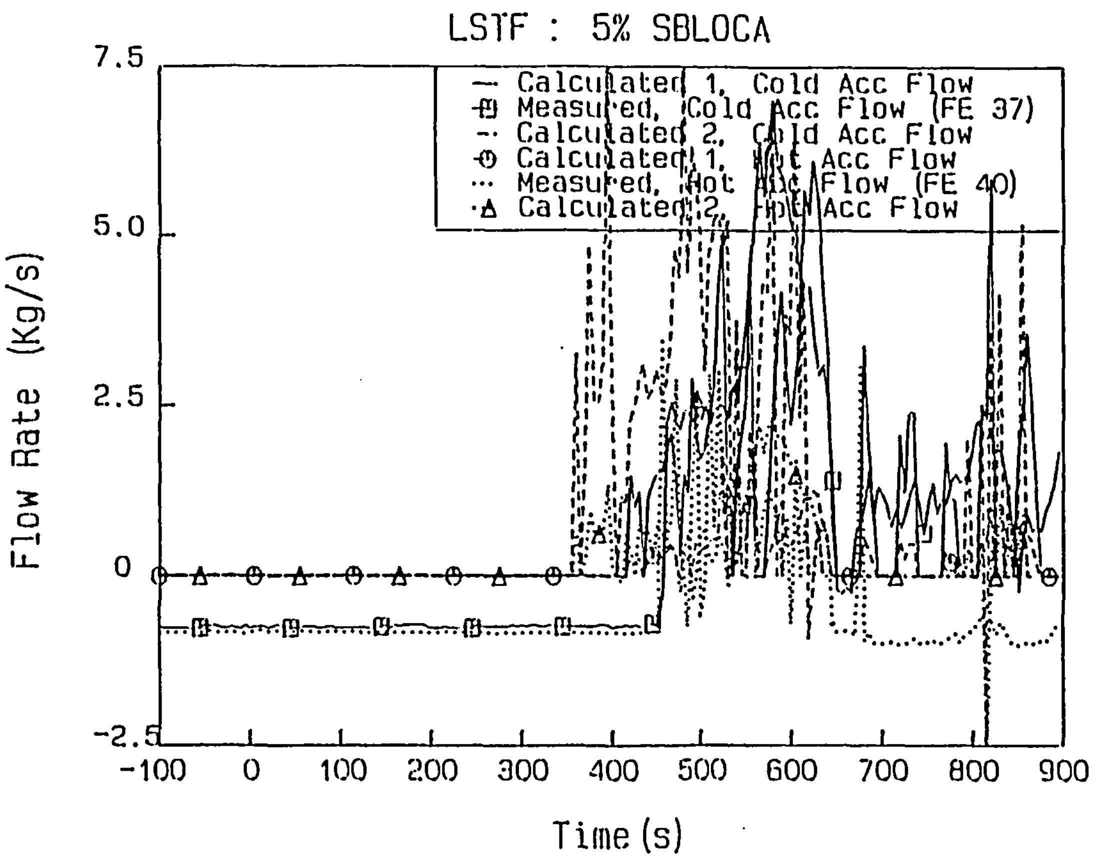

Fig.11 Acc Flow Rates

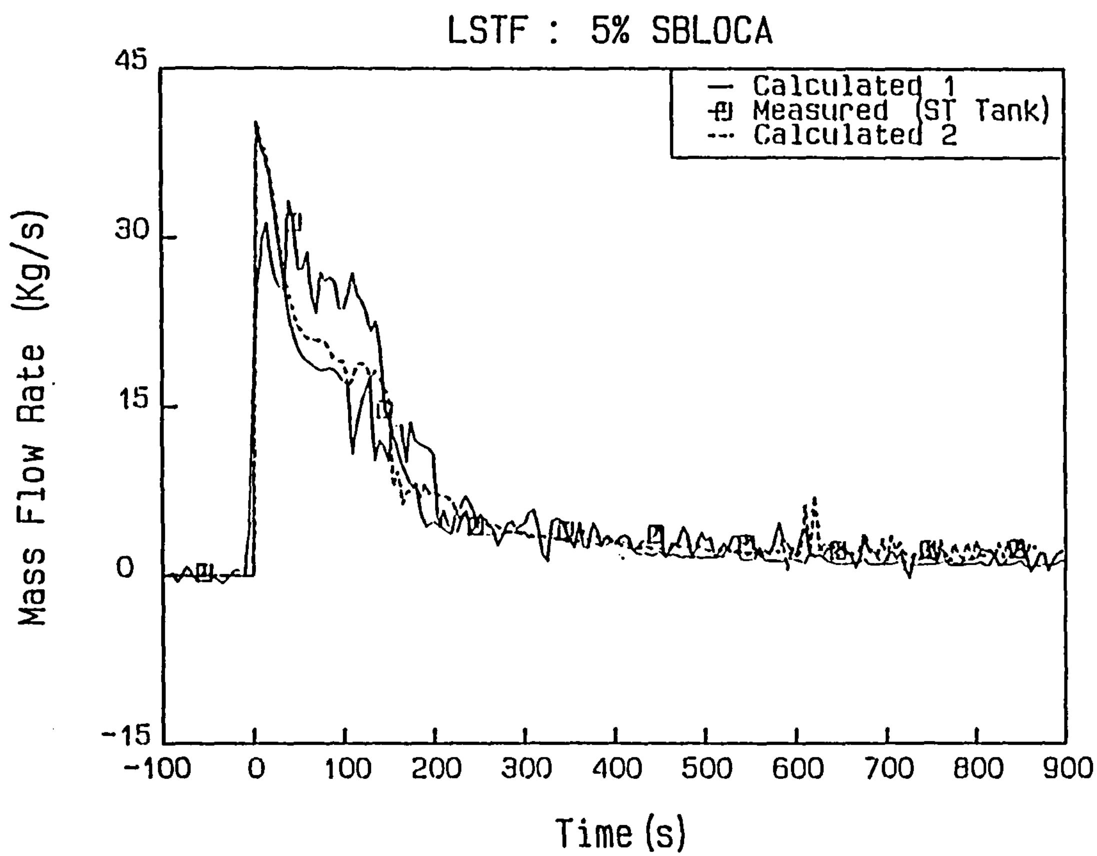

Fig. 12 Break Flow Calculated from Catch Tank Level Rise

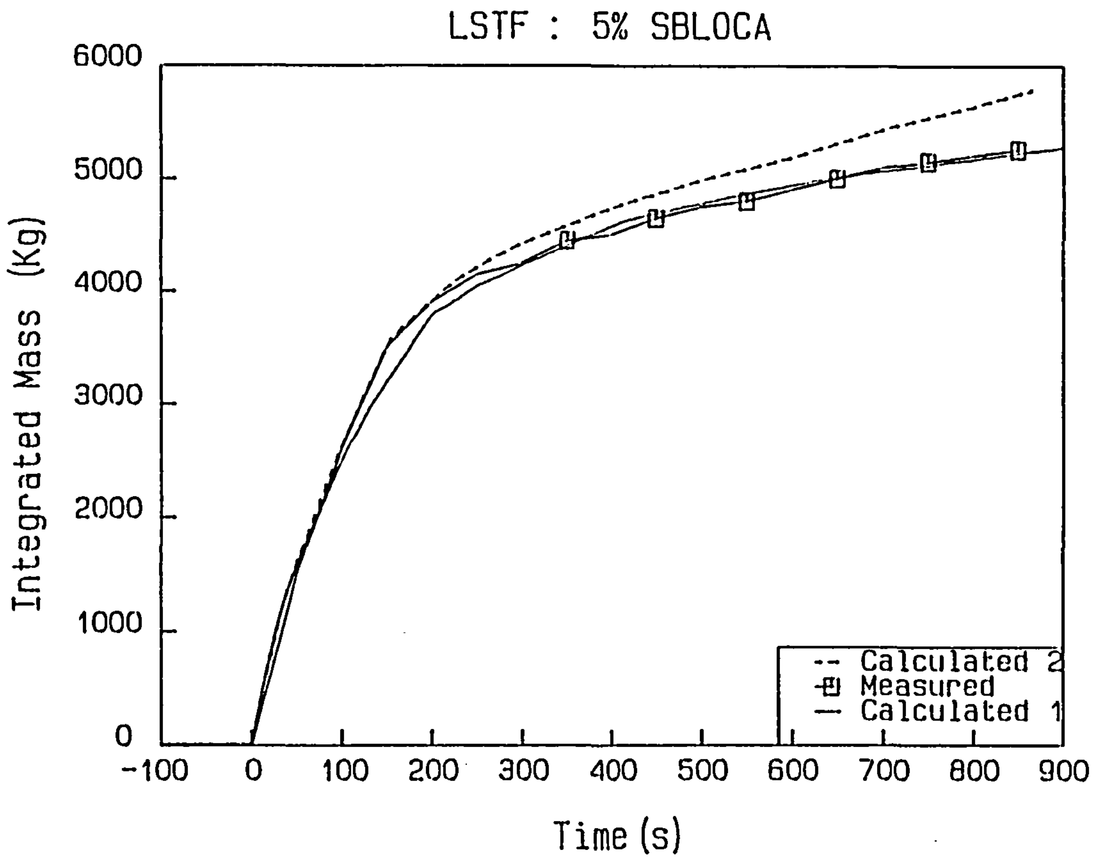

Fig. 13 Integrated Break Mass Flow

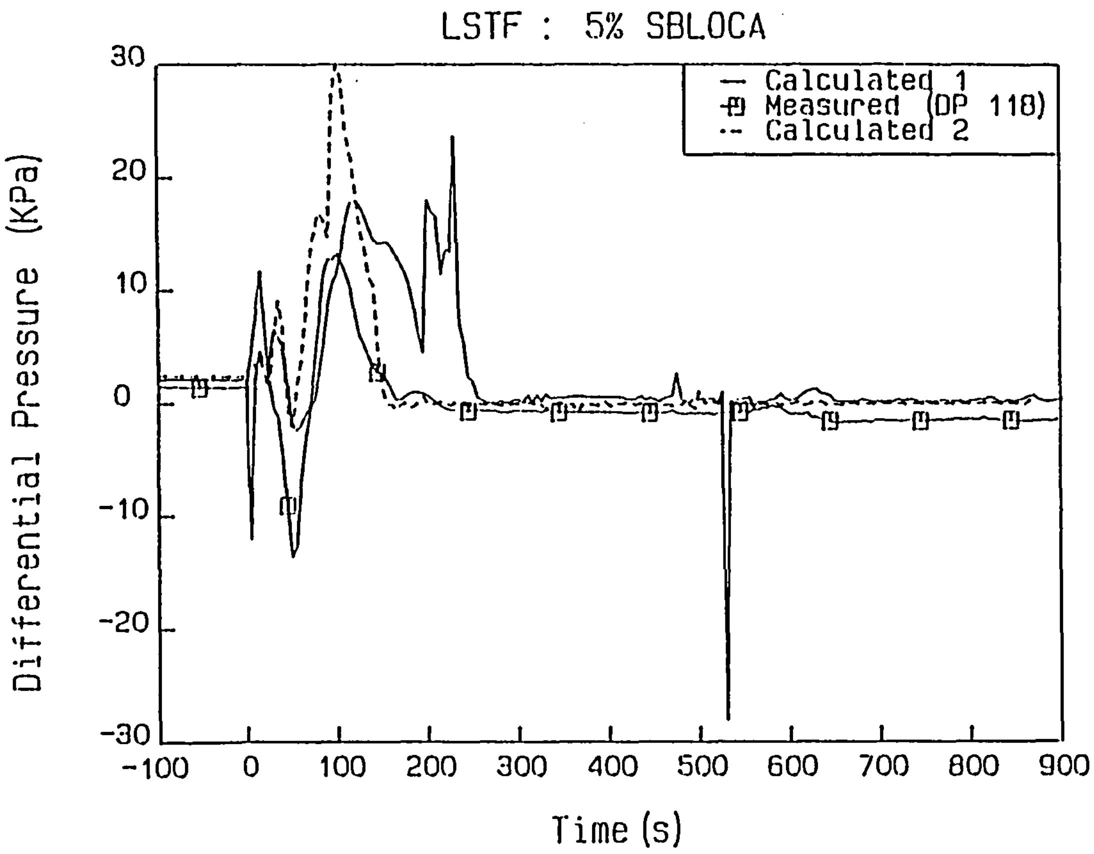

Fig.14 SG Pressure Difference

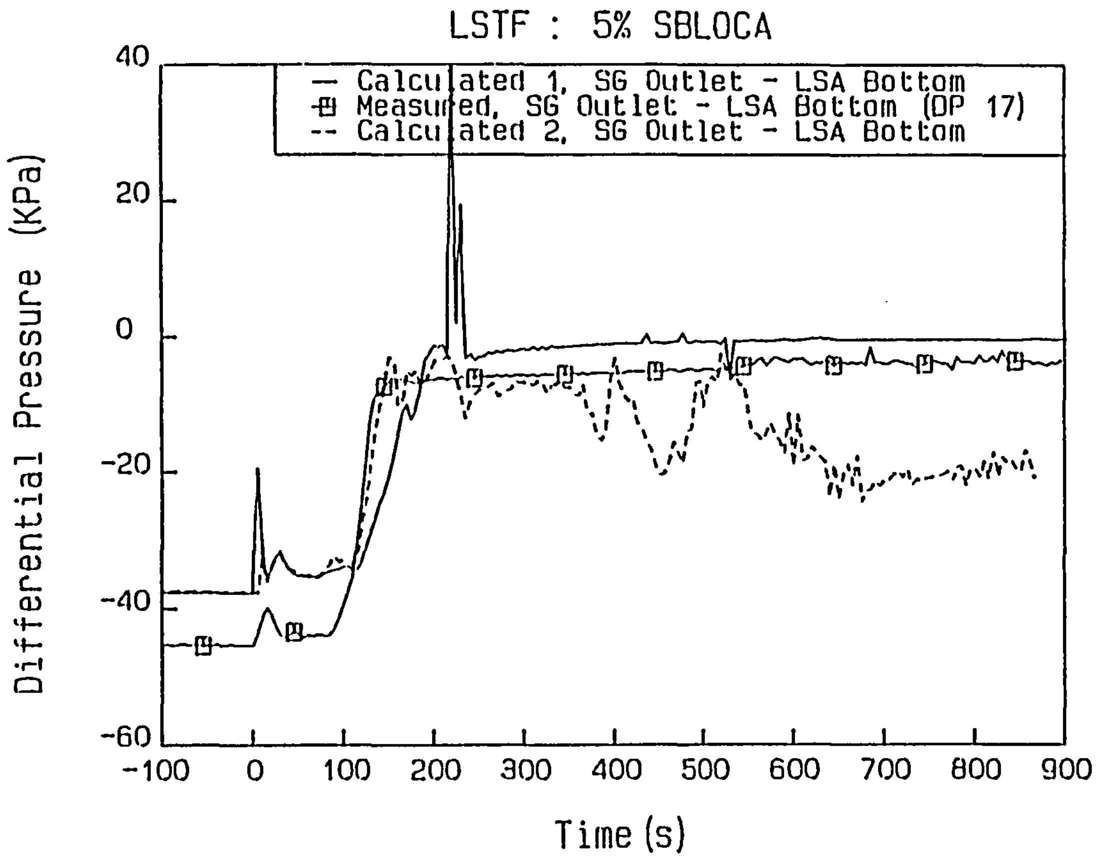

Fig. 15 Crossover Leg Downflow Differential Pressure

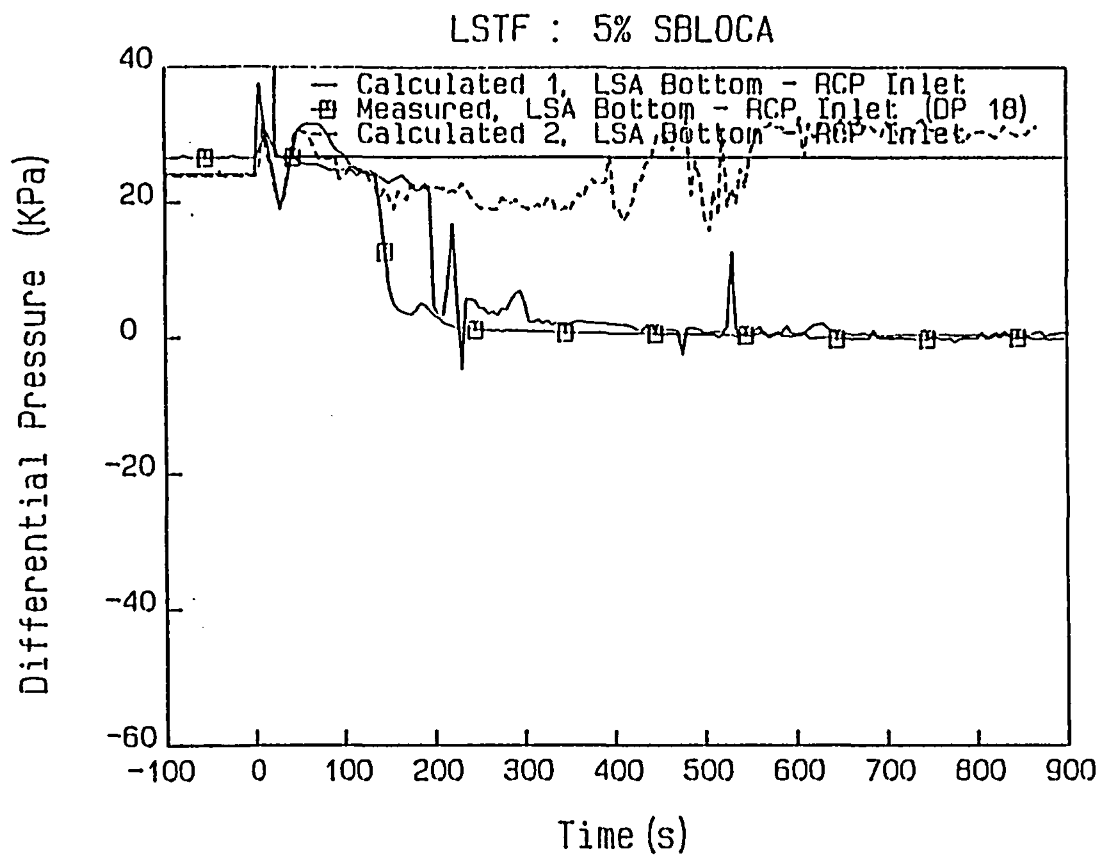

Fig.16 Crossover Leg Upflow Differential Pressure

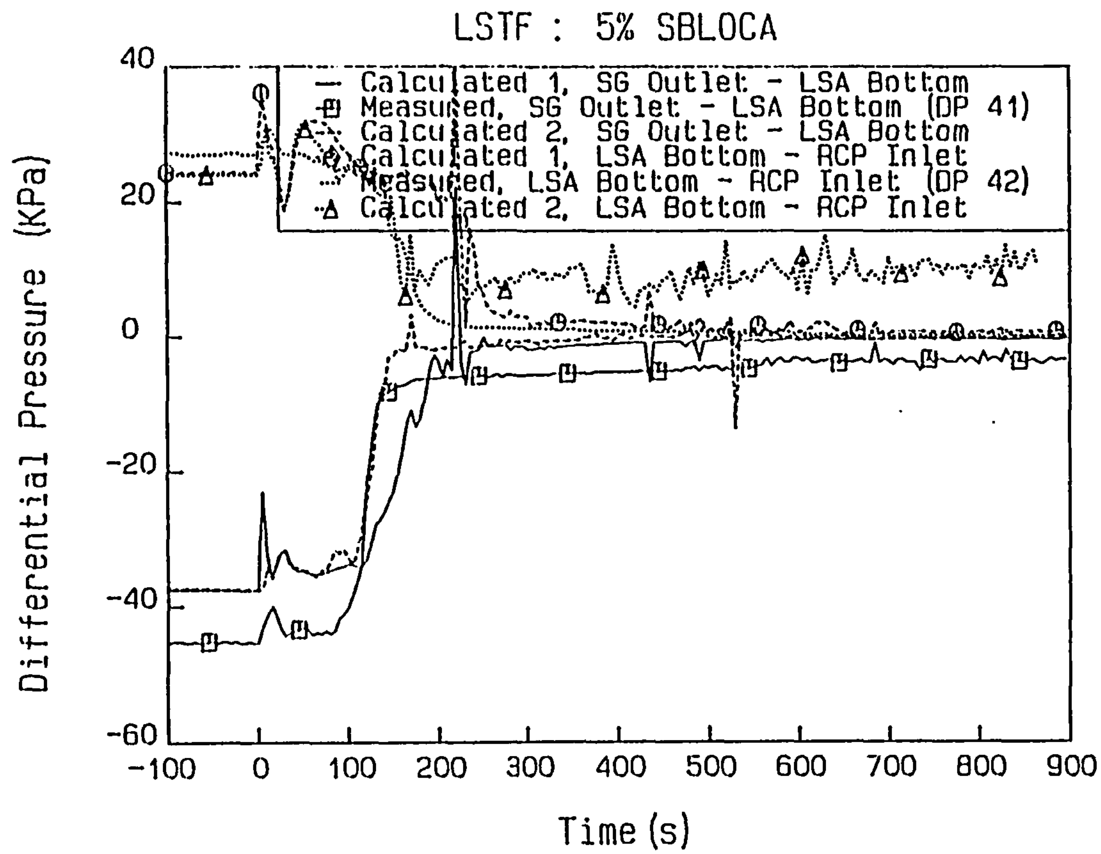

Fig. 17 Cold Leg-B Differential Pressure

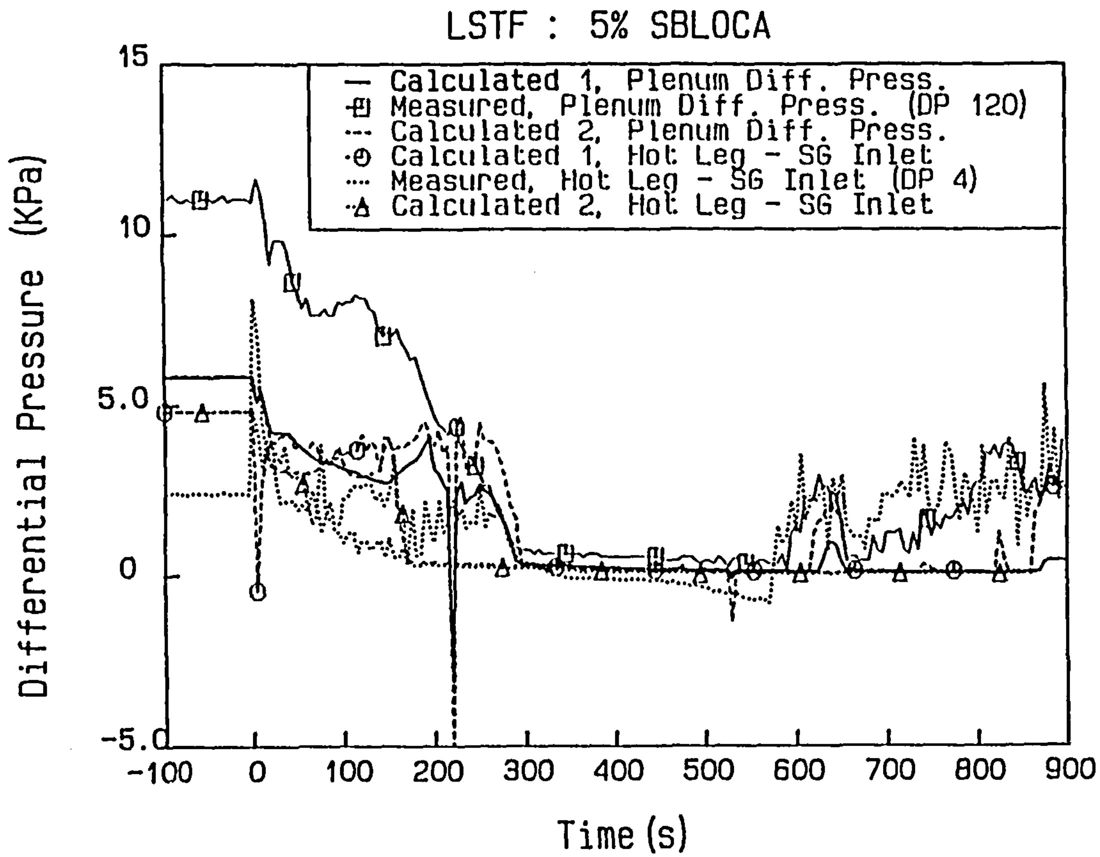

Fig. 18 SG-I Inlet Plenum Differential Pressure

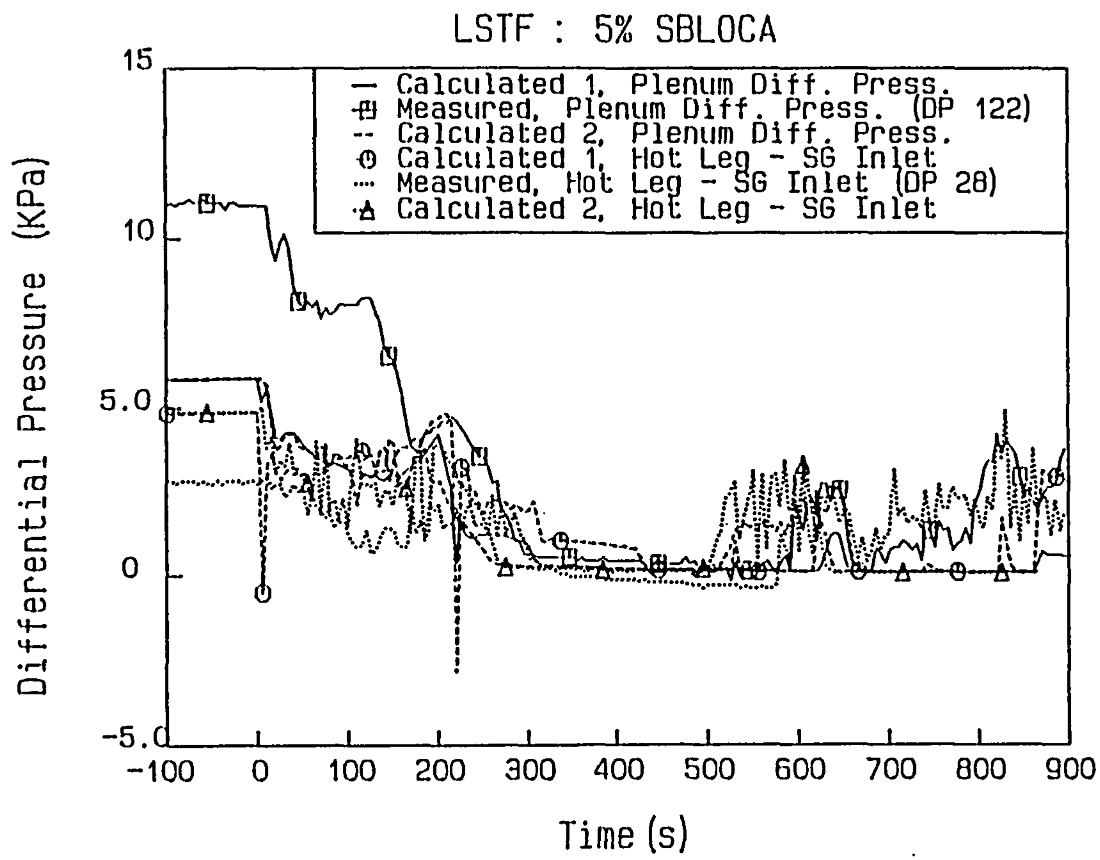

Fig. 19 SG-B Inlet Plenum Differential Pressures

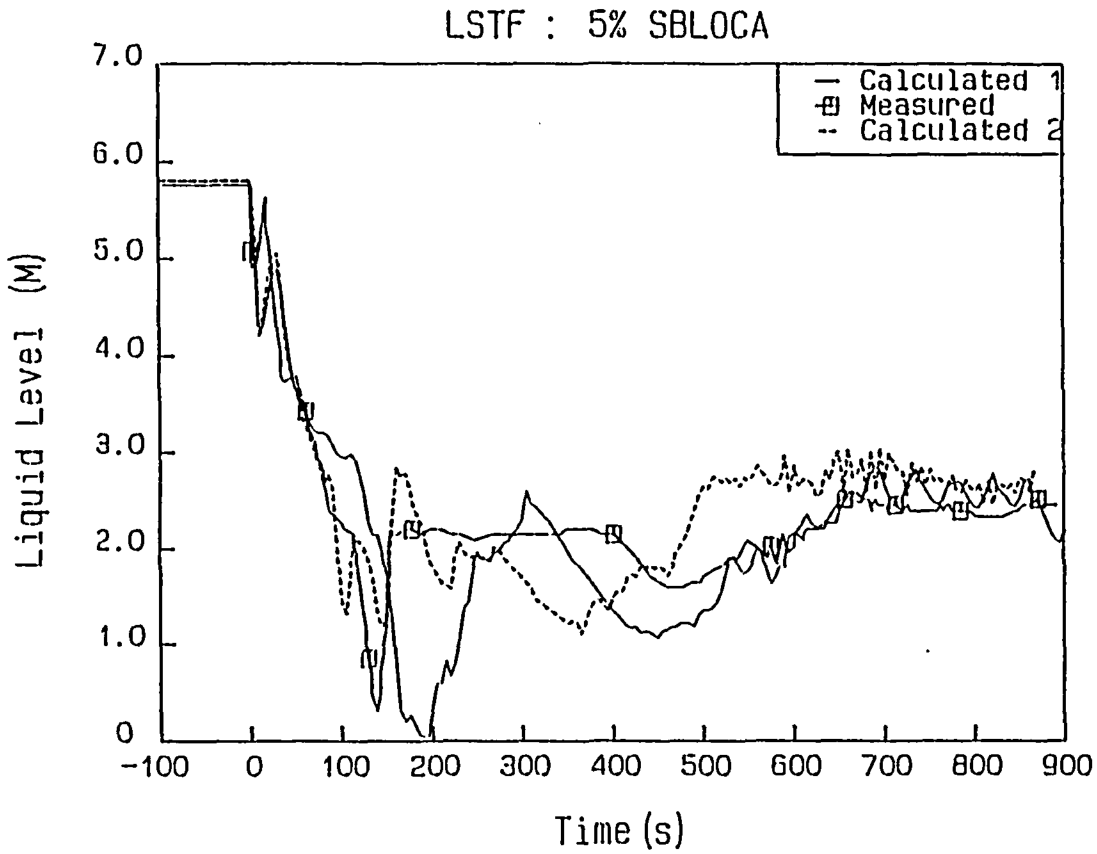

Fig. 20 Core Collapsed Liquid Level

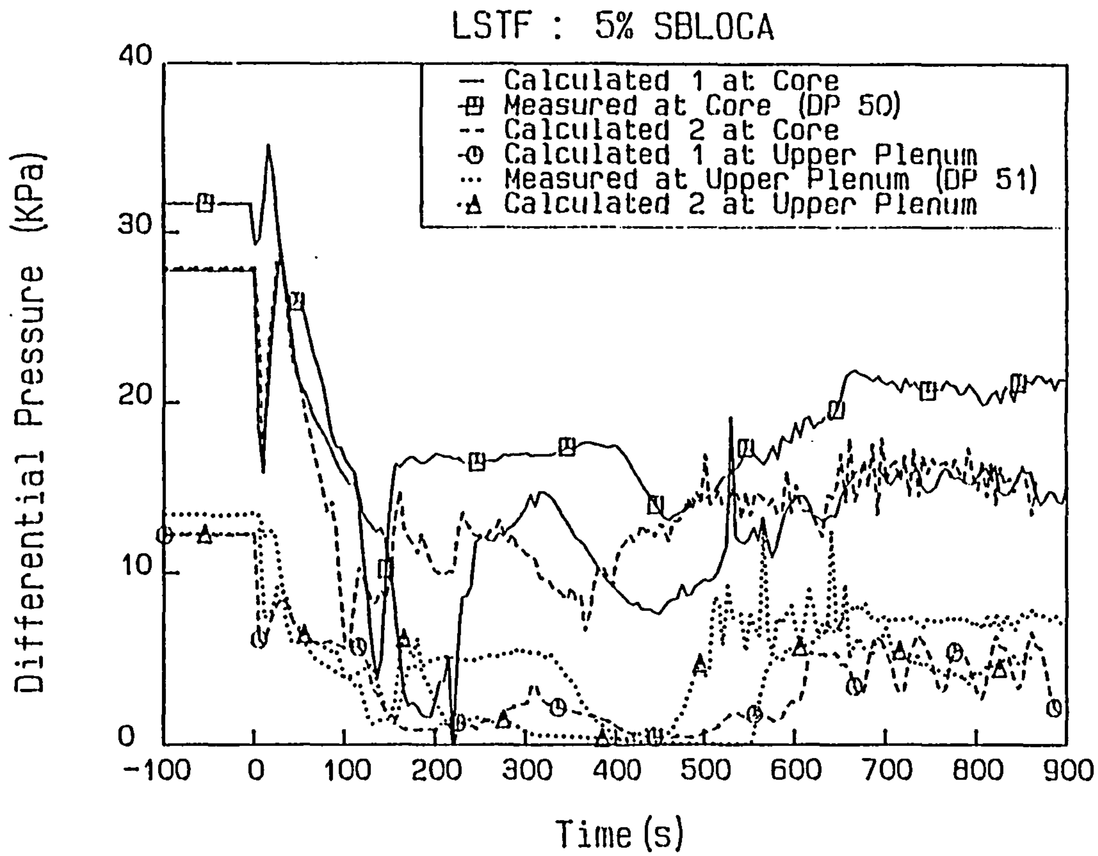

Fig.21 Core and Upper Plenum Differential Pressures

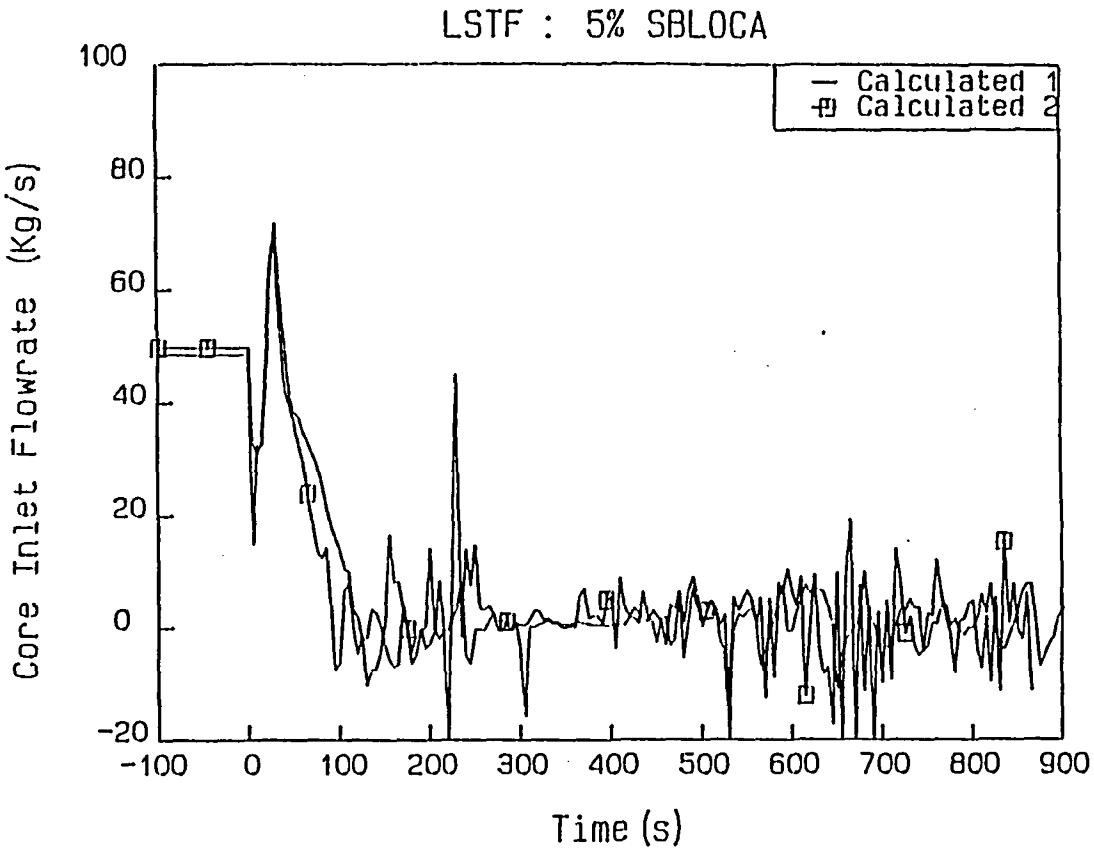

Fig. 22 Core Inlet Flow Rate

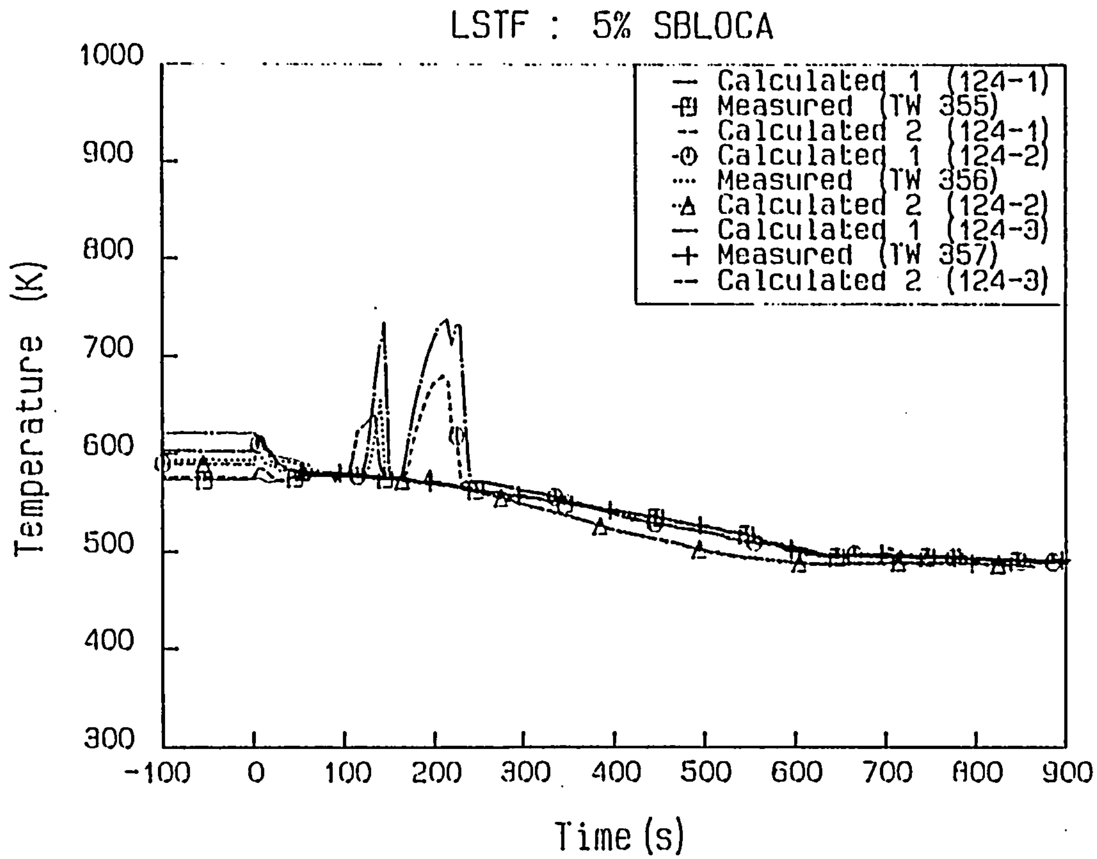

Fig. 23 Rod Surface Temperatures - A

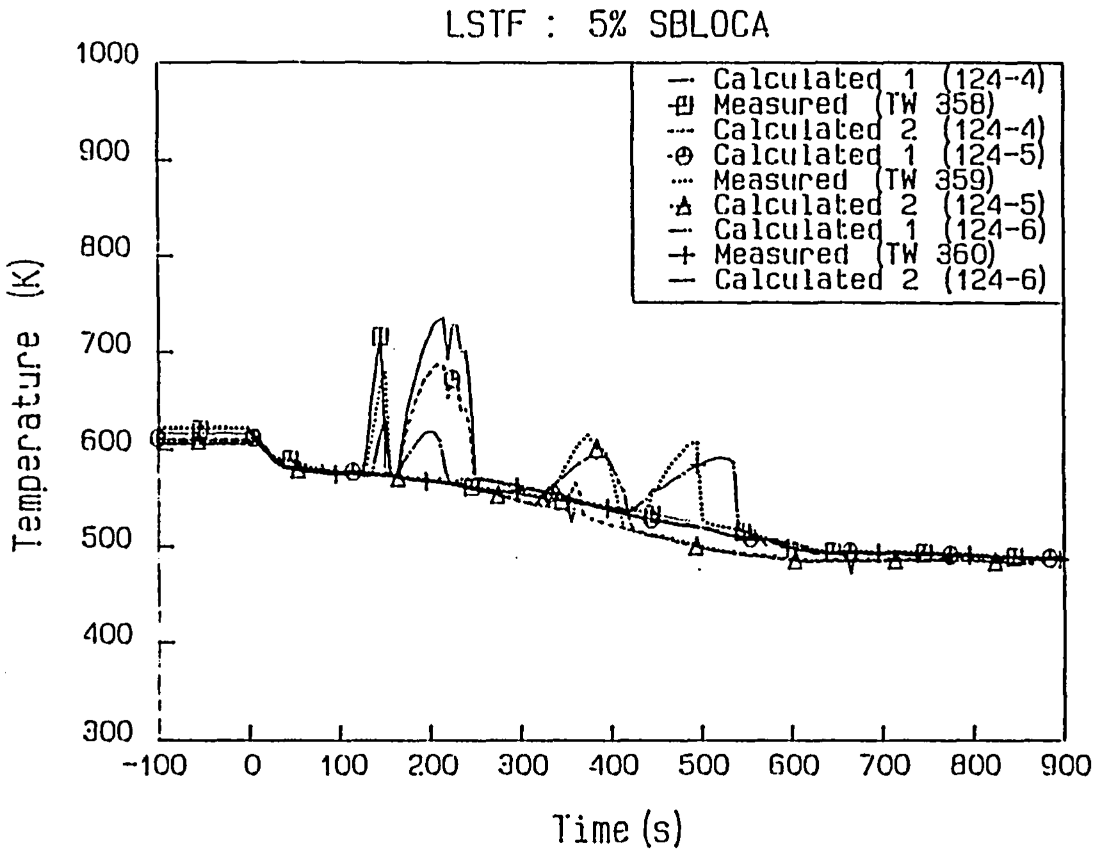

Fig. 24 Rod Surface Temperatures - B

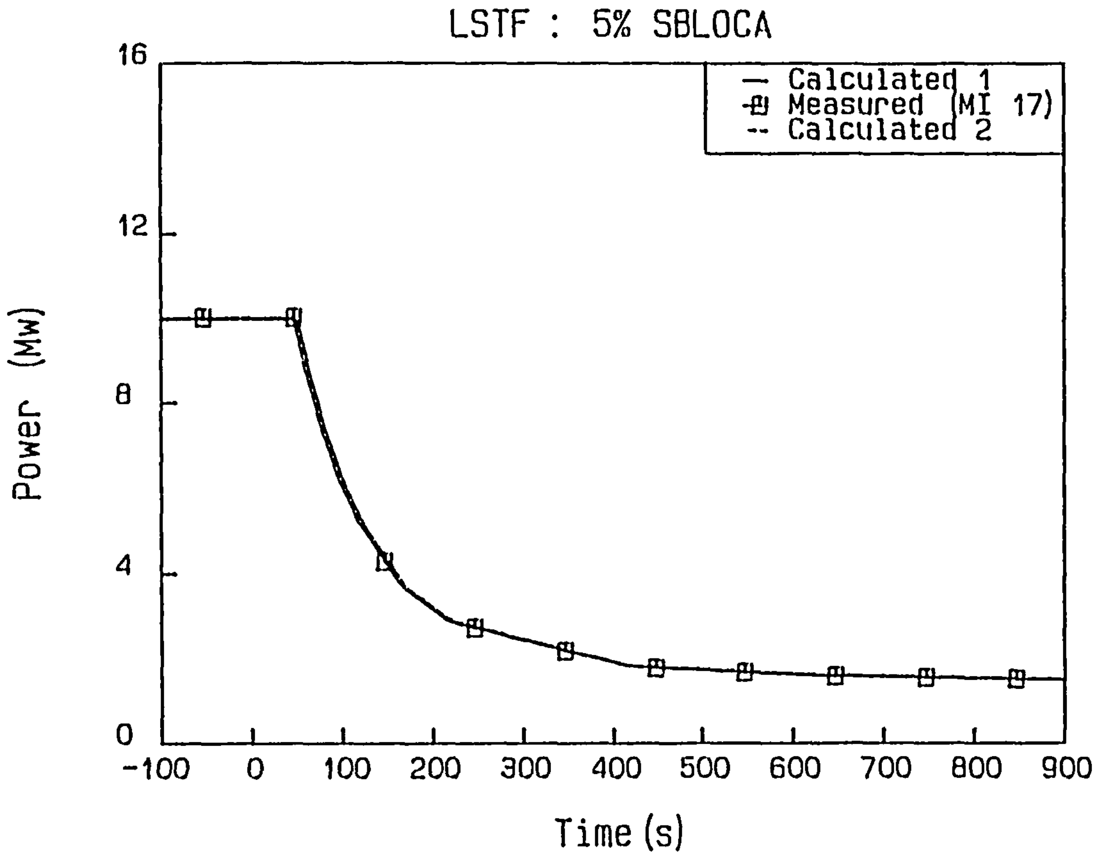

Fig. 25 Total Core Power

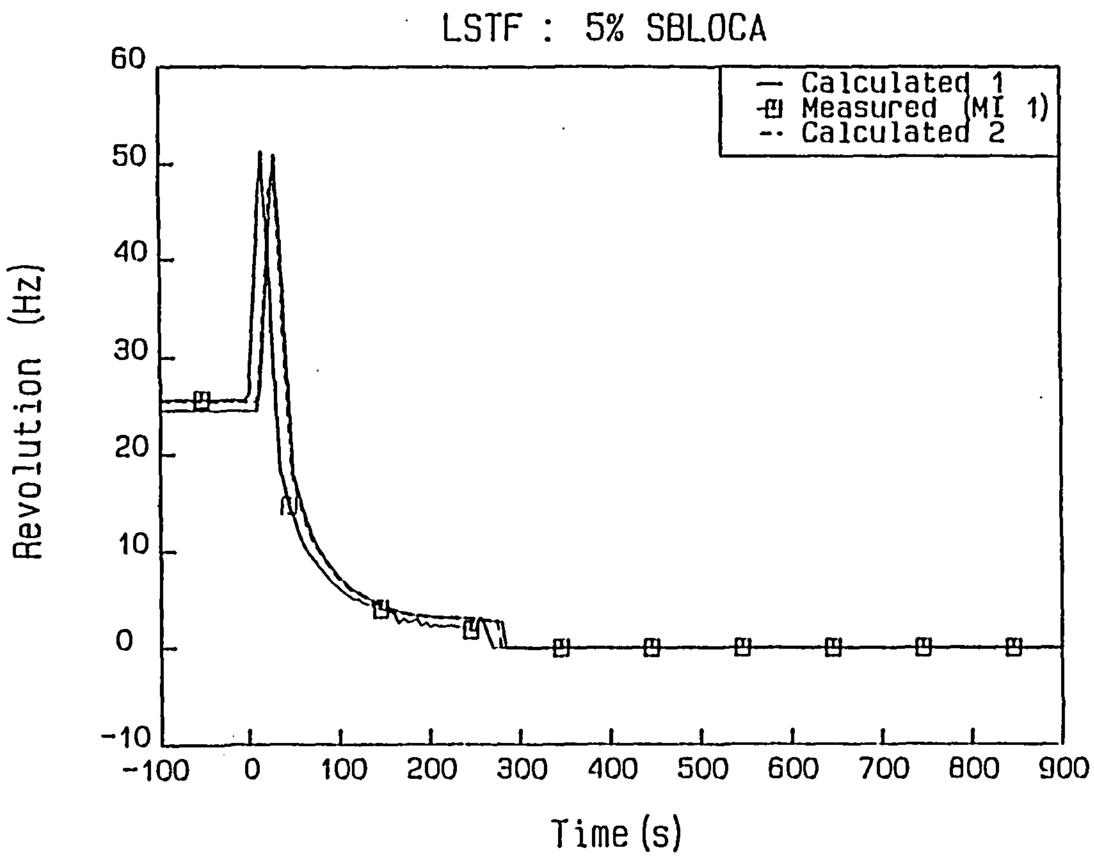

Fig. 26 RCP Rotation Speed in Primary Loop I (1Hz=30RPM)

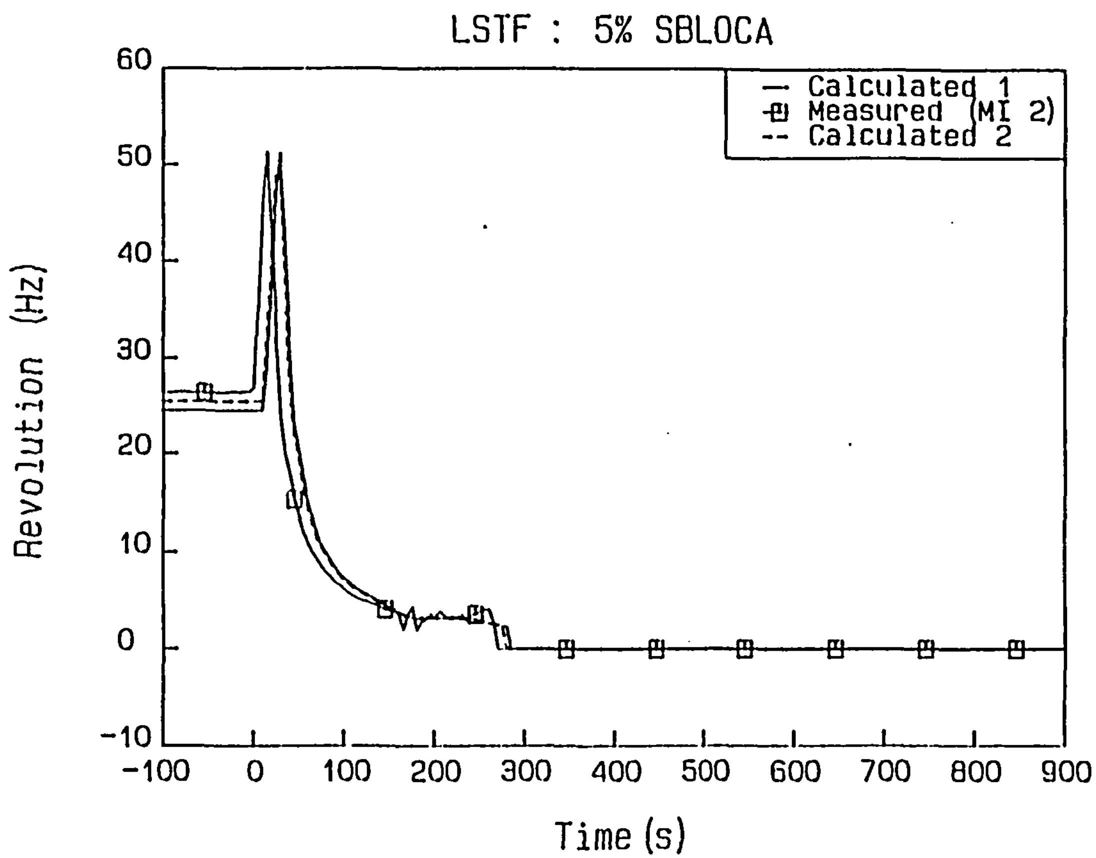

Fig. 27 RCP Rotation Speed in Primary Loop B (1Hz=30RPM)

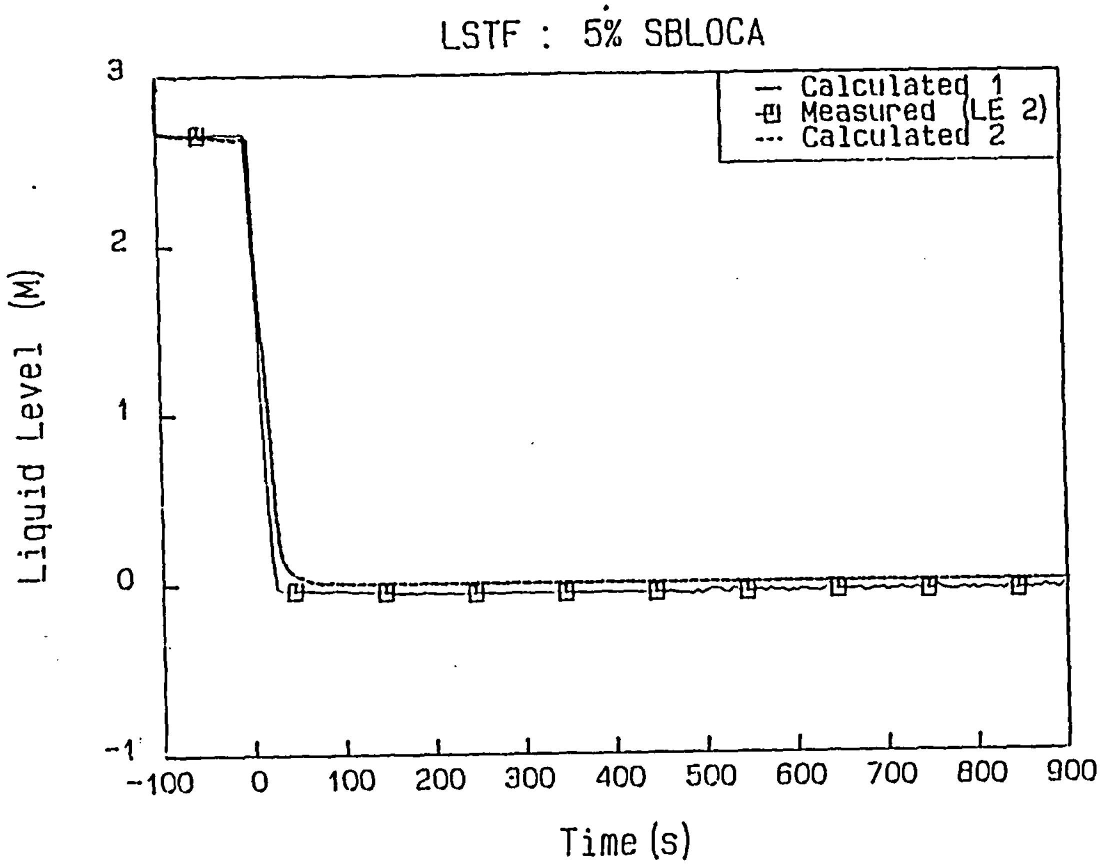

Fig. 28 Pressurizer Liquid Level

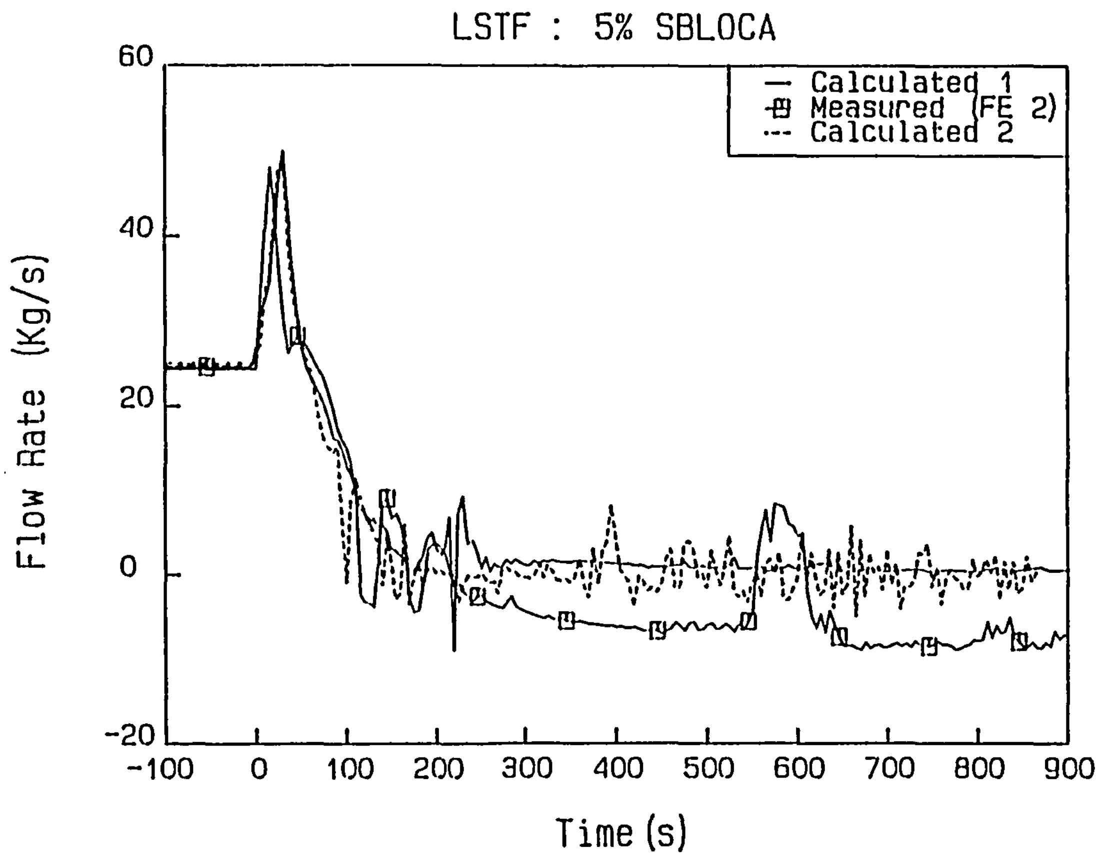

Fig. 29 Primary Loop I Flow Rate

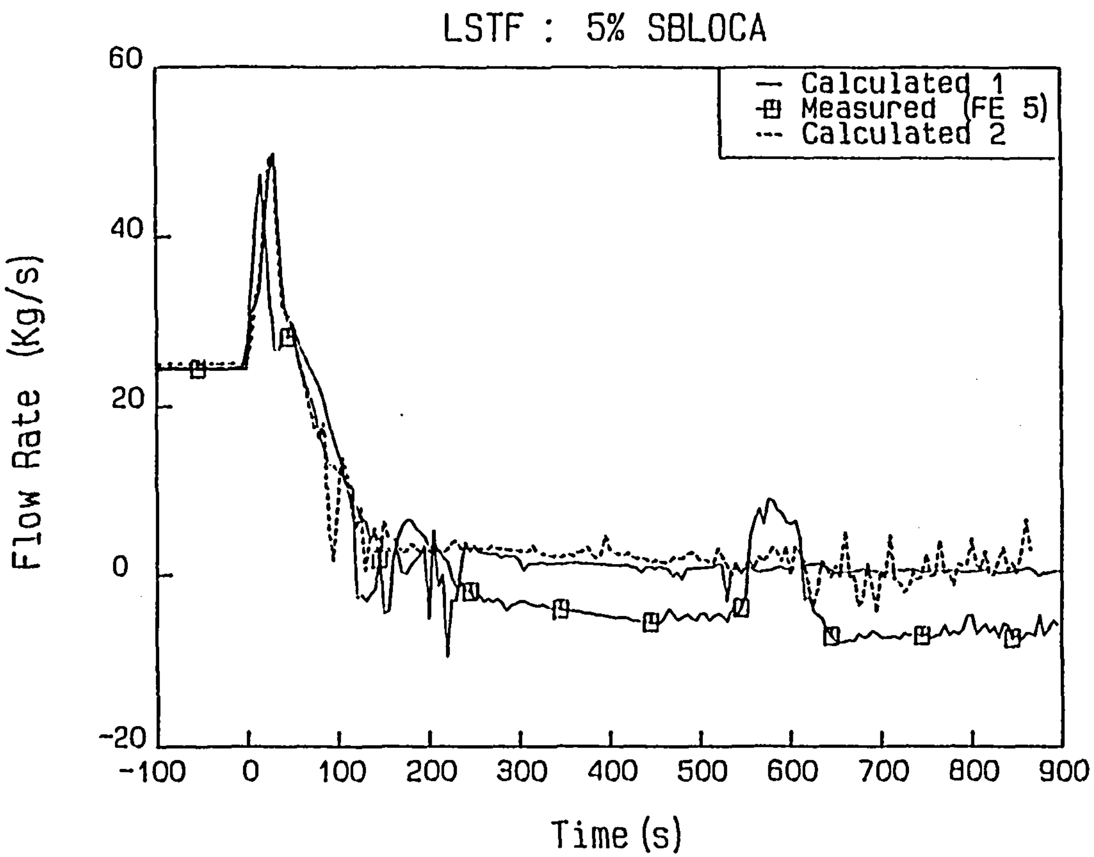

Fig.30 Primary Loop B Flow Rate

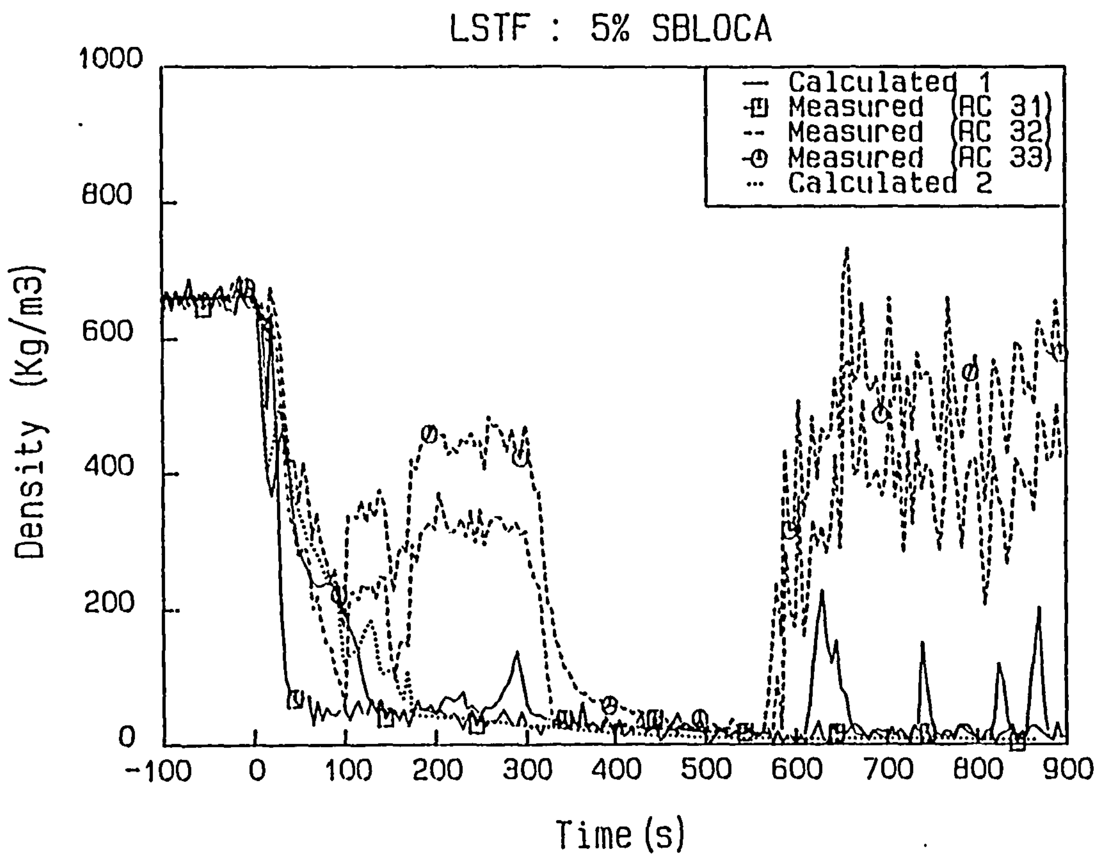

Fig. 31 Density in Hot Leg I

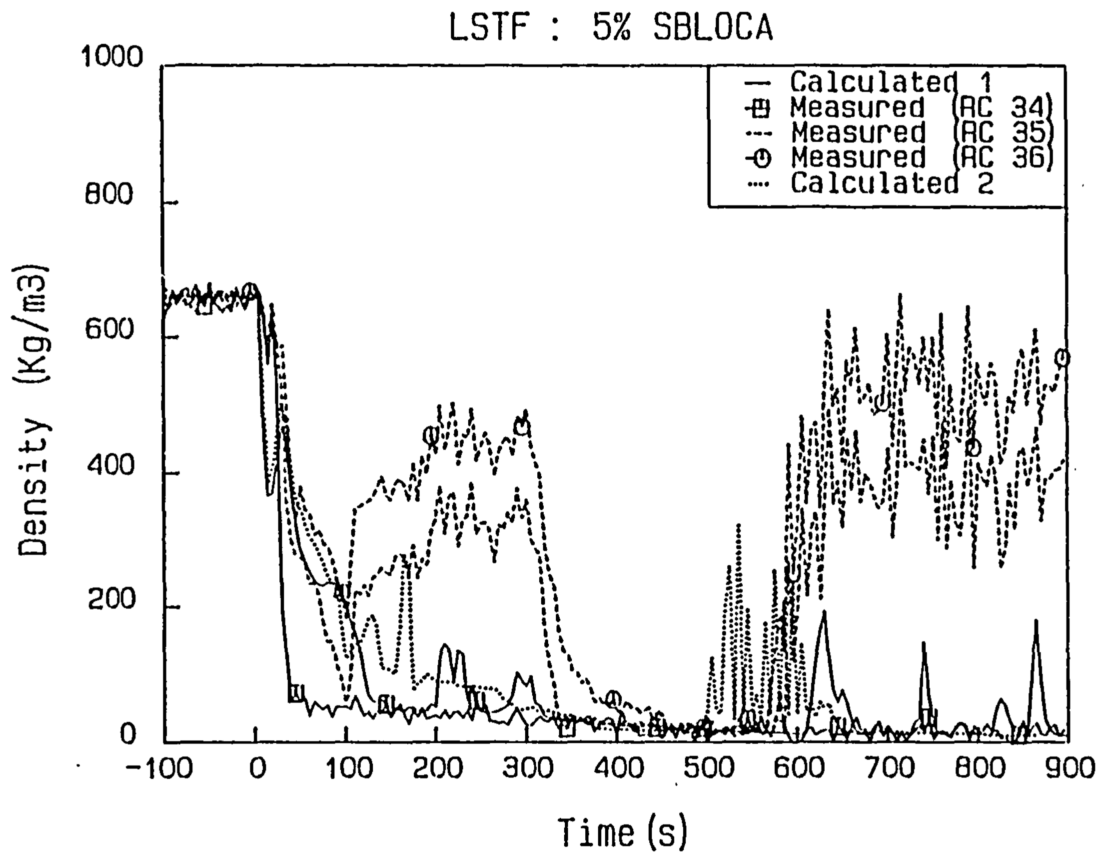

Fig.32 Density in Hot Leg B

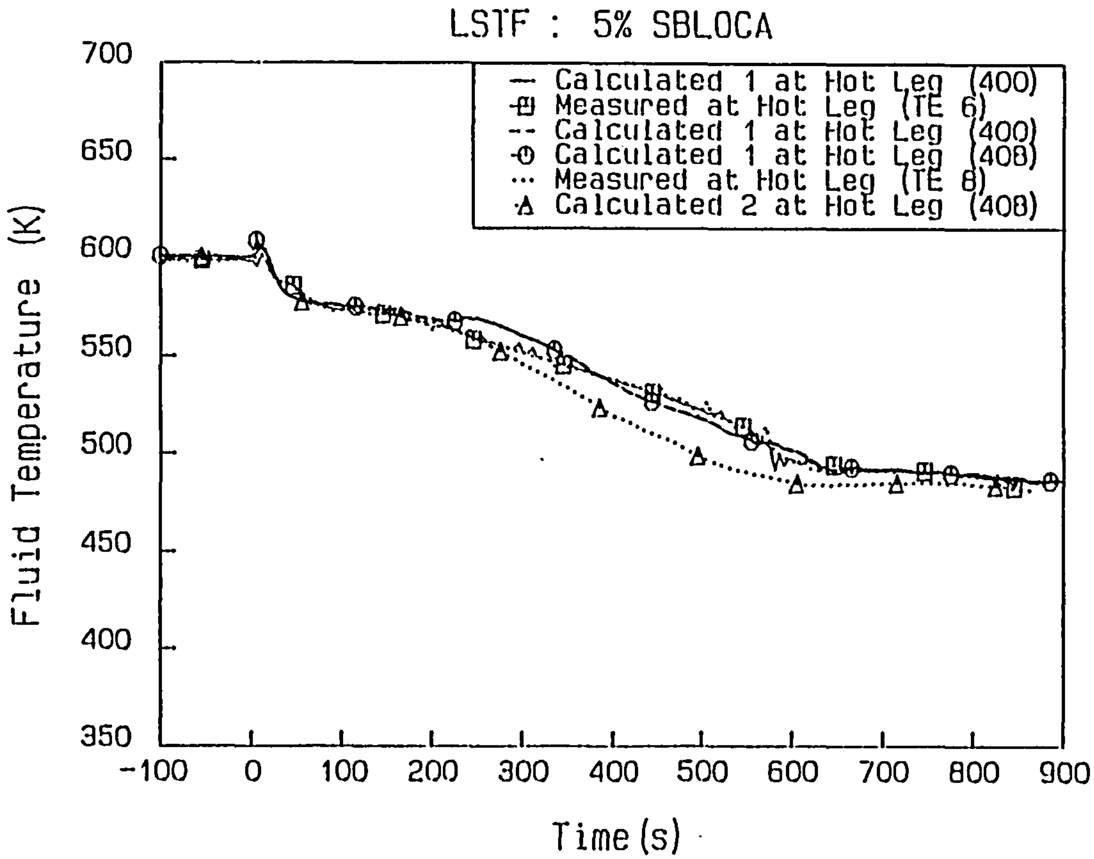

Fig.33 Hot Leg-I Fluid Temperatures

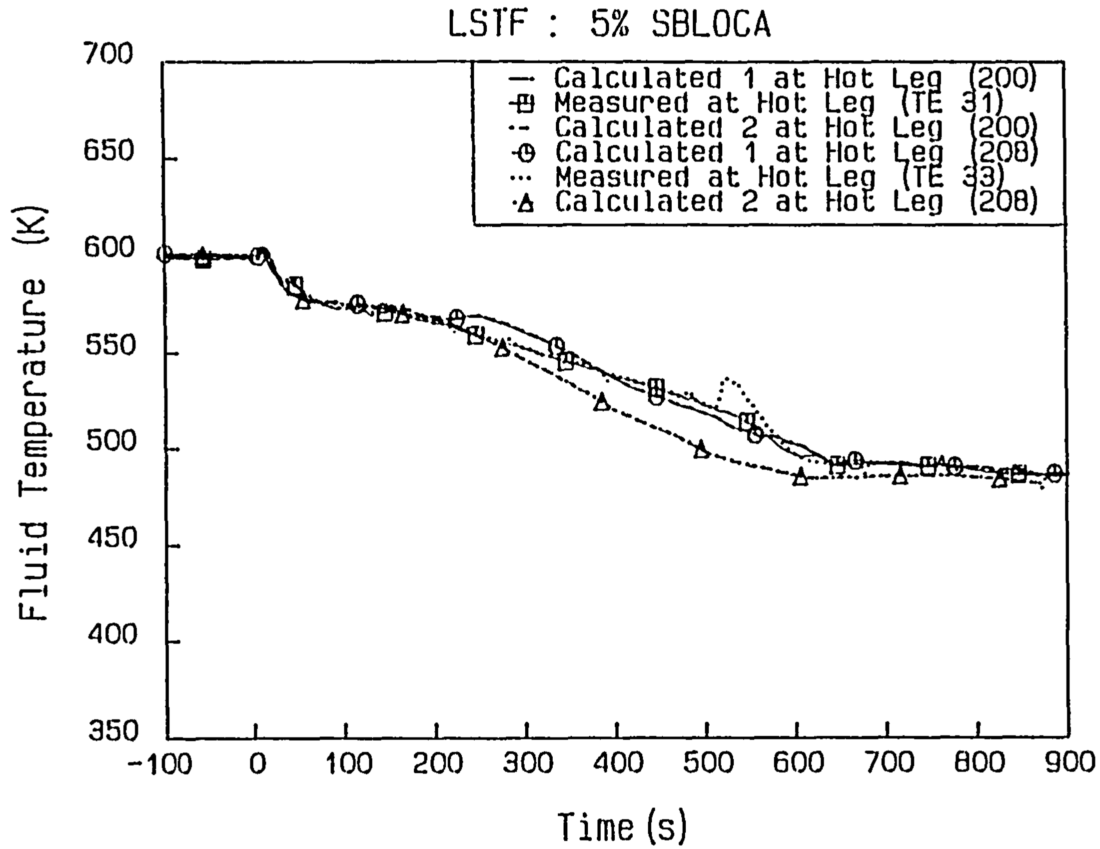

Fig. 34 Hot Leg-B Fluid Temperatures

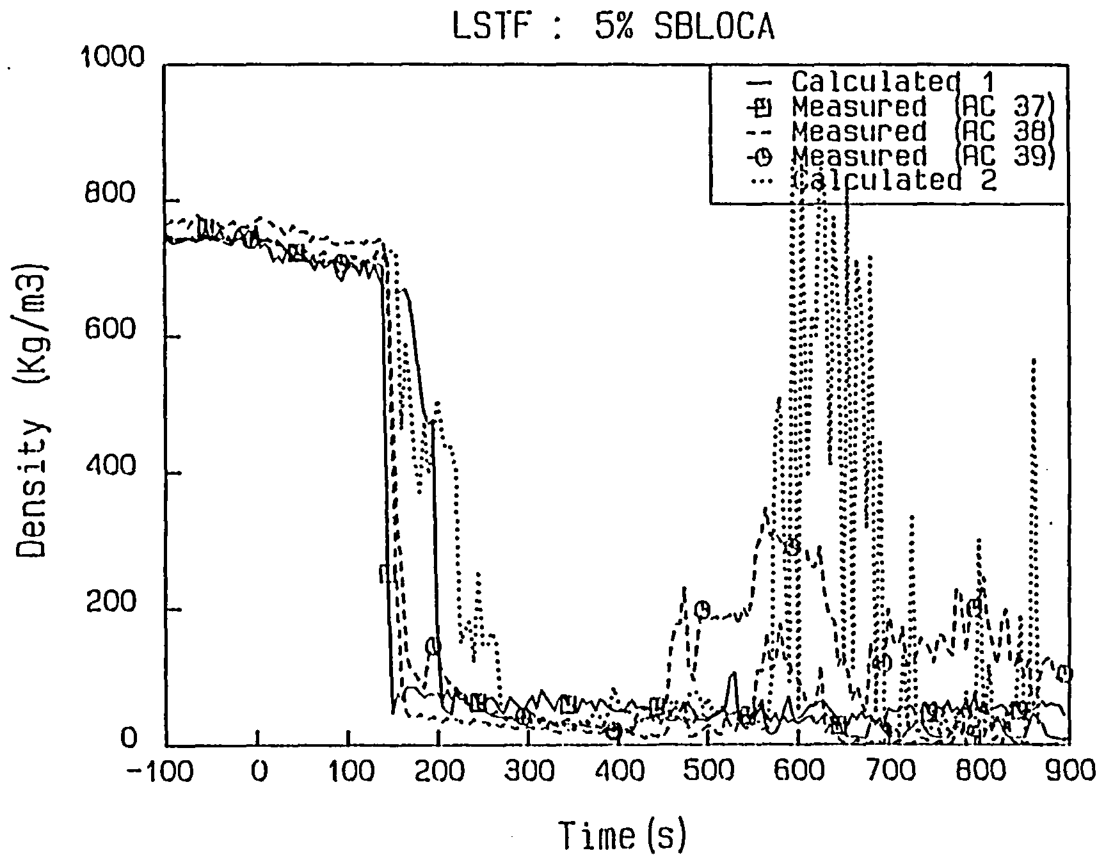

Fig. 35 Density in Cold Leg I

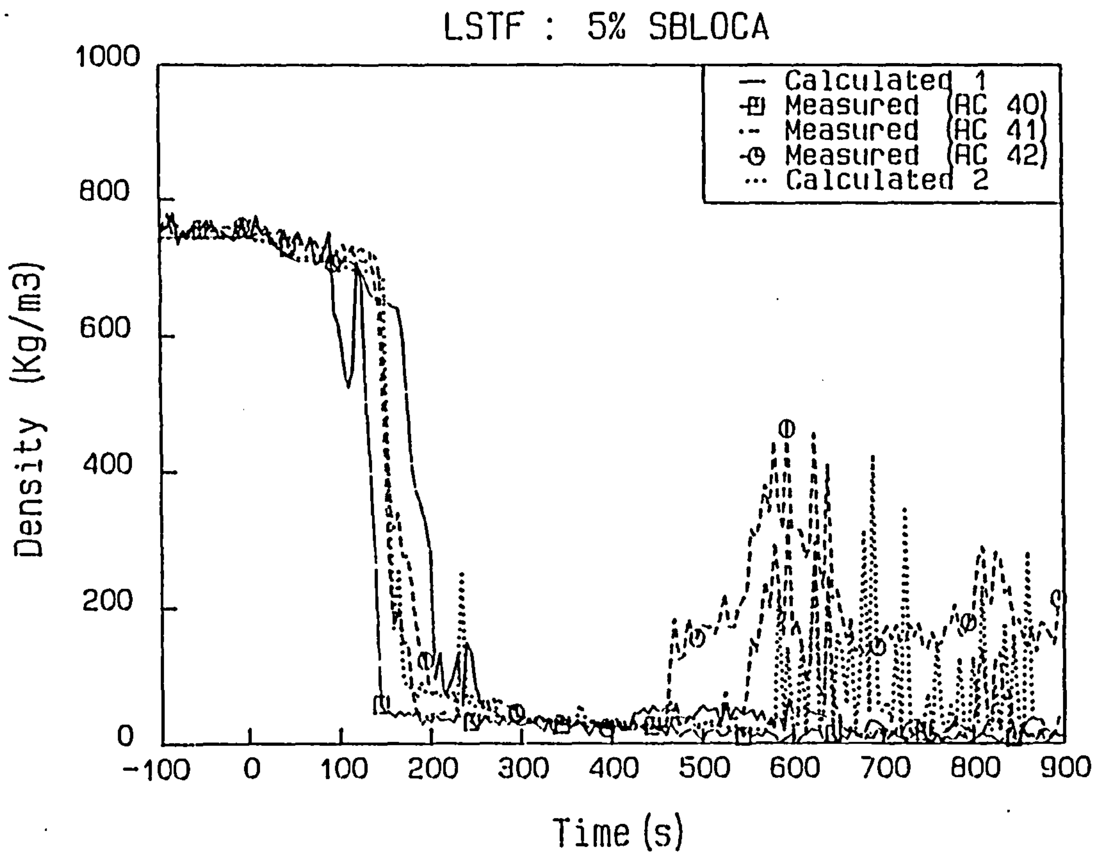

Fig. 36 Density in Cold Leg B

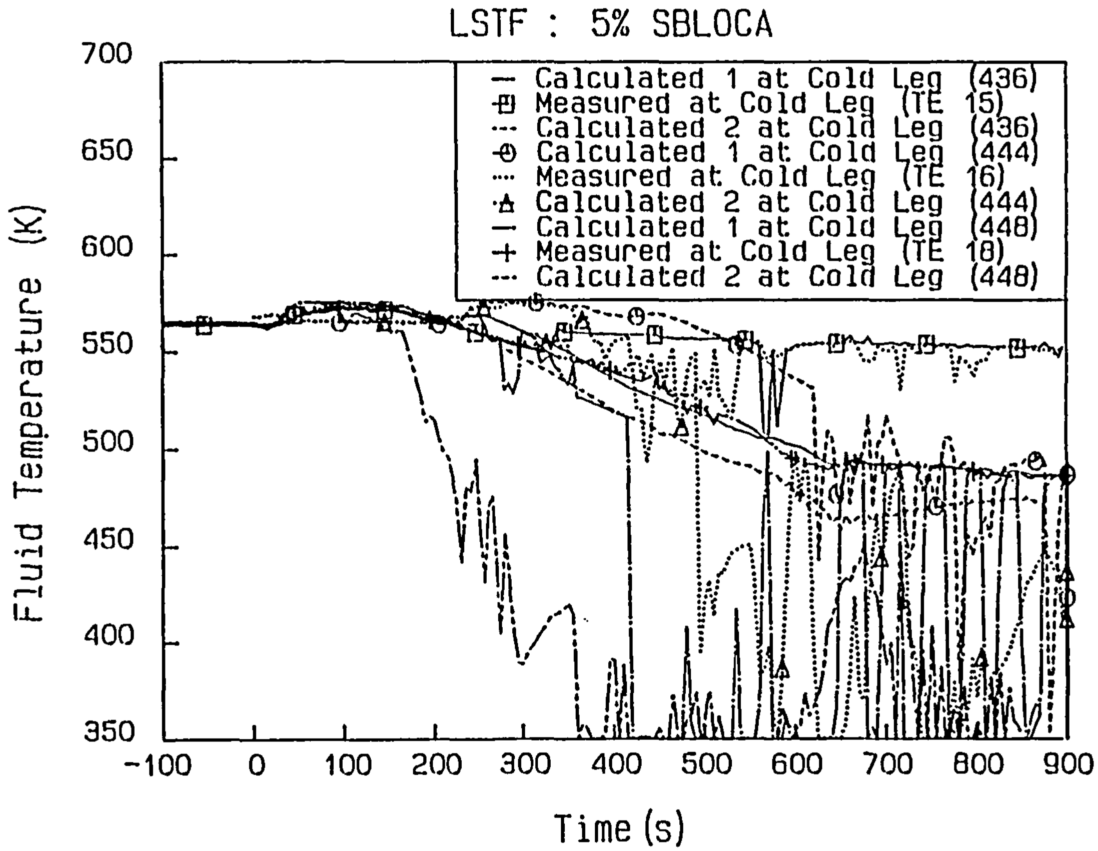

Fig.37 Cold Leg-I Fluid Temperatures

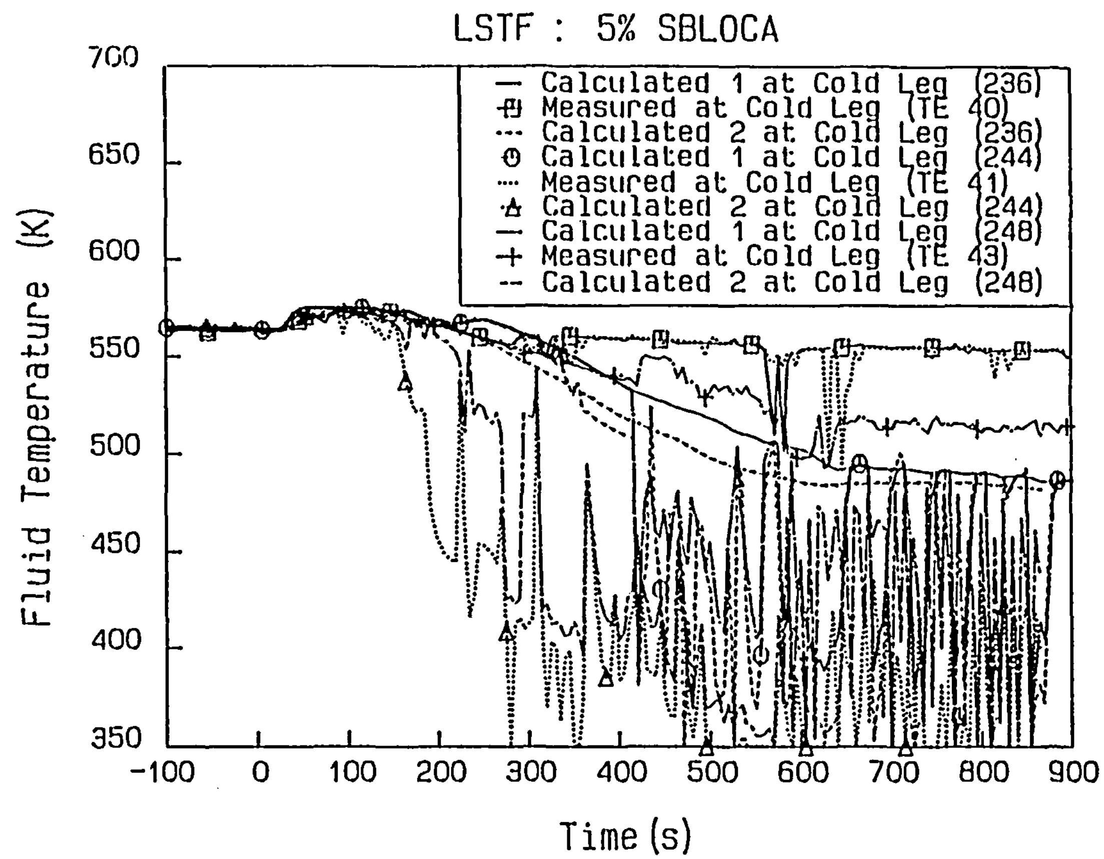

Fig. 38 Cold Leg-B Fluid Temperatures

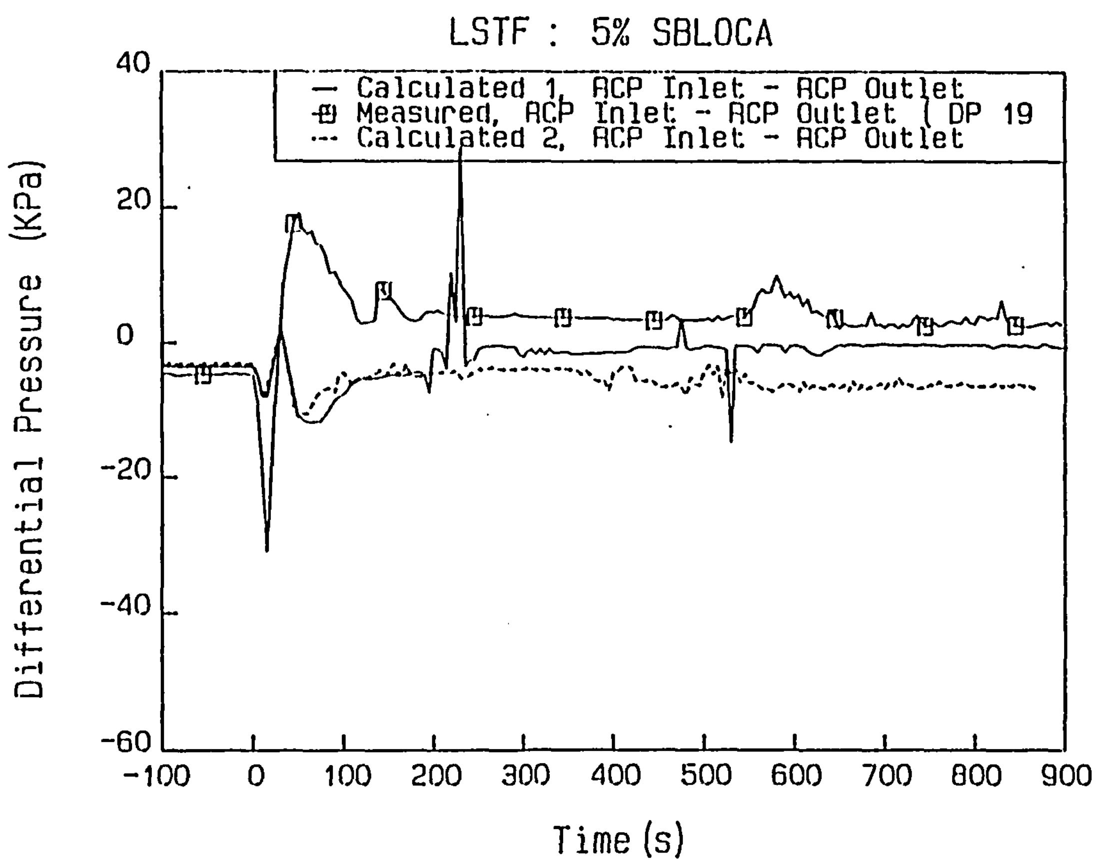

Fig. 39 ACP Differential Pressure

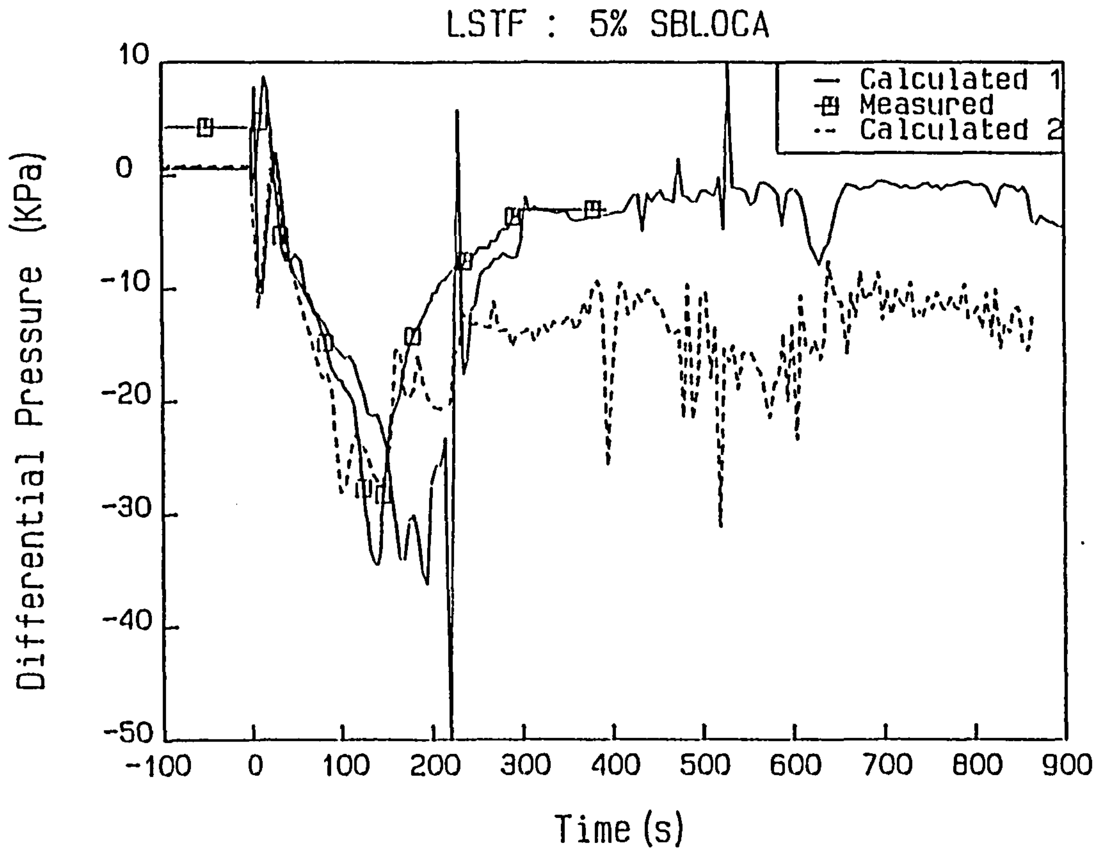

Fig.40 Upper Plenum - Downcomer Differential Pressure

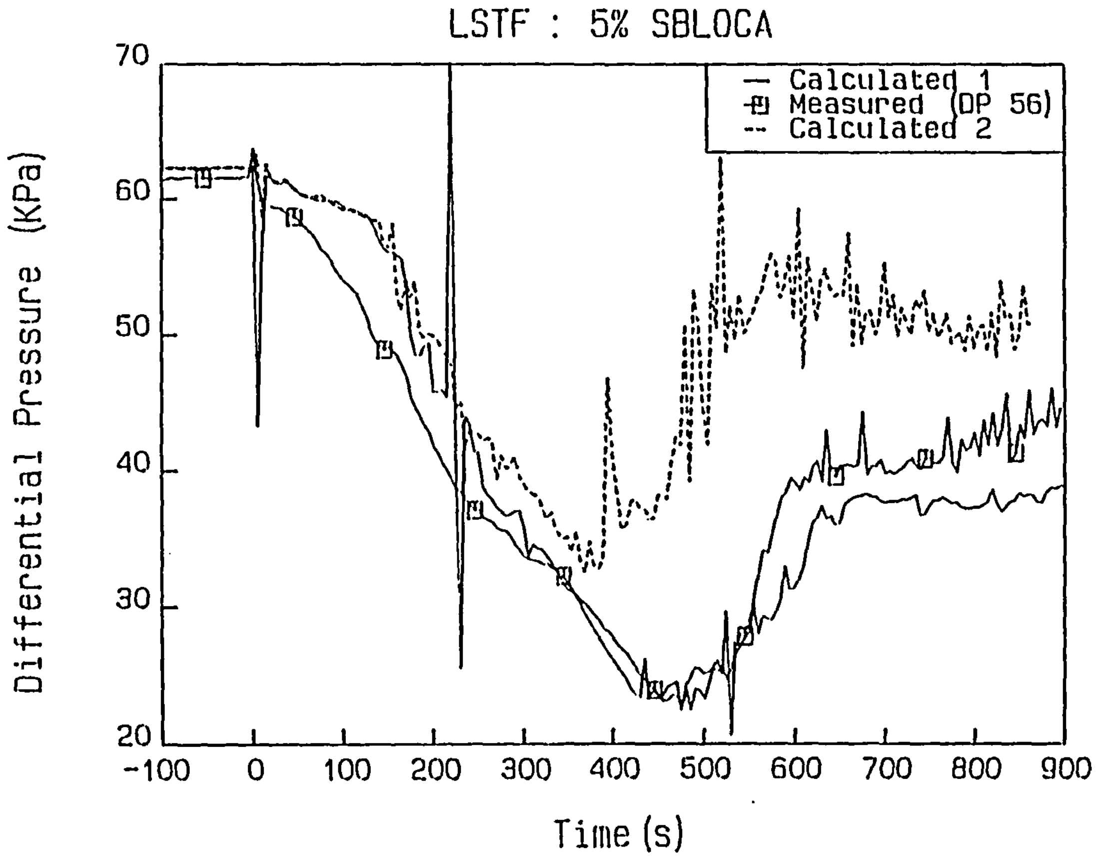

Fig.41 PV Downcomer Differential Pressure

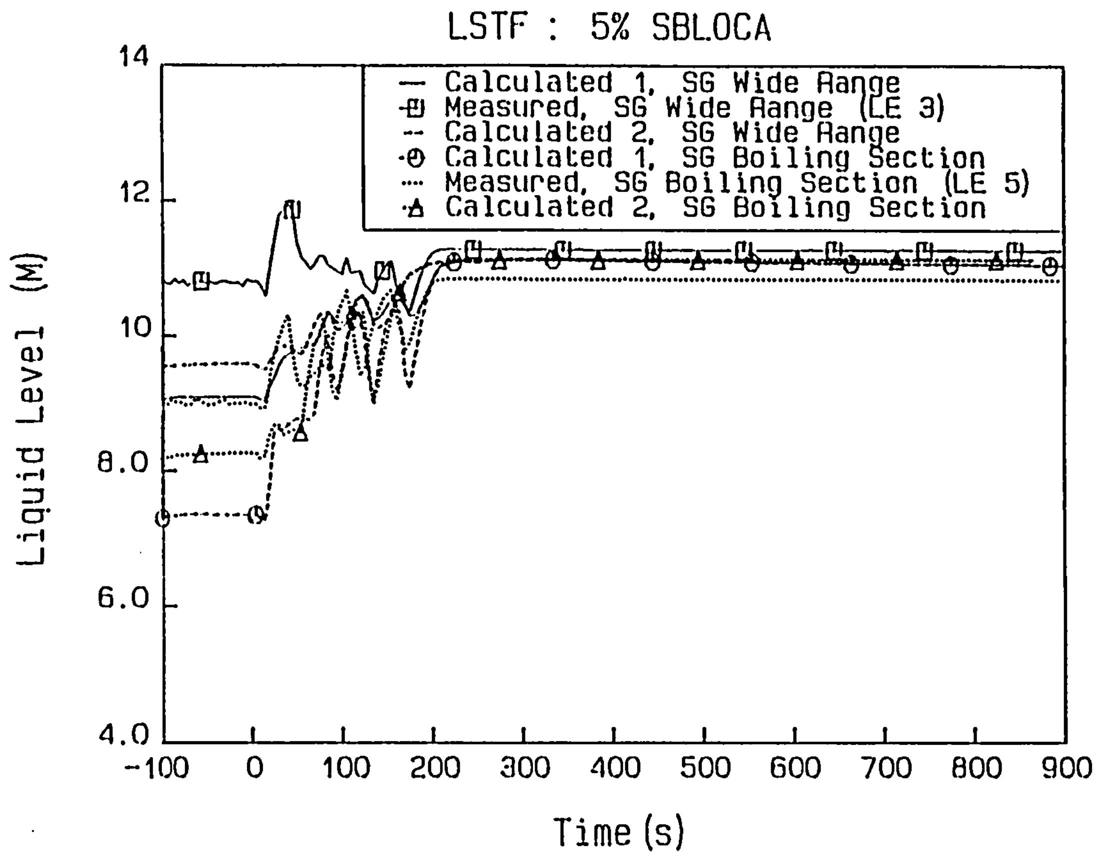

Fig. 42 Steam Generator-I Liquid Levels

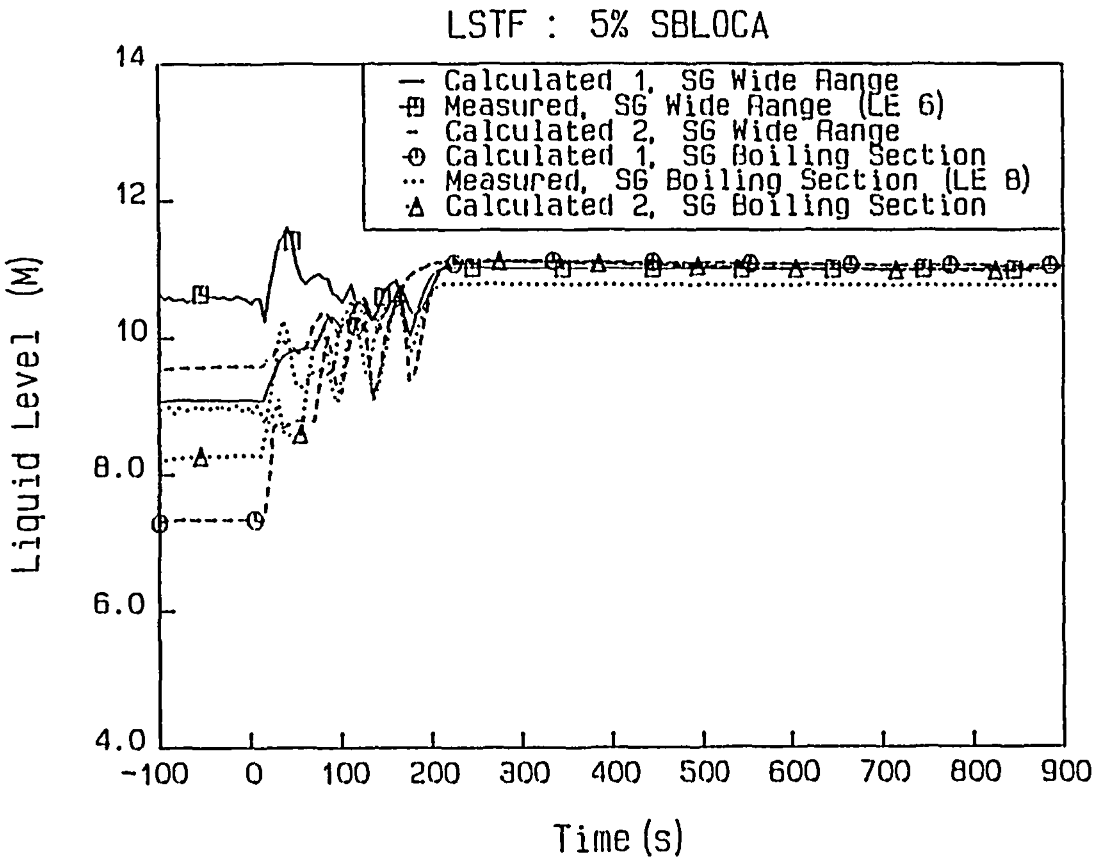

Fig. 43 Steam Generator-B Liquid Levels

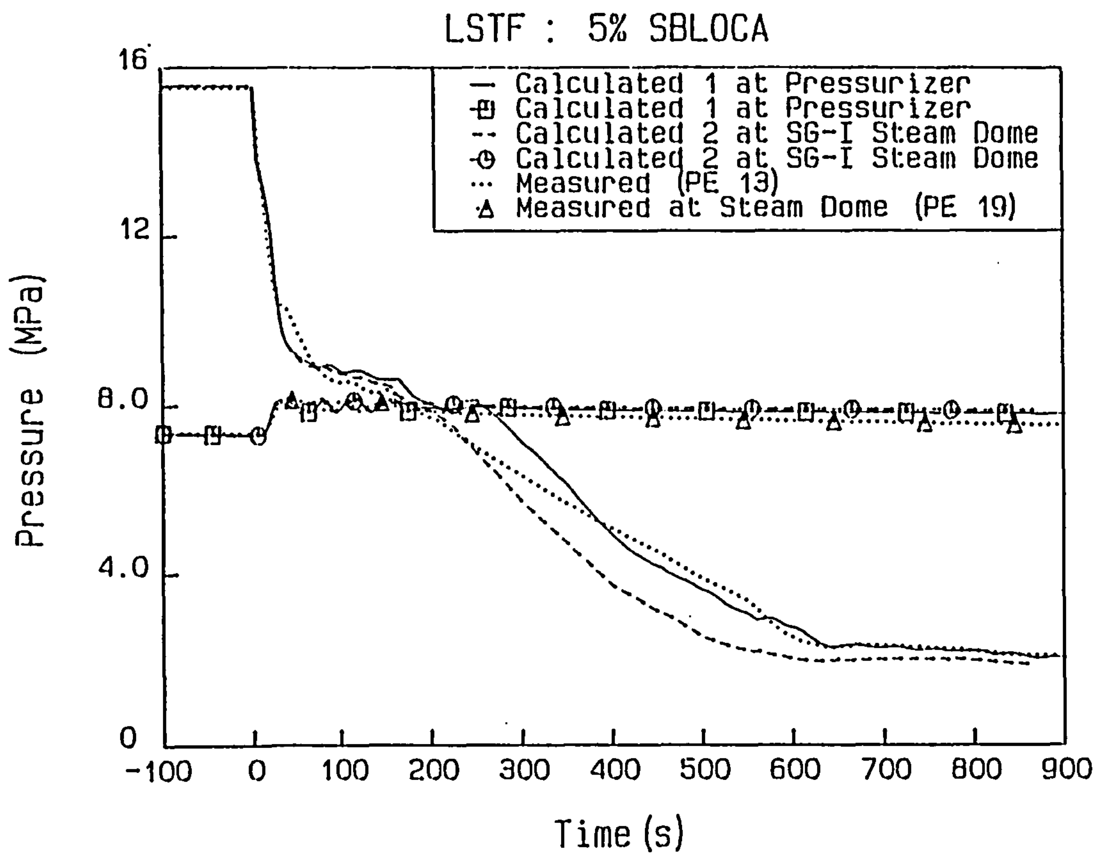

Fig. 44 Primary and Secondary Pressures

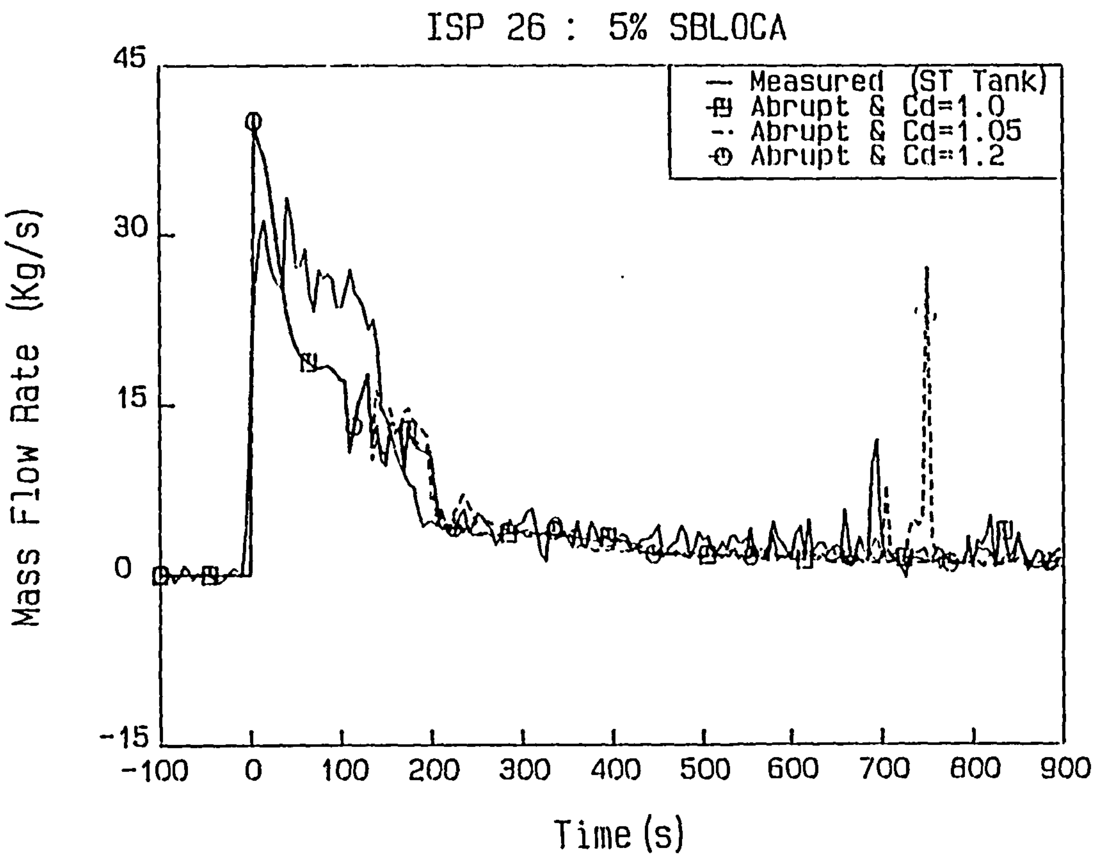

Fig. 45 Break Flow Calculated from Catch Tank Level Rise

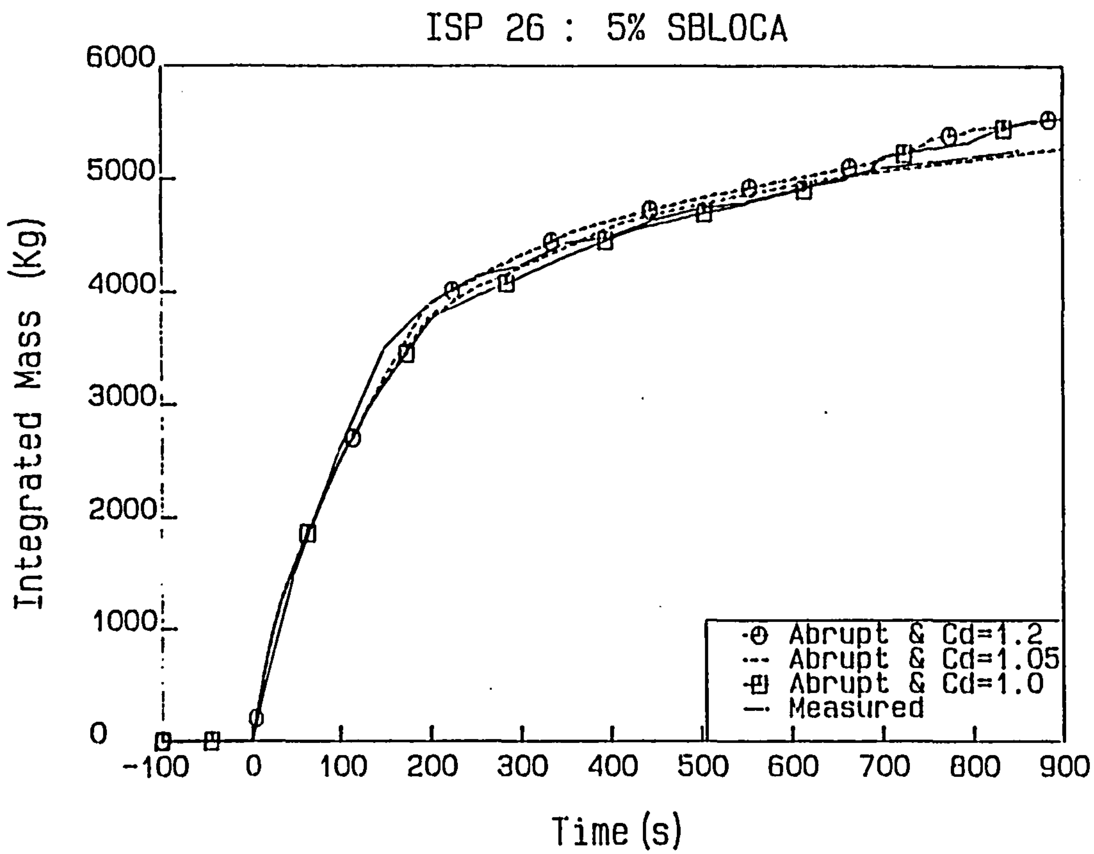

Fig. 46 Integrated Break Mass Flow

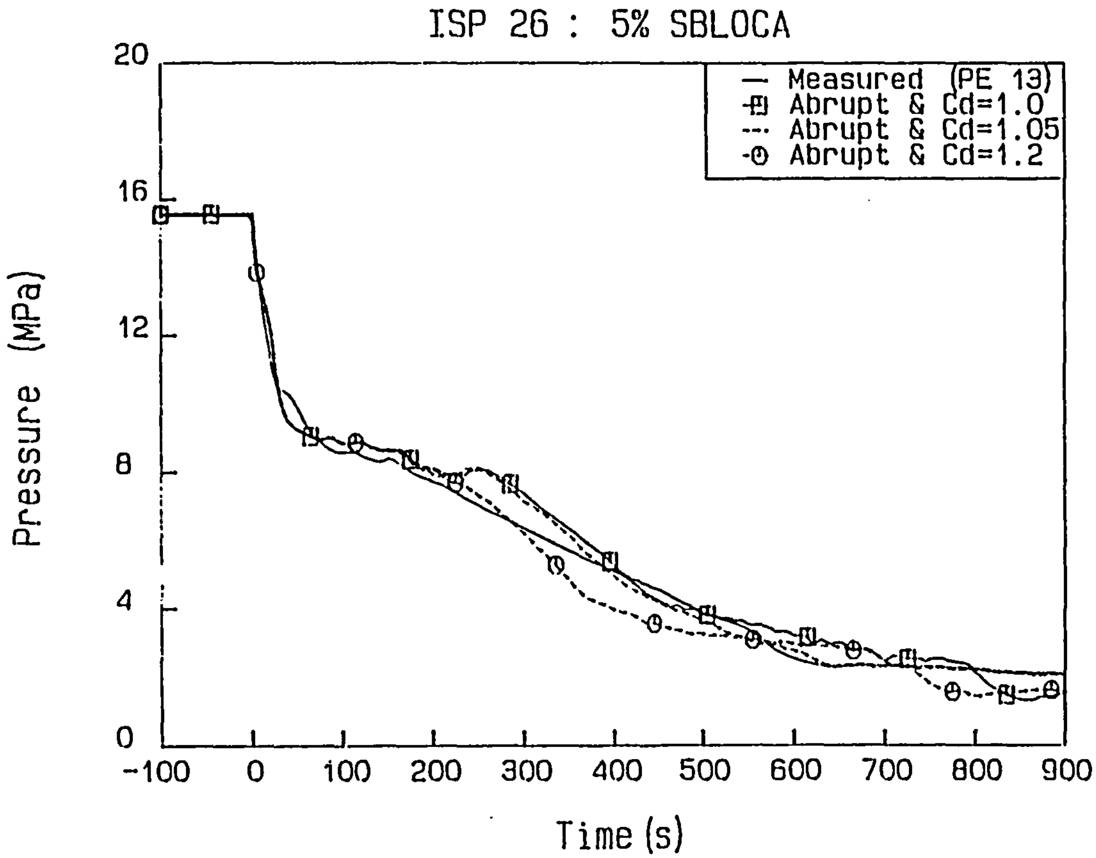

Fig. 47 Pressurizer Pressure

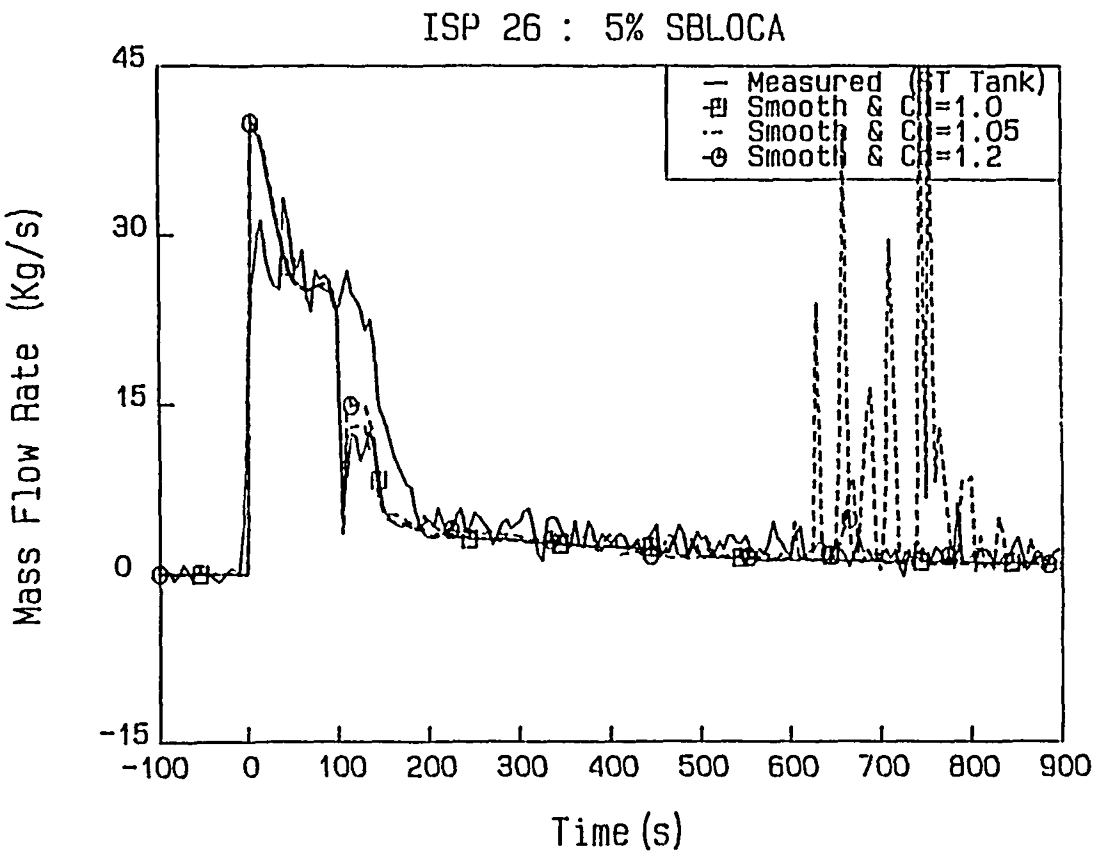

Fig. 48 Break Flow Calculated from Catch Tank Level Rise

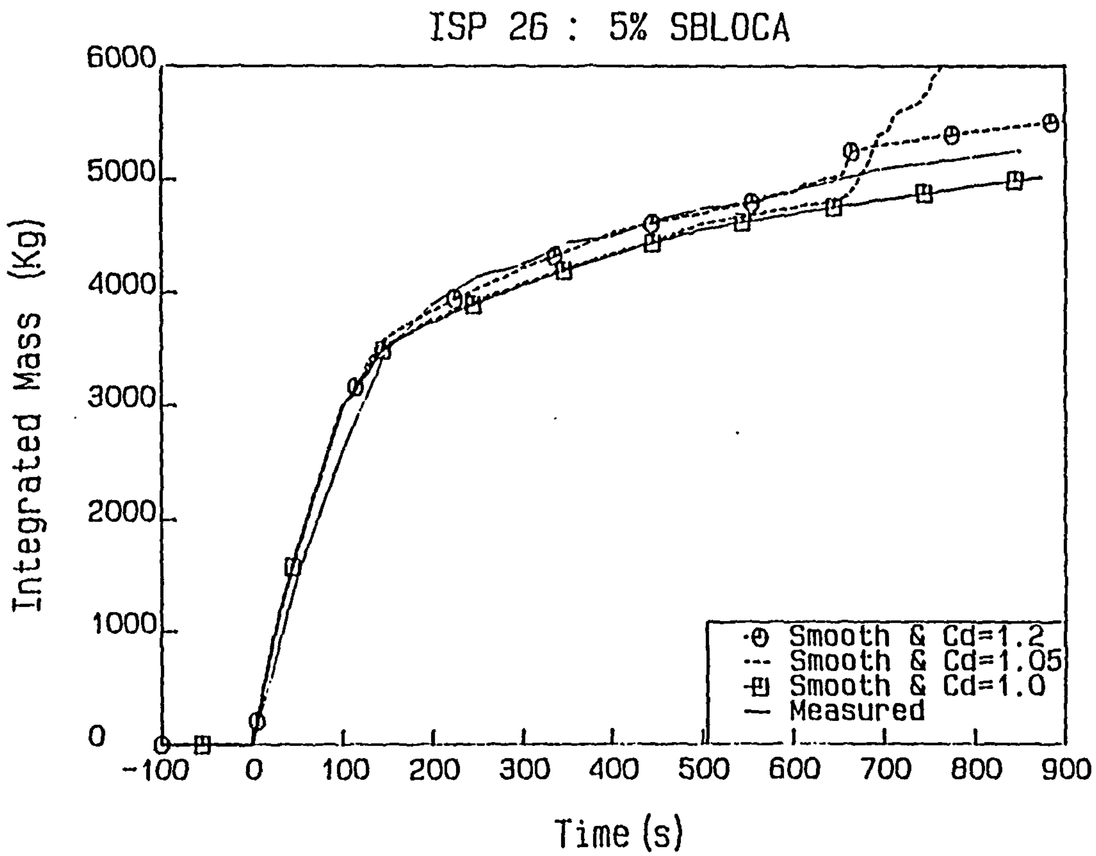

Fig. 49 Integrated Break Mass Flow

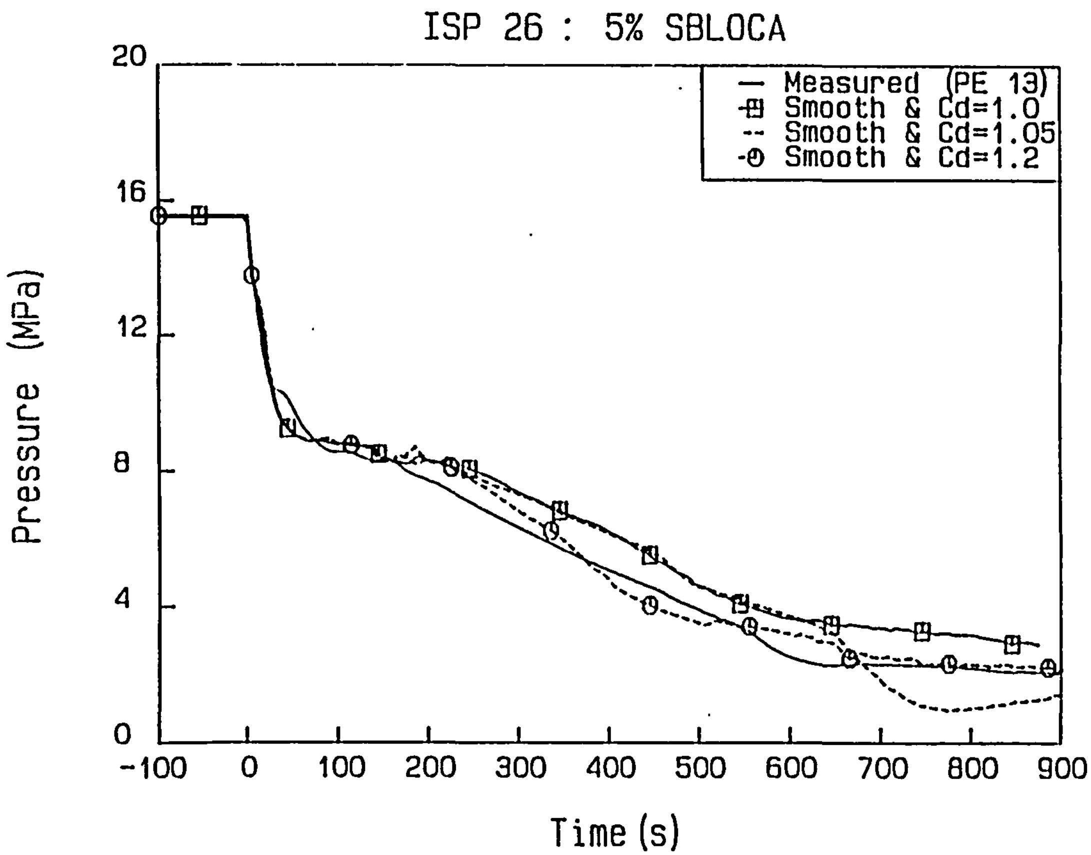

Fig.50 Pressurizer Pressure

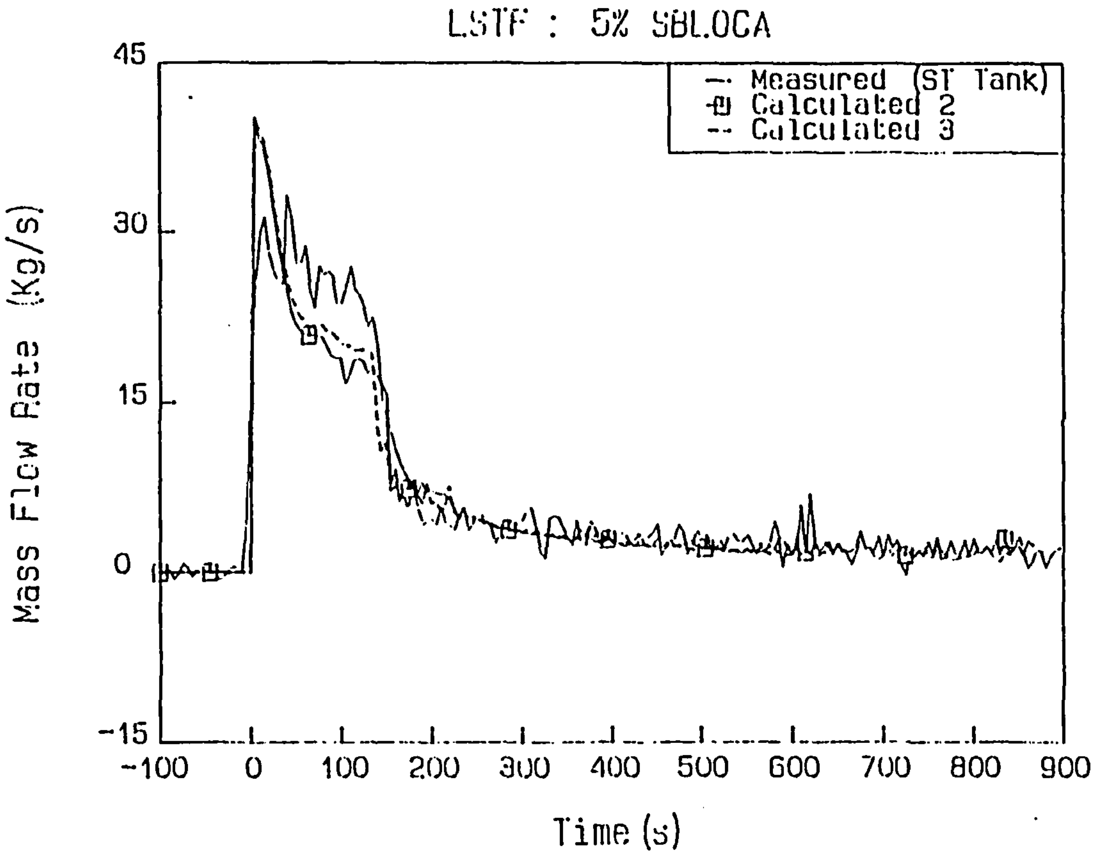

Fig.51 Break Flow Calculated from Catch Tank Level Rise

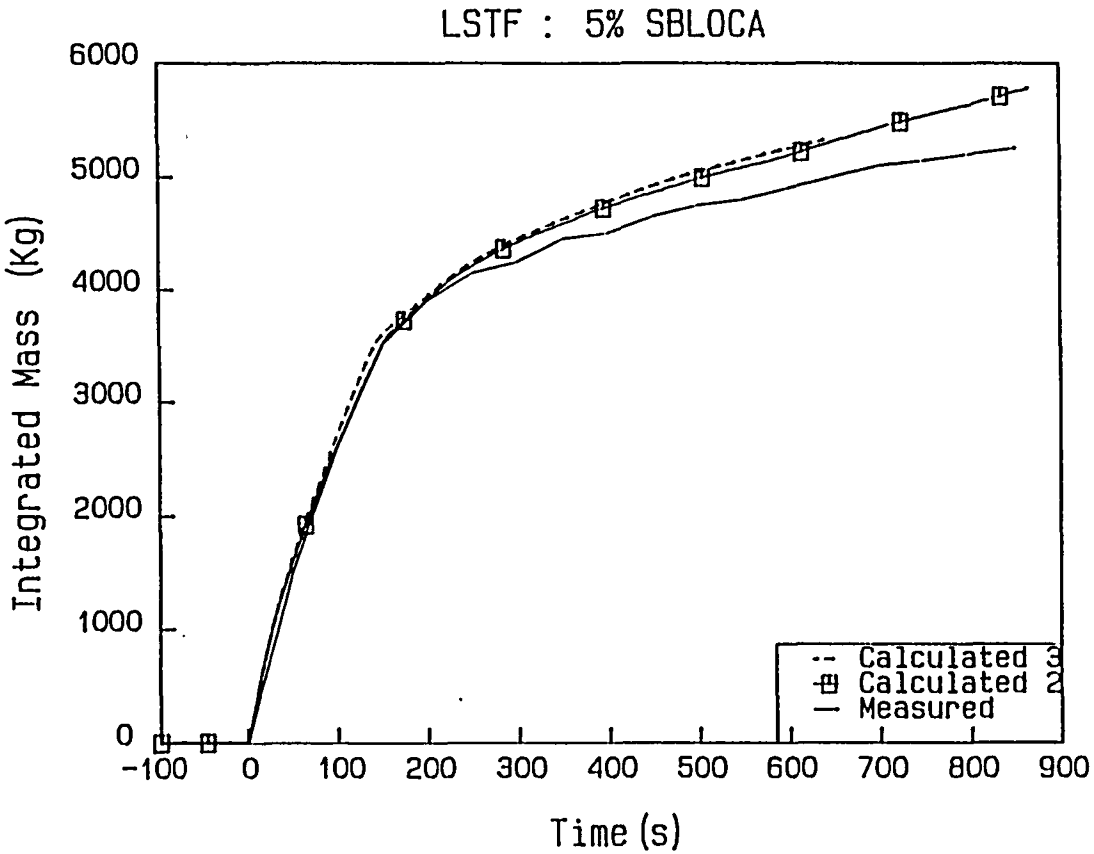

Fig.52 Integrated Break Mass Flow

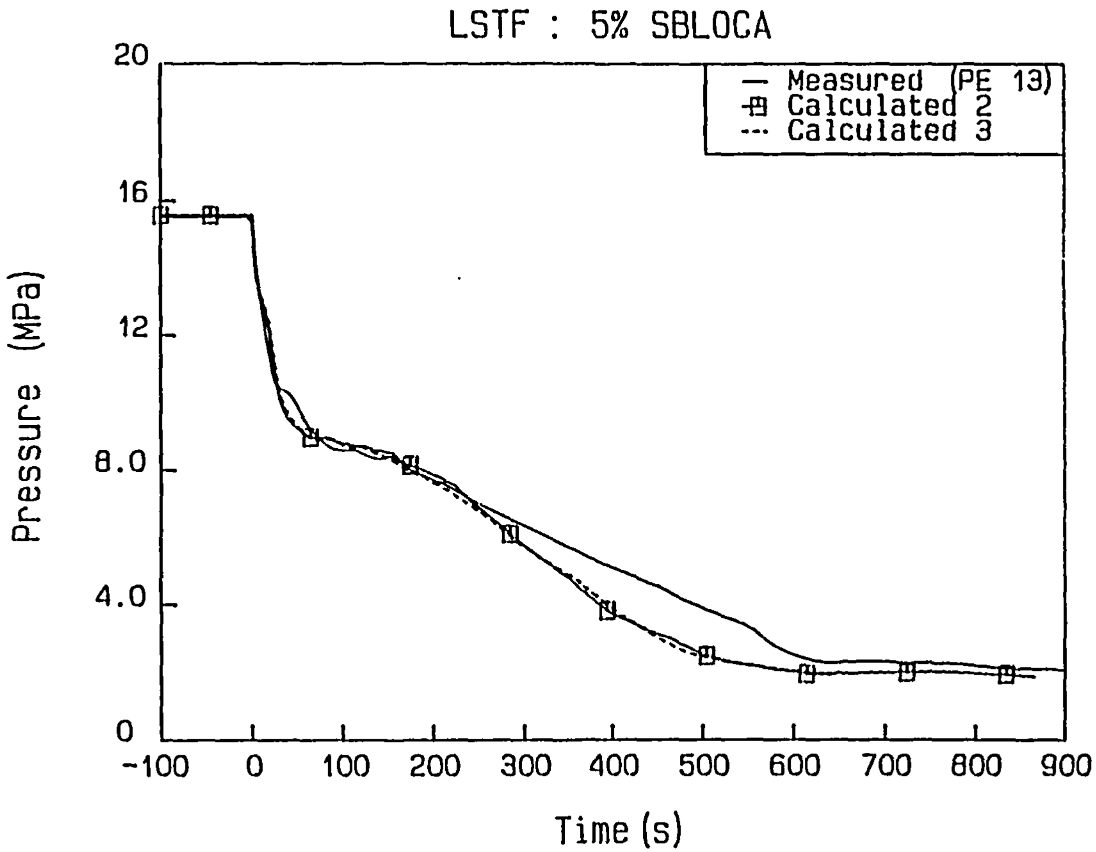

Fig.53 Pressurizer Pressure

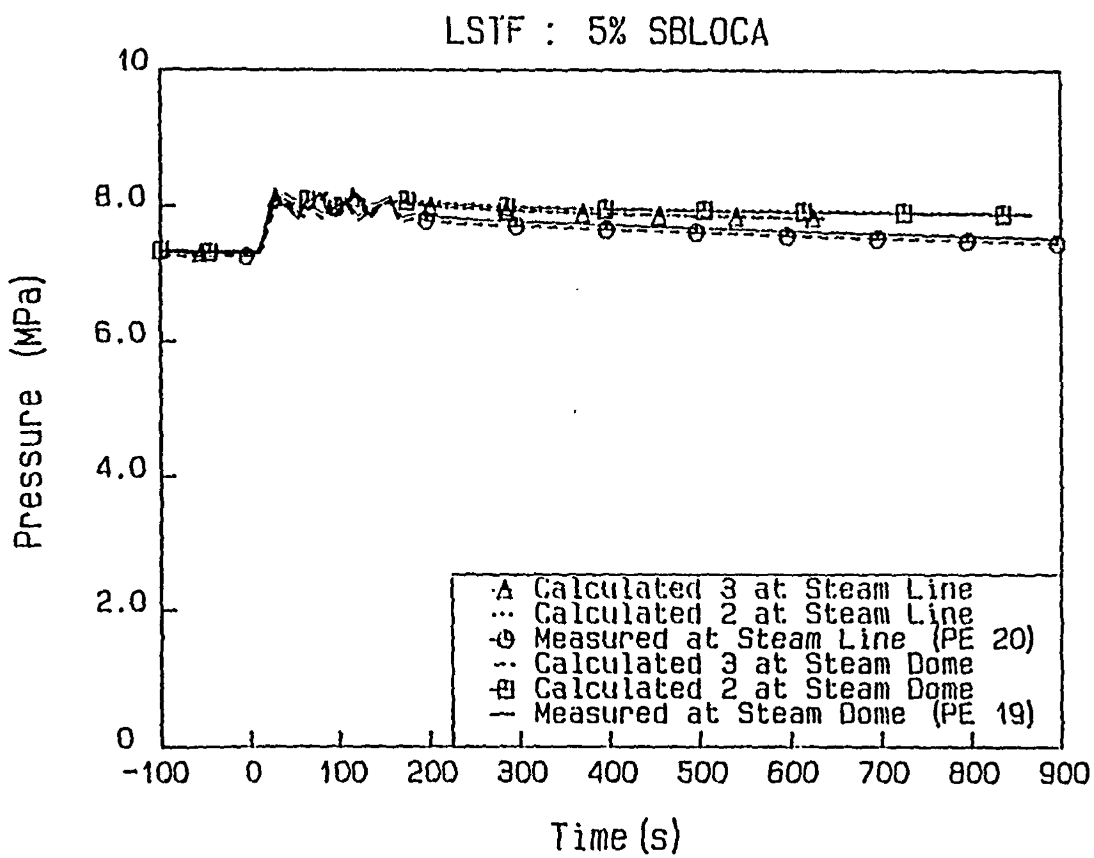

Fig.54 SG-I Steam Dome / Line Pressures

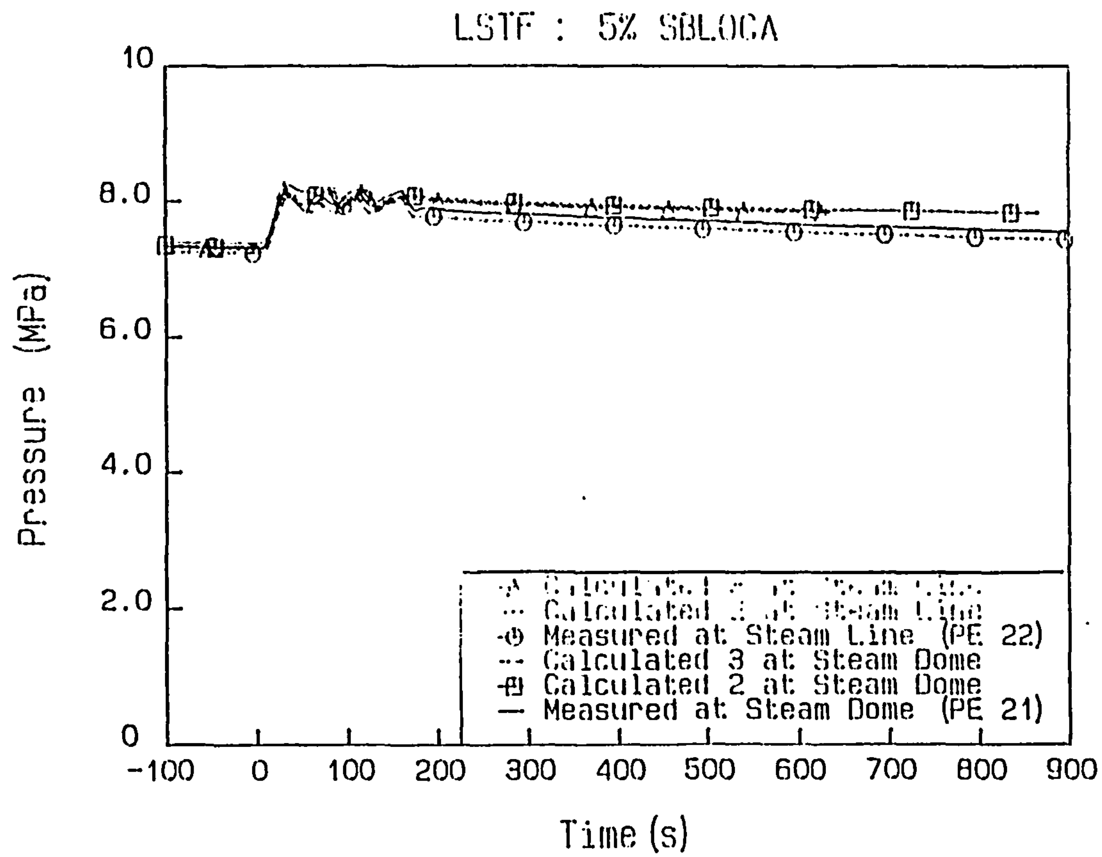

Fig.55 SG-B Steam Dome / Line Pressures

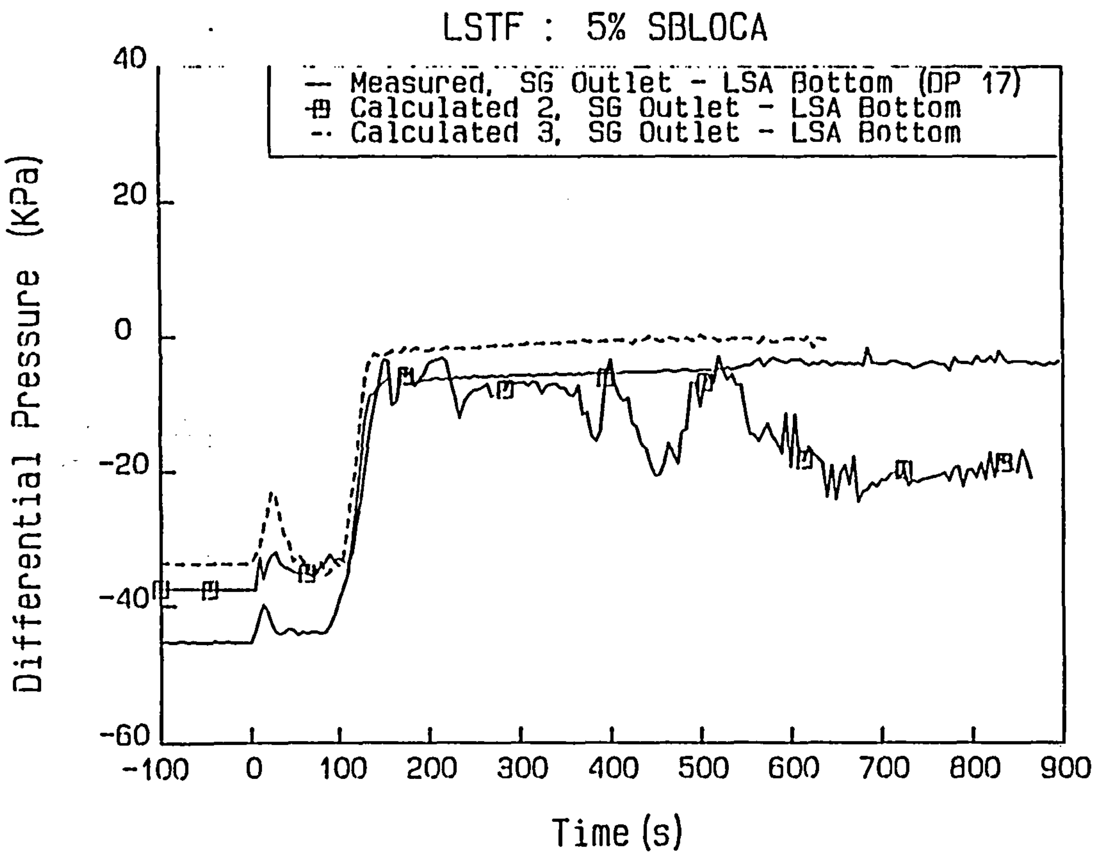

Fig.56 Crossover Leg Downflow Differential Pressure

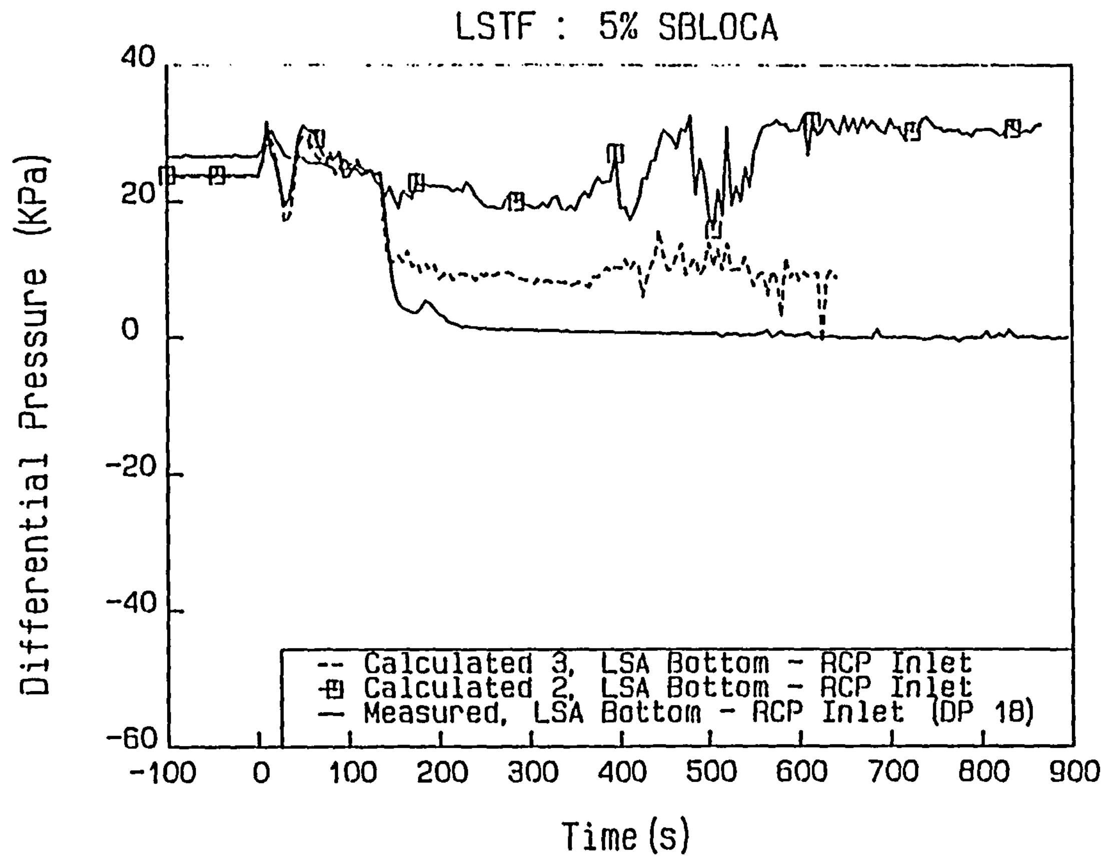

Fig. 57 Crossover Leg Upflow Differential Pressure

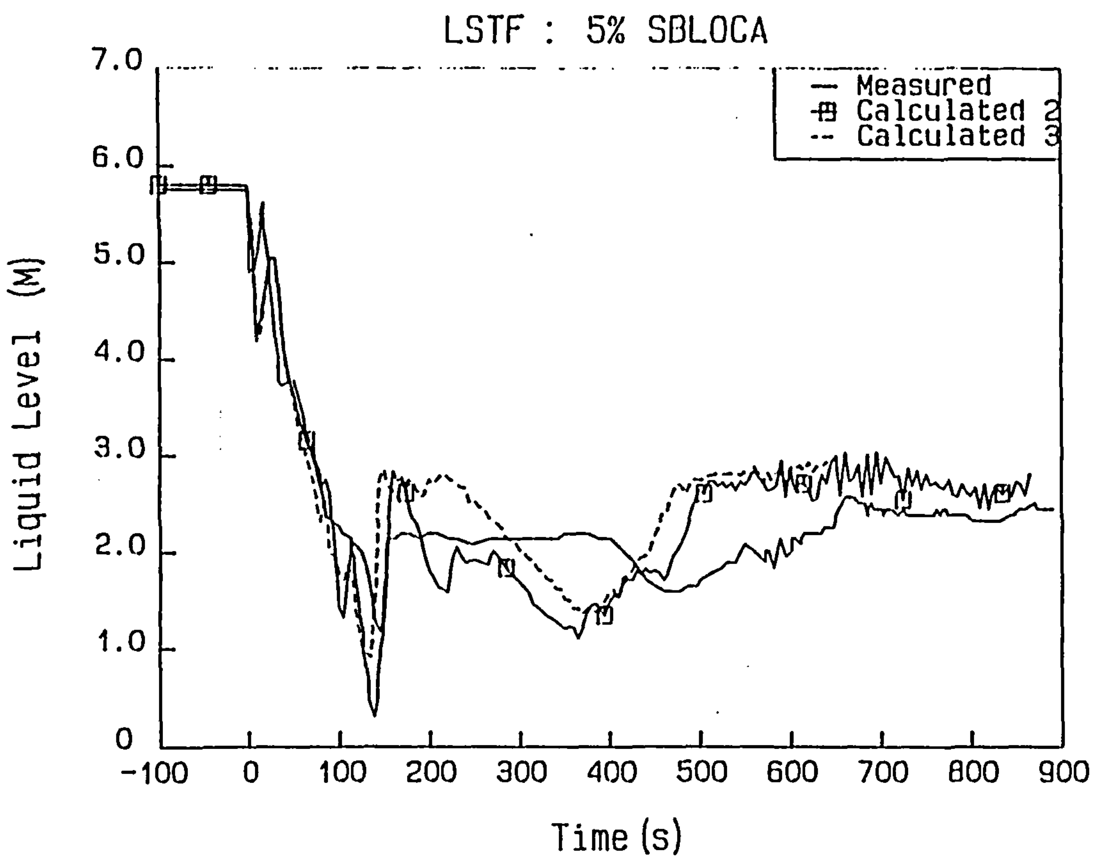

Fig. 58 Core Collapsed Liquid Level

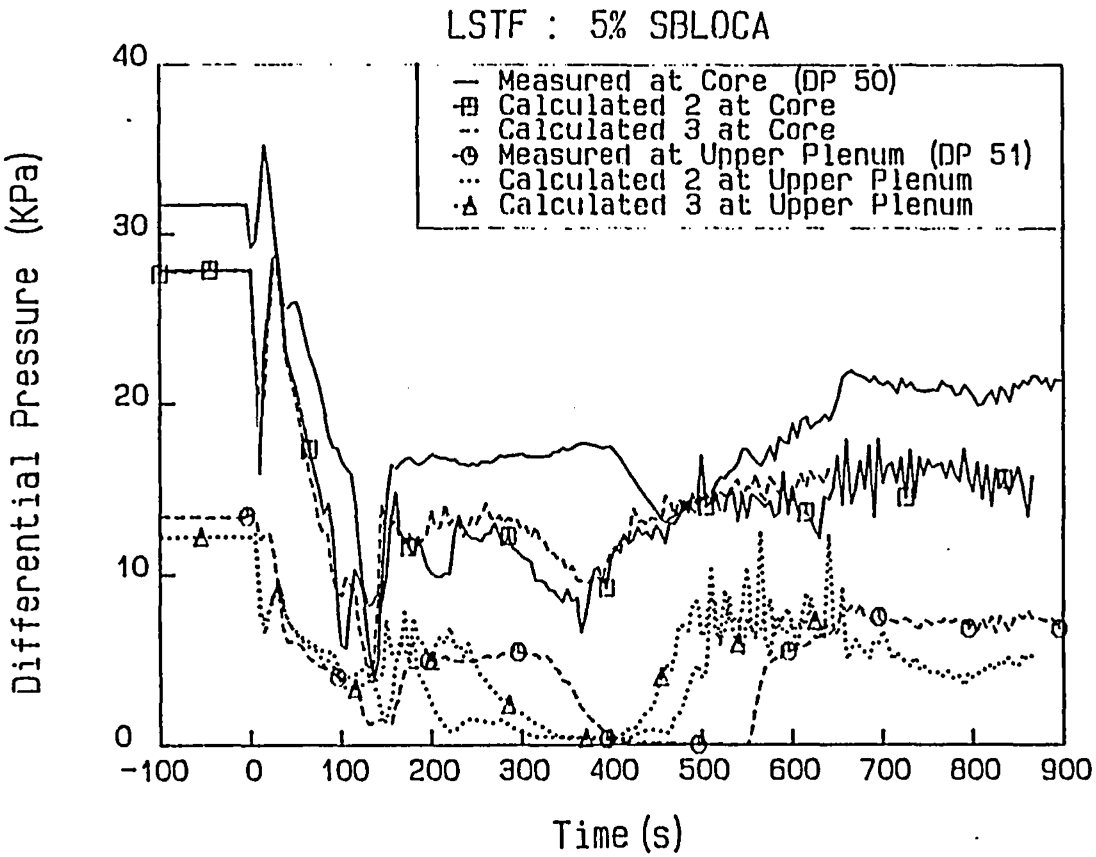

Fig. 59 Core and Upper Plenum Differential Pressures

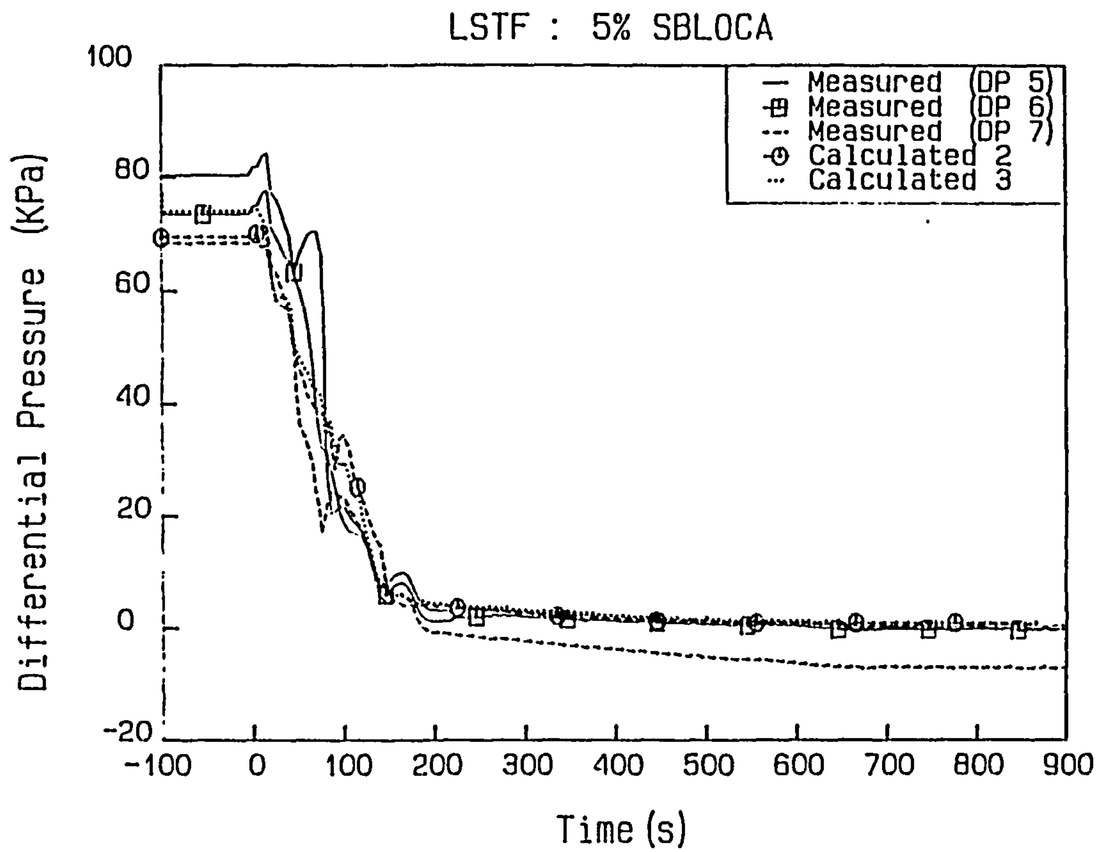

Fig.60 SG-I Inlet - Tube Top Differential Pressure

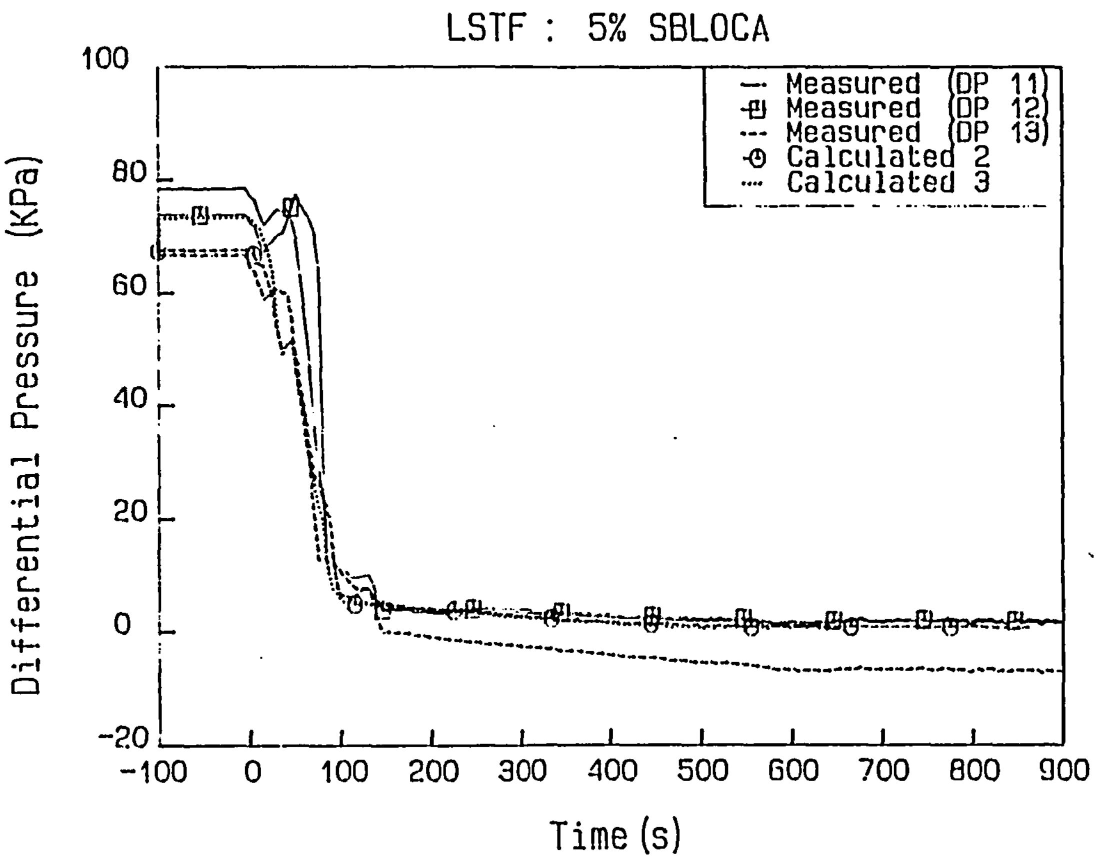

Fig.61 SG-I Outlet - Tube Top Differential Pressure

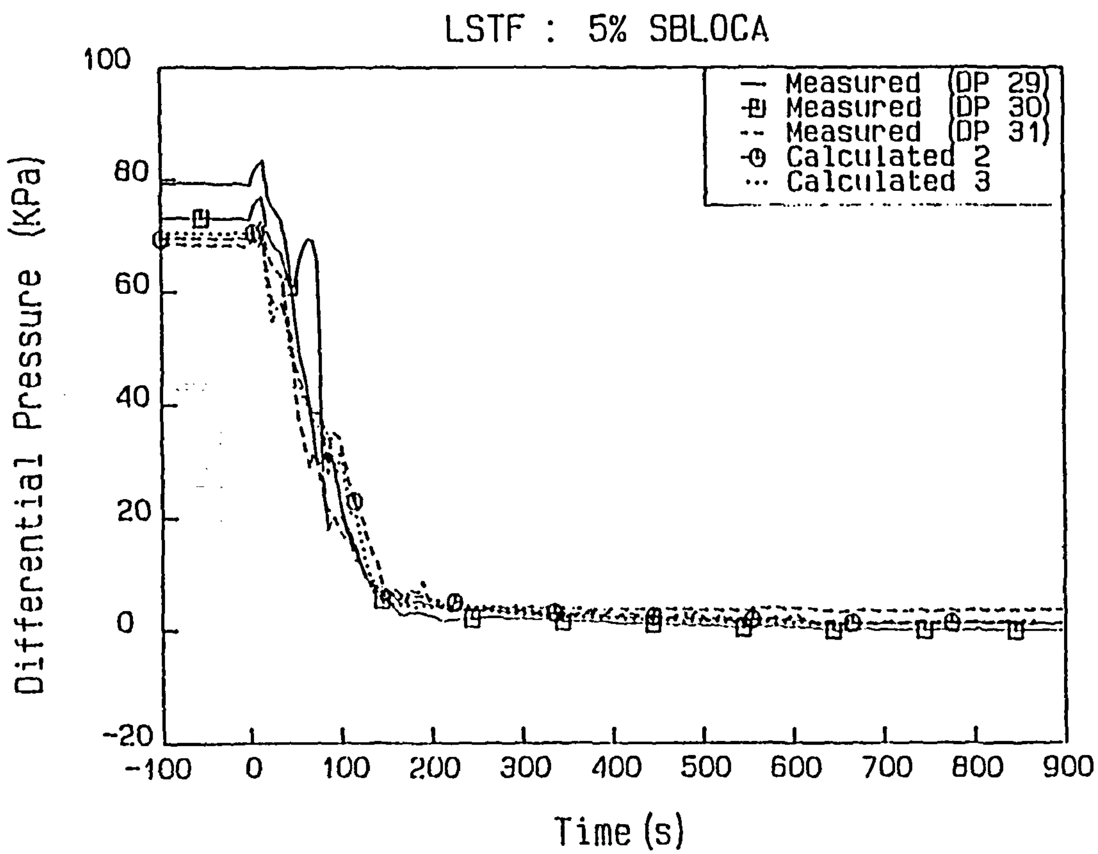

Fig. 62 SG-B Inlet - Tube Top Differential Pressure

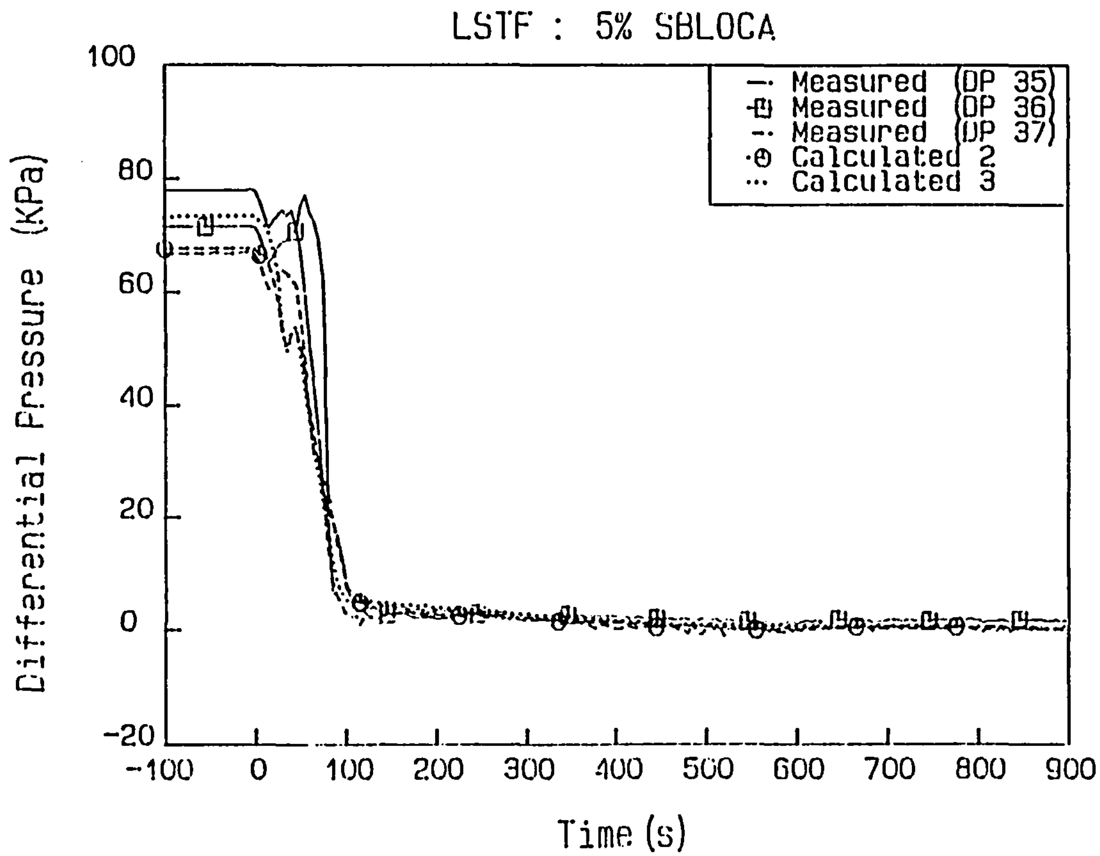

Fig.63 SG-B Outlet - Tube Top Differential Pressure

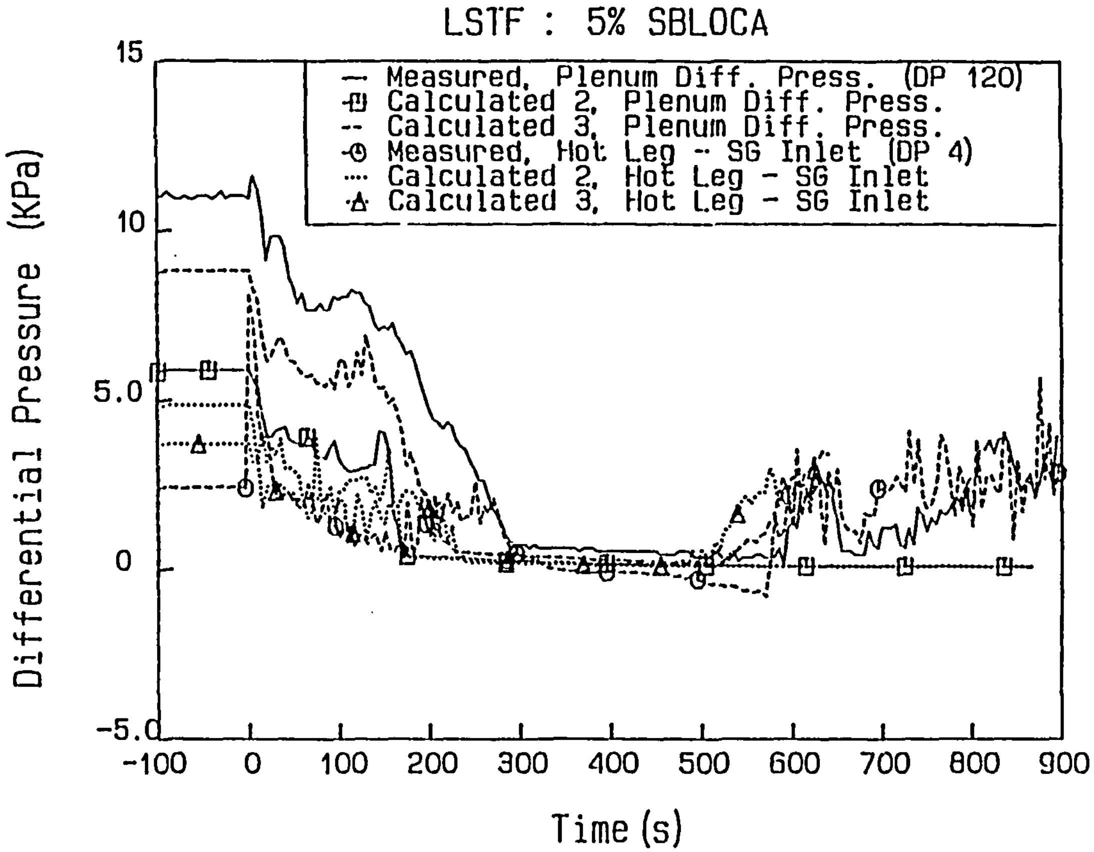

Fig.64 SG-I Inlet Plenum Differential Pressure

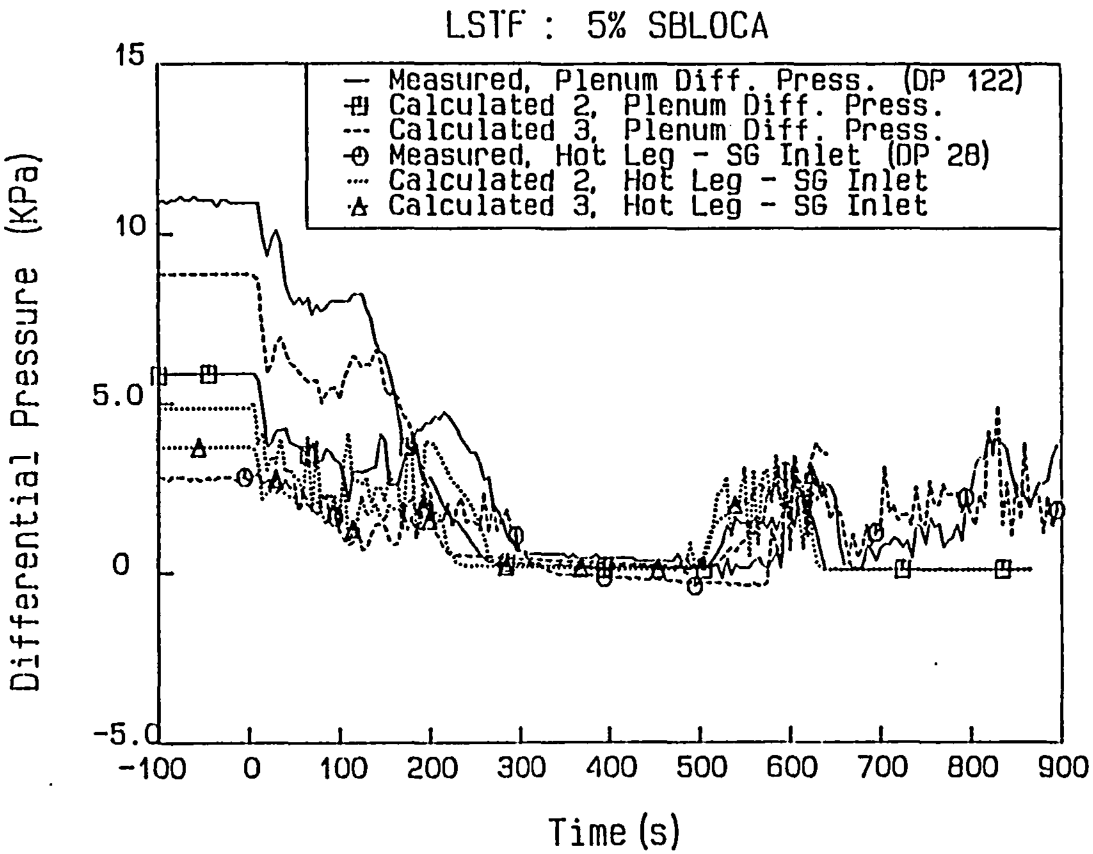

Fig. 65 SG-B Inlet Plenum Differential Pressures

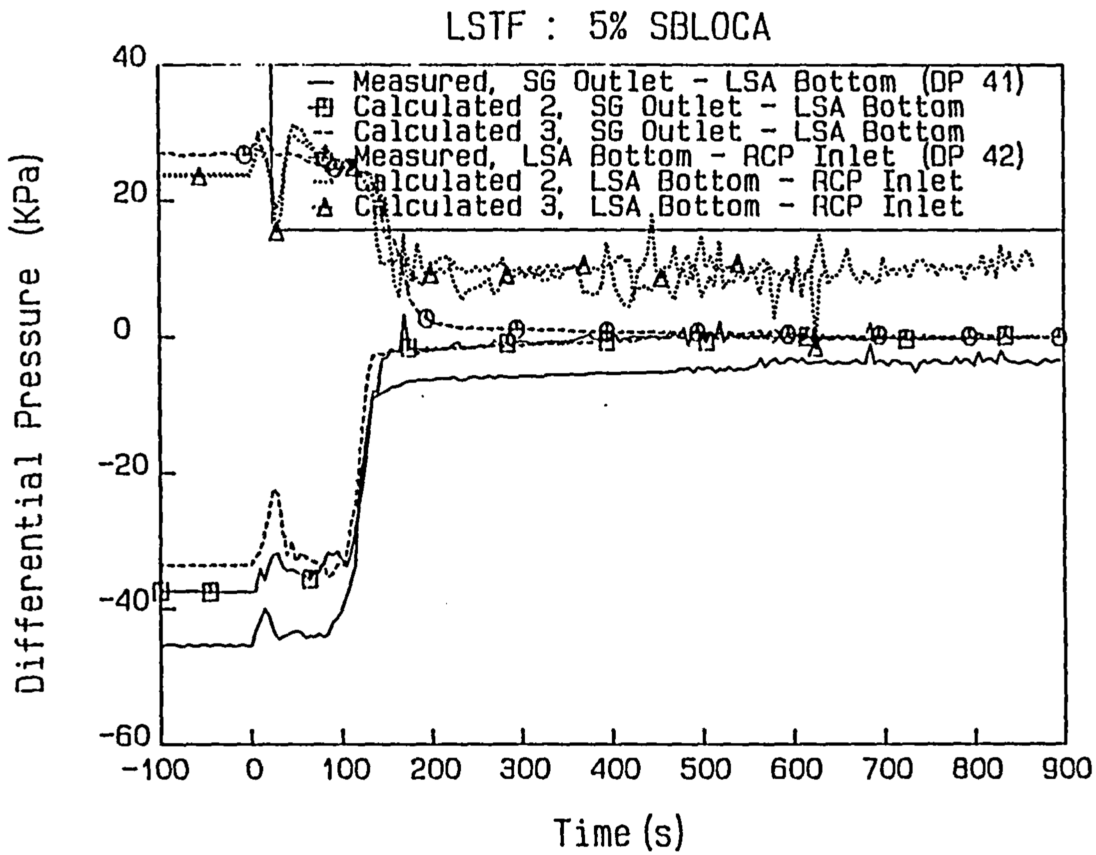

Fig.66 Cold Leg-B Differential Pressure

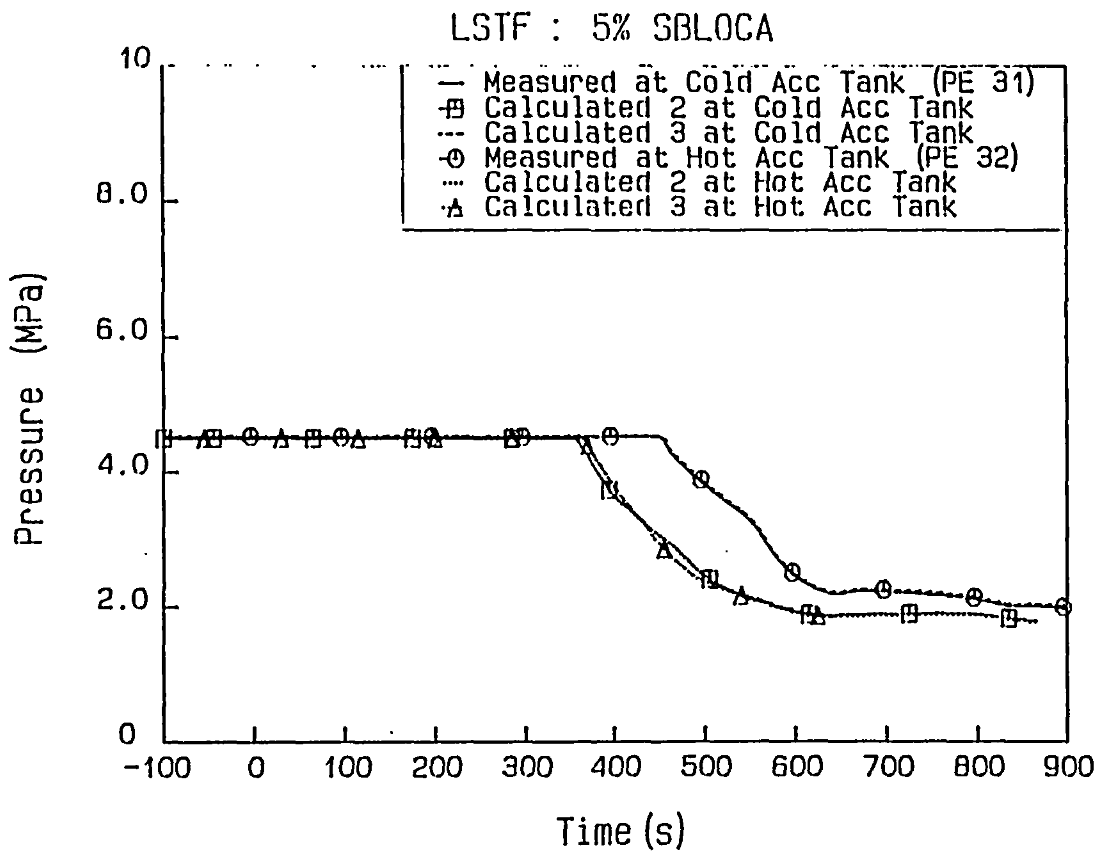

Fig. 67 Cold Acc Tank/Hot Acc tank Pressures

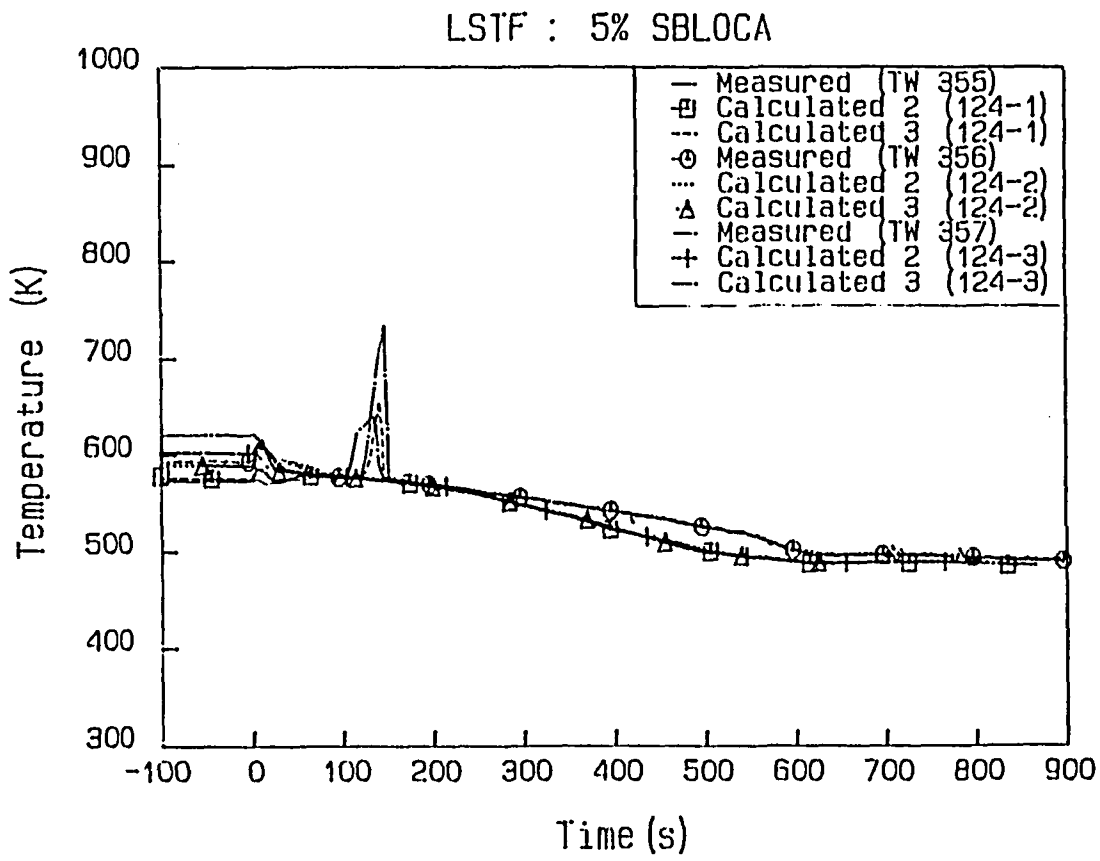

Fig.68 Rod Surface Temperatures - A

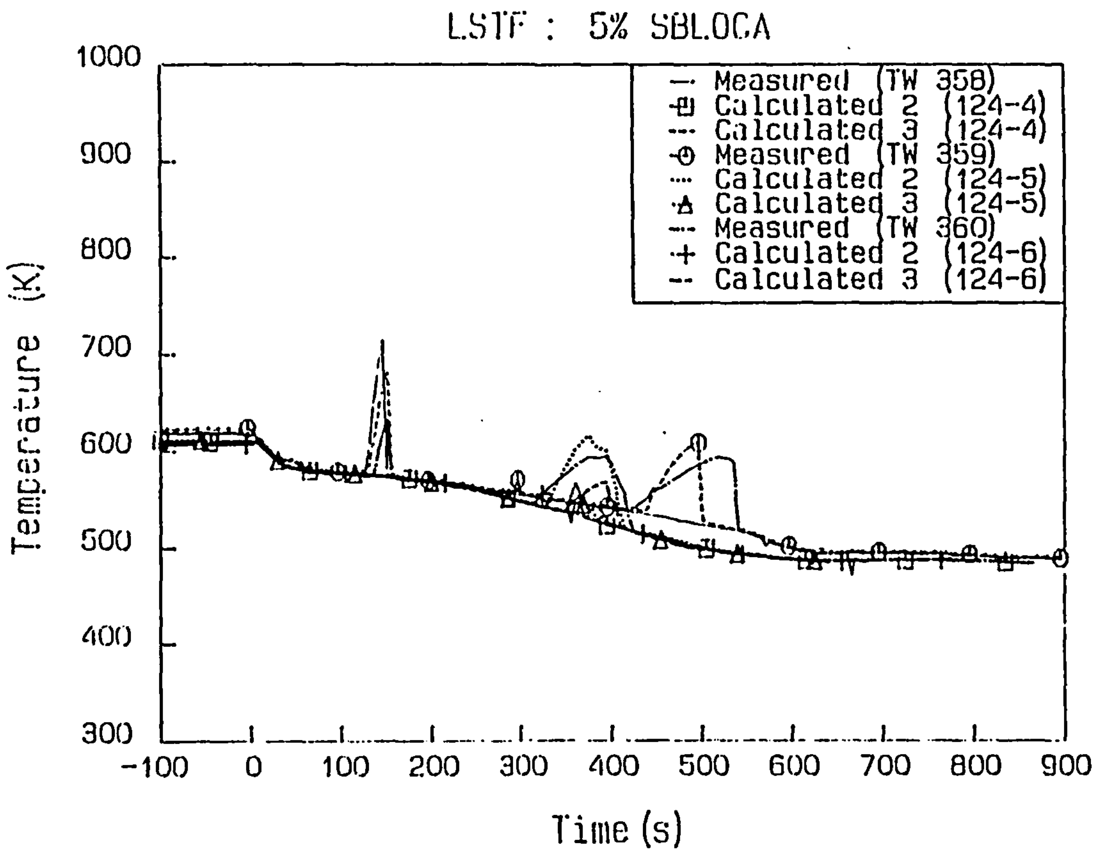

Fig.69 Rod Surface Temperatures - B

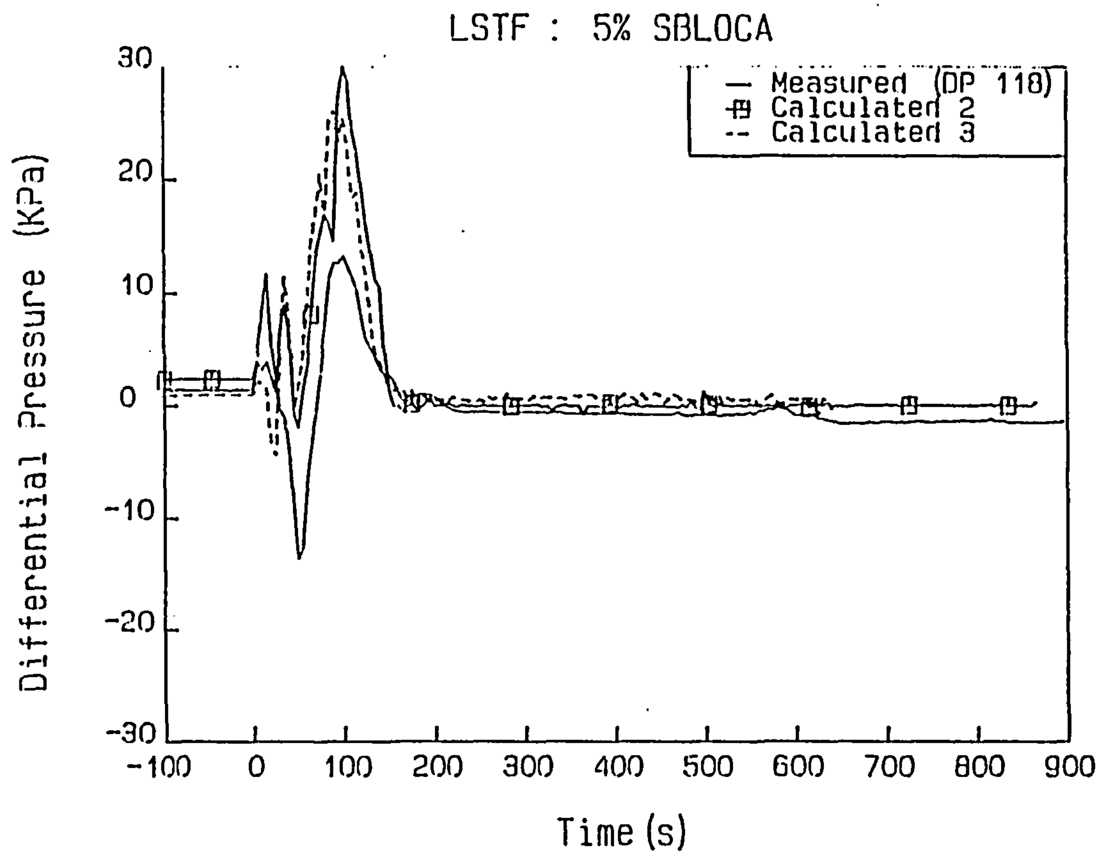

Fig. 70 SG Pressure Difference

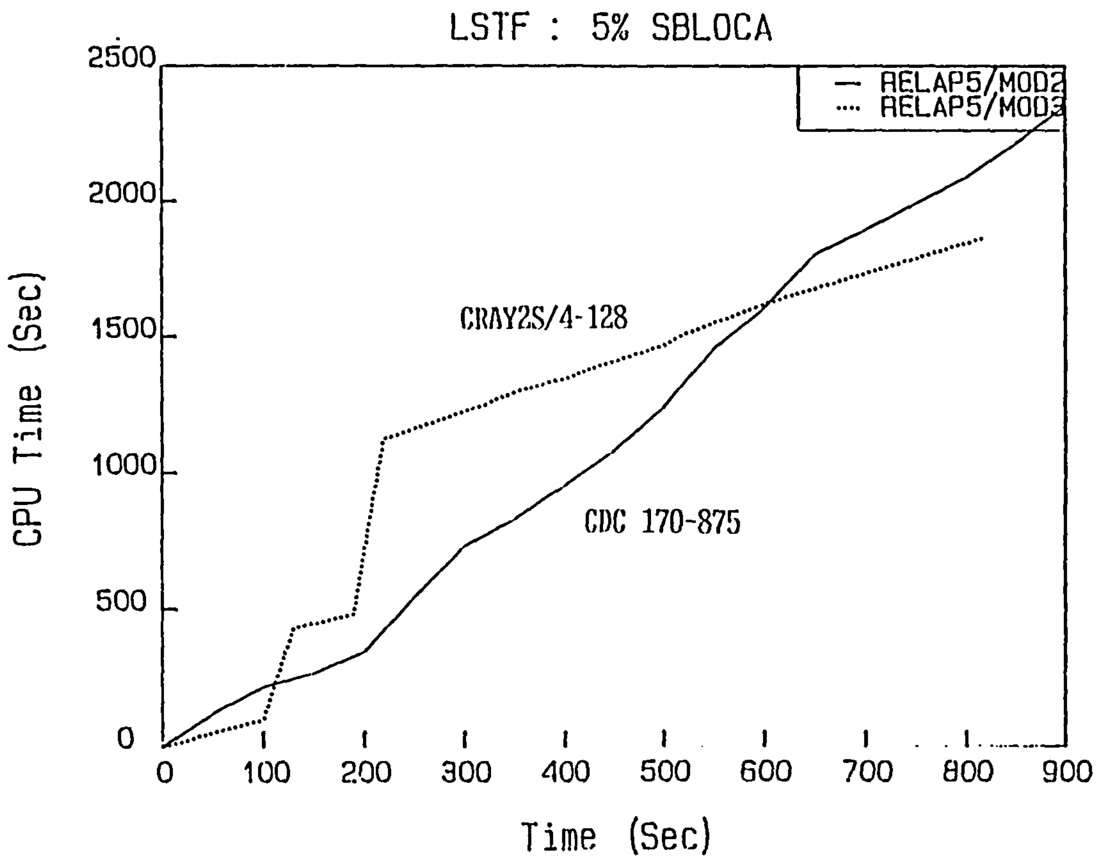

Fig. 71 CPU Time in Base Calculations

Appendix

```
*******************************************************
*
= lstf test sb-cl-18 base input deck with relap5/mod3
*
*******************************************************
*
0000100     new    transnt
*
0000101     run
0000102     si
0000105     5.0   2.0
*
0000110     nitrogen
0000115     1.0
*
0000120    124010000    0.00    water    primary
0000121    504010000    7.9639  water    secndry
0000122    900010000    0.00    water    contain
*
*  time step control
*
*
0000201    200.0   1.0-6   0.05   3    100   2000   2000
0000202    300.0   1.0-6   0.5   3    10    200    200
0000203    330.0   1.0-6   0.01  3    100    2000  2000
*
20800001  sonicj  915000000
20800002  xej     915000000
20800003  sathf   248010000
20800004  sathg   248010000
*
********************************************************
*    minor edits
*******************************************************
*
301  p          610010000
302  p          516010000
303  p          316010000
304  p          700010000
305  p          710010000
306  cntrlvar  761
307  cntrlvar  763
308  cntrlvar  758
309  cntrlvar  765
310  cntrlvar  766
311  cntrlvar  767
312  cntrlvar  750
313  cntrlvar  751
314  cntrlvar  768
315  cntrlvar  754
316  cntrlvar  755
```

317	cntrlvar	769
318	cntrlvar	752
319	cntrlvar	753
320	cntrlvar	770
321	cntrlvar	756
322	cntrlvar	757
323	cntrlvar	771
324	cntrlvar	610
325	cntrlvar	128
326	cntrlvar	124
327	cntrlvar	516
328	cntrlvar	316
329	cntrlvar	504
330	cntrlvar	304
**331	tempg	600020000
**332	tempf	600020000
* 333	tempg	148010000
* 334	tempf	148010000
331	sonicj	915000000
332	xej	915000000
333	voidgj	915000000
334	mflowj	120010000
335	tempg	120010000
336	tempf	120010000
337	tempg	128010000
338	tempf	128010000
* 339	tempg	104010000
* 340	tempf	104010000
341	tempg	400010000
342	tempf	400010000
343	tempg	200010000
344	tempf	200010000
345	tempg	452010000
346	tempf	452010000
347	tempg	252010000
348	tempf	252010000
349	httemp	124100109
350	httemp	124100209
351	httemp	124100309
352	httemp	124100409
353	httemp	124100509
354	httemp	124100609
355	cntrlvar	780
356	cntrlvar	790
357	mflowj	915000000
358	mflowj	700010000
359	mflowj	710010000
360	pmpvel	240
361	pmpvel	440
362	cntrlvar	888
363	cputime	0

```
364  voidg     124010000
365  voidg     124020000
366  voidg     124030000
367  voidg     124040000
368  voidg     124050000
369  voidg     124060000
370  mflowj    369000000
371  mflowj    569000000
372  p         244010000
373  p         448010000
374  cntrlvar  772
375  cntrlvar  773
376  cntrlvar  436
377  cntrlvar  236
378  cntrlvar  136
379  cntrlvar  137
380  cntrlvar  138
381  cntrlvar  139
382  cntrlvar  104
383  cntrlvar  105
384  cntrlvar  106
385  cntrlvar  107
386  cntrlvar  500
387  cntrlvar  300
388  cntrlvar  720
389  cntrlvar  740
390  cntrlvar  920
391  floreg    406010000
392  floreg    206010000
393  floreg    452010000
394  floreg    252010000
395   cntrlvar     915
396   voidg     248010000
397   voidg     400010000
*395  cntrlvar  934
*396  cntrlvar  944
*397  cntrlvar  954
*398  cntrlvar  964
*399  cntrlvar  974
*
************************************************************
* variable trips
************************************************************
*
0000501  p     610010000   lt    null  0    1.297e+7    1 *low pres
*
0000502 time           0   ge    null  0    1.e6        1 *power
*
0000505  p     610010000   lt    null  0    1.227e+7    1 *rcp&si
*
0000506   time       0   ge    timeof    505    17.0  1  *lpsi delay
```

```
*
0000507  time          0   ge   null  0      1.0e6    n *rcp delay
*
0000510  time          0   ge   timeof  505  12.0     1 *il hpi
*
0000512  time          0   ge   timeof  505  12.0     n *bl hpi
*
0000514  cntrlvar  30      ge  cntrlvar  31    0.0    n *mean temp
0000516  cntrlvar  30      lt  cntrlvar  31    0.0    n
*
0000520  p      610010000  ge   null  0   1.646e+7    1 *high pres
*
0000522  p      610010000  ge   null  0   1.726e+7    n *pzr sfty
*
0000524  p      610010000  ge   null  0   1.568e+7    n *pzr spry
*
0000526  p      610010000  gt   null  0   1.607e+7    n * porv
0000528  p      610010000  gt   null  0   1.620e+7    n
*
0000529  time          0   ge   null  0   0.0         1 *pzr prp. htrs
*
0000530  p      610010000  lt   null  0   1.540e+7    n *pzr bkup htrs
0000531  p      610010000  lt   null  0   1.534e+7    n
*
0000532  cntrlvar    610   lt   null  0   0.25656     n *lo nrm pr lvl
*
0000535  time          0   ge   null  0  200.0     1 *cl break
*
0000536  time          0   ge   null  0   0.0         1 *bl flow
0000537  time          0   lt   null  0   0.0         1 *valve
*
0000538  time          0   lt   null  0   0.0         1 *il flow
0000539  time          0   lt   null  0   0.0         1 *valve
*
0000550  p  610010000   ge  null 0  1.297e+7    1 *main feed
*
0000552  time          0   ge   timeof  536  10000.0  1 *aux fed
*
0000554  cntrlvar  308     lt   null   0   0.44       n *aux feed
0000555  cntrlvar  508     lt   null   0   0.44       n
*
0000560  p   316010000     gt   null   0    7.82e+6   n *bl sg rel
0000561  p   316010000     gt   null   0    8.2e+6   n
*
0000564  p   316010000     gt   null   0    7.69e+6   n *bl sg saf
0000565  p   316010000     gt   null   0    8.68e+6   n
*
0000568  time        0     lt   null   0    0.0       n *bl msiv
0000569  p   316010000     lt   null   0    4.235e+6  1
*
0000570  p   516010000     gt   null   0    7.82e+6   n *il sg rel
```

```
0000571  p    516010000    gt    null   0    8.2e+6   n
*
0000574  p    516010000    gt    null   0    7.69e+6   n *il sg saf
0000575  p    516010000    gt    null   0    8.68e+6   n
*
0000578  time          0   lt   null   0   0.0        n *il msiv
0000579  p      516010000  lt   null   0   4.235e+6   1
*
0000580  cntrlvar  308     lt    null   0   0.25       1 *low sg lev
0000581  cntrlvar  508     lt    null   0   0.25       1
*
0000583  time       0      ge    null   0    0.0       n *stm hdr vlv
*
0000585  time       0      lt    null   0    0.0       n *stm thrtl
*
0000586  time       0      ge    null   0   11.0       n * valve
*
0000599  time       0      lt    null   0   200.0      n * ss pres
*
*
******************************************************************
*   logical trips
******************************************************************
*
0000601    -603   and   571   n * il sec relief valve
0000602     603   and   570   n
0000603     601   or    602   n
*
0000604    -606   and   575   n * il sec safety valve
0000605     606   and   574   n
0000606     604   or    605   n
*
0000607    -609   and   561   n * bl sec relief valve
0000608     609   and   560   n
0000609     607   or    608   n
*
0000610    -612   and   565   n * bl sec safety valve
0000611     612   and   564   n
0000612     610   or    611   n
*
0000613    -615   and   528   n * porv
0000614     615   and   526   n
0000615     613   or    614   n
*
0000620     580   or    581   1 * reactor trip
0000621     520   or    620   1
0000622     621   or    501   1
*
0000623     552   and   554   n * sg aux feed, bl
0000624     552   and   555   n *            , il
*
```

```
0000625   -586   or   -586   n * steam sink pressure
*
0000626    579   or    568   1 * hpi
0000627    626   or    505   1
*
0000630   -632   and   531   n * pzr backup heater cntl
0000631    632   and   530   n
0000632    630   or    631   n
*
0000633   -505   and  -532   n * pzr htrs off on sis or low pzr lvl
0000634     632   and   633 n    *pzr htrs off on low pzr level
*
*
*****************************************************************
*  hydrodynamic components
*****************************************************************
*
*****************************************************************
*  reactor vessel
*****************************************************************
1000000     inannl      snglvol
1000101   0.0     1.5684   0.13609   0.0  -90.  -1.5684
1000102   4.57e-5   0.106    00
*1000200   0          15669968. 1262572.3 2443840.8 0.0
1000200 003        15669968.   567.5
*
*****************************************************************
1040000     inann       branch
1040001   4          0
1040101   0.0     0.600     0.05425  0.0    -90.0  -0.600    4.57e-5
1040102     0.106    00
*1040200   0          15677916. 1259386.1 2443653.5 0.0
1040200  003     15677916.   567.5
1041101      104000000   100010000   0.0          0.0    0.0    0000
1042101      104010000   108000000   0.0          0.0    0.0    0000
1043101      252010000   104000000   0.03365    0.345  0.345  0101
1044101      452010000   104000000   0.03365    0.345  0.345  0101
1041201   3.72622-3 3.72622-3 0.0                          * .24192712
1042201   .71183539 .71183539 0.0                          * 48.158681
1043201   .96085447 .96085447 0.0                          * 24.199945
1044201   .96096109 .96096109 0.0                          * 24.200657
*
*****************************************************************
1080000   downcmer   annulus
1080001   9
1080101   0.09774  9
1080301   0.6757    1
1080302   0.8670    2
1080303   0.610     8
1080304   1.2588    9
1080601  -90.0     9
```

```
1080701  -0.6757  1
1080702  -0.8670  2
1080703  -0.610   8
1080704  -1.2588  9
1080801   4.573e-5   0.106   9
1081001   00        9
1081101   0000      8
*1081201  0          15682417. 1260080.6 2443547.4 0.0        0.0        1
1081201 003         15682417.  567.5  0.  0.  0.  1
*1081202  0          15688051. 1260938.8 2443414.6 0.0        0.0        2
1081202 003         15688051.  567.5  0.  0.  0.  2
*1081203  0          15693443. 1261719.6 2443287.6 0.0        0.0        3
1081203  003         15693443.  567.5  0.  0.  0.  3
*1081204  0          15697895. 1262438.4 2443182.8 0.0        0.0        4
1081204 003         15697895.  567.5  0.  0.  0.  4
*1081205  0          15702346. 1263027.9 2443078.0 0.0        0.0        5
1081205 003         15702346.  567.5  0.  0.  0.  5
*1081206  0          15706796. 1263433.3 2442973.3 0.0        0.0        6
1081206 003         15706796.  567.5  0.  0.  0.  6
*1081207  0          15711245. 1263648.4 2442868.6 0.0        0.0        7
1081207 003        15711245.   567.5  0.  0.  0.  7
*1081208  0          15715694. 1263720.1 2442763.9 0.0        0.0        8
1081208 003       15715694.    567.5  0.  0.  0.  8
*1081209  0          15722509. 1263721.2 2442603.7 0.0        0.0        9
1081209 003         15722509.  567.5  0.  0.  0.  9
1081300   0
1081301   .65871571 .65871571 0.0       1                  * 48.158687
1081302   .65898280 .65898280 0.0       2                  * 48.158693
1081303   .65922606 .65922606 0.0       3                  * 48.158697
1081304   .65945084 .65945084 0.0       4                  * 48.158699
1081305   .65963484 .65963484 0.0       5                  * 48.158700
1081306   .65976032 .65976032 0.0       6                  * 48.158700
1081307   .65982512 .65982512 0.0       7                  * 48.158698
1081308   .65984417 .65984417 0.0       8                  * 48.158695
*
*****************************************************************
1120000     lplovol     snglvol
1120101     0.0   0.626  0.1661  0.0    90.0    0.626    4.57e-5
1120102     0.0104   00
*1120200   0          15732812. 1260987.0 2442361.5 0.0
1120200 003        15732812.   567.5
*
*****************************************************************
1160000     lowrplnm    branch
1160001   3         0
1160101     0.0   0.4762  0.0943   0.0  90.0  0.4762   4.57e-5
1160102     0.0104   00
*1160200   0          15728774. 1263722.5 2442456.4 0.0
1160200 003      15728774.     567.5
1161101     108010000   116010000   0.09774     1.0   1.0   0100
1162101     112010000   116000000   0.23623     0.0   0.0   0000
```

```
1163101     116010000   120000000   0.15931     8.34  8.34   0000
* 1162101     112010000   116000000   0.0         0.0   0.0    0000
* 1163101     116010000   120000000   0.1038      8.34  8.34   0000
1161201   .65983851 .65983851 0.0                          * 48.158680
1162201   .115004-9 .152679-9 0.0                          * 17.0061-9
1163201   .62131130 .62131130 0.0                          * 48.158664
1162110   0.0104      1.0       1.0       1.0
1163110   0.0104      1.0       1.0       1.0
*
*******************************************************************
1200000     corein      branch
1200001   1         0
1200101     0.0   1.2588  0.1821   0.0   90.0   1.2588    4.57e-5
1200102     0.0104     00
*1200200   0          15721639. 1263726.1 2442624.1 0.0
1200200  003     15721639.    567.5
1201101     120010000   124000000   0.13657     0.85  0.85  0000
1201201   .481857   .481857   0.0                          * 48.158607
1201110   0.009721      1.0       1.0       1.0
*
*******************************************************************
1240000   core     pipe
1240001   6
1240101   0.0         6
1240201   0.119868    5
* 1240201   0.06774     5
1240301   0.610       6
1240401   0.07312     6
1240601  90.0         6
1240701   0.610       6
1240801   4.57e-5   0.00832  6
1240901   0.68    0.68  5
1241001   00100       6
1241101   0000        5
*1241201   0          15713996. 1281265.0 2442803.9 0.0        0.0       1
1241201 003     15713996.   573.05  0.  0.  0.  1
*1241202   0          15708831. 1317062.4 2442925.4 0.0        0.0       2
1241202 003     15708831.   578.6   0.  0.  0.  2
*1241203   0          15703749. 1365699.2 2443045.0 0.0        0.0       3
1241203 003     15703749.   584.15  0.  0.  0.  3
*1241204   0          15698764. 1414083.2 2443162.3 0.0        0.0       4
1241204 003     15698764.   589.70  0.  0.  0.  4
*1241205   0          15693863. 1449245.9 2443277.8 0.0        0.0       5
1241205 003     15693863.   595.25  0.  0.  0.  5
*1241206   0          15689012. 1465987.5 2443392.0 0.0        0.0       6
1241206 003     15689012.   600.5   0.  0.  0.  6
1241300   0
1241301   .96034412 .96034412 0.0       1                  * 48.158578
1241302   .97815501 .97815501 0.0       2                  * 48.158541
1241303   1.0046451 1.0046451 0.0       3                  * 48.158496
1241304   1.0341781 1.0341781 0.0       4                  * 48.158441
```

```
1241305   1.0577423 1.0577423 0.0       5                  * 48.158378
1241401   0.00832     1.0      1.0      1.0      5
*                                                                    *
*****************************************************************
1280000    creoutlt   branch                                         *
1280001   3           0
1280101    0.0    0.867  0.1522    0.0    90.0    0.867    4.57e-5      *
1280102    0.0    00                                                 *
*1280200    0          15680901. 1464738.1 2443583.1 0.0
1280200 003        15680901.    600.5
1281101     124010000    128000000  0.15255    1.272    1.272     0000
1282101     128010000    132000000  0.16737    0.0    0.0     0000
1283101     156010000    128010000  0.085679  420.    420.    0000
* 1281101     124010000    128000000  0.03114    1.272    1.272     0000
* 1282101     128010000    132000000  0.0  0.0    0.0     0000
* 1283101     156010000    128010000  0.1144     420.    420.    0000
1281201   2.3270926 2.3270926 0.0                          * 48.158308
1282201   .46385815 .46385815 0.0                          * 48.399826
1283201   3.01830-3 3.01830-3 0.0                          * .24167236
1281110   0.28097      1.0      1.0      1.0
1282110   0.4063       1.0      1.0      1.0
1283110   0.3078       1.0      1.0      1.0
*
*********************************************************************
1320000      upplnm       snglvol
1320101      0.0    0.6757  0.1060    0.0    90.0   0.6757    4.57e-5
1320102      0.321    00
*1320200    0          15675850. 1463705.5 2443702.1 0.0
1320200  003        15675850.     600.5
*
*********************************************************************
1360000      upplnml      branch
1360001   5           0
1360101   0.0     0.600    0.09389  0.0   90.0     0.600     4.57e-5
1360102      0.321    00
1360200   0          15671715. 1462948.6 2443799.6 0.0
1360200 003        15671715.     600.5
1361101      136000000    200000000    0.05520       0.265   0.265   0102
1362101      136000000    400000000    0.05520       0.265   0.265   0102
1363101      132010000    136000000    0.15669       0.0     0.0    0000
1364101      140000000    136010000    0.14305       0.0     0.0    0000
* 1363101      132010000    136000000    0.0           0.0     0.0    0000
* 1364101      140000000    136010000    0.0           0.0     0.0    0000
1365101      104000000    136000000    1.0e-4        40.     40.   0103
1361201    .65833557 .65833557 0.0                        * 24.200218
1362201    .65830429 .65830429 0.0                        * 24.199069
1363201    .46469046 .46469046 0.0                        * 48.399714
1364201    -4.0444-6 -4.0444-6 0.0                        * -326.21-6
1365201     0.551075    0.550175 0.0                       * 0.041000
1363110     0.321       1.0      1.0      1.0
1364110     0.321       1.0      1.0      1.0
```

```
*
*********************************************************************
1400000     uptopvol    snglvol
1400101     0.0   0.3674  0.0445   0.0   90.0  0.3674   4.57e-5
1400102     0.321   00
*1400200   0          15668458. 1274378.1 2443876.4 0.0
1400200  003          15668458.    600.5
*
*********************************************************************
1440000     tophat      snglvol
1440101     0.0   0.897   0.1655   0.0   90.0   0.897    4.57e-5
1440102     0.95    00
*1440200   0          15661376. 1265008.8 2444043.5 0.0
1440200 003           15661376.   595.0
*
*********************************************************************
1480000     uhmidvol    branch
1480001   2         0
1480101   0.0   0.725  0.1970    0.0   90.0   0.725    4.57e-5
1480102     0.256  00
*1480200   0          15655440. 1263579.0 2444183.5 0.0
1480200 003           15655440.  595.0
1481101     100000000   148000000   9.5e-5  0.0    0.0   0100  * uh/dc leak
1482101     144010000   148000000   0.0    0.0    0.0   0000
1481201   3.73012-3 3.73012-3 0.0                        * .24180655
1482201   -356.96-9 -356.92-9 0.0                        * -49.179-6
*
*********************************************************************
1520000     uhtopvol    branch
1520001   2         0
1520101   0.0   0.504  0.1475   0.0   90.0   0.504    4.57e-5
1520102     0.0     00
*1520200   0          15650939. 1262745.7 2444289.7 0.0
1520200 003          15650939.   595.0
1521101     148010000   152000000   0.0    0.0    0.0    0000
1522101     152000000   156000000  0.00199  1.472  1.472  0000
1521201   1.19108-3 1.19108-3 0.0                        * .24167128
1522201   .16263527 .16263526 0.0                        * .24176700
*                                                            *
*****************************************************************
1560000     gdetub     pipe
1560001     2
1560101     0.0        2
1560201     0.0102     1
1560301     1.9260     1
1560302     1.6431     2
1560401     0.06209    1
1560402     0.06286    2
1560601   -90.0        2
1560701    -1.9260     1
1560702    -1.6431     2
```

```
1560801   4.57e-5   0.0      2
1560901   3.34    3.34    1
1561001   00         2
1561101   0000       1
*1561201   0         15659815. 1264980.5 2444080.3 0.0       0.0       1
1561201 003        15659815.  594.  0.  0.  0. 1
*1561202   0         15672498. 1384706.7 2443781.2 0.0       0.0       2
1561202 003        15672498.  597.  0.  0.  0. 2
1561300   0
1561301   .03175404 .03175404 0.0       1               * .24169252
*                                                                       *
*****************************************************************
*  loop without pressurizer (broken loop)
*****************************************************************
*
2000000    nphotleg   snglvol
2000101    0.0337  1.3246  0.0  0.0  0.0  0.0  4.57e-5 0.207  00
*2000200   0         15671308. 1462950.6 2443809.2 0.0
2000200 003         15671308.   600.5
*
*****************************************************************
2020000   blhlbyps     branch
2020001   1          0
2020101   3.53e-4  2.65   0.0  0.0  0.0  0.0  4.57e-5  0.0     00
*2020200   0         15671269. 1462952.3 2443810.1 0.0
2020200 003         15671269.  567.5
2021101     104010000   202000000   3.53e-4   0.0    0.0   0100
2021201   0.0   0.0    0.0
*
*********************************************************************
2030000   blhlbyp   valve
2030101   202010000   204000000  3.53e-4 27.6 27.6 0100
2030201   0      0.913 0.913 0.0
2030300   srvvlv
2030301   203
*
*****************************************************************
2040000   blhlbyps     branch
2040001   1          0
2040101   3.53e-4  1.66   0.0  0.0 90.0  0.30  4.57e-5  0.0     00
*2040200   0         15671269. 1462952.3 2443810.1 0.0
2040200 003         15671269.  567.5
2041101     204010000   200000000   3.53e-4   0.0    0.0   0101
2041201   0.0   0.0    0.0
*
*****************************************************************
2060000   nphotleg     branch
2060001   2          0
2060101   0.0337  1.3843  0.0  0.0  0.0  0.0  4.57e-5  0.207  00
*2060200   0         15671269. 1462952.3 2443810.1 0.0
2060200 003         15671269.   600.5
```

```
2061101    200010000  206000000  0.0337     0.0  0.0  0000
2062101    206010000  208000000  0.0337     0.0  0.0  0000
2061201  1.0783423 1.0783423 0.0                    * 24.200171
2062201  1.0783417 1.0783417 0.0                    * 24.200126
*
*****************************************************************
2080000    wphotleg     pipe
2080001    2
2080101    0.0337         2
2080301    0.7043         1
2080302    0.5278         2
2080601    0.0            1
2080602   50.0            2
2080701    0.0            1
2080702    0.4043         2
2080801    4.57e-5  0.207 2
2080901    0.05    0.05   1
2081001    00             2
2081101   100000          1
*2081201   0          15671238. 1462953.4 2443810.9 0.0      0.0      1
2081201 003          15671238.  600.5  0.  0.  0. 1
*2081202   0          15669897. 1462953.9 2443842.5 0.0      0.0      2
2081202 003          15669897.  600.5  0.  0.  0. 2
2081300   0
2081301   1.0783412 1.0783412 0.0       1                * 24.200096
2081401    0.     0.    0.55    0.785    1
*
***********************************************************************
2090000    nphotleg    sngljun
2090101    208010000   212000000   0.0337     0.0  0.0  0100
2090201   0          1.0783441 1.0783441 0.0               * 24.200078
*
*****************************************************************
2120000    npsgin      snglvol
2120101    0.0   0.706   0.125    0.0   90.0   0.706   4.57e-5
2120102    0.377   00
*2120200   0          15666381. 1462958.0 2443925.4 0.0
2120200 003          15666381.    600.5
*
***********************************************************************
2130000    npsgfbj     sngljun
2130101    212010000   216000000   0.2093     0.0  0.0  0000
2130201   0         .17362836 .17362836 0.0                * 24.199962
*
*****************************************************************
2160000    npsgfb      snglvol
2160101    0.0   1.1035   0.2323    0.0   90.0   1.1035   4.57e-5
2160102    0.4474   00
*2160200   0          15660476. 1462958.2 2444064.7 0.0
2160200 003          15660476.    600.5
*
```

```
***********************************************************************
2170000     npsgin      sngljun
2170101     216010000   220000000   0.0425      0.0     0.0 100100
2170110     0.    0.    0.725    1.
2170201   0          .85507596 .85507596 0.0              * 24.199843
*
*****************************************************************
2200000     npsgtube    pipe
2200001          8
2200101     0.0425      8
2200301     2.8724      1
2200302     2.5654      3
2200303     2.1728      5
2200304     2.5654      7
2200305     2.8724      8
2200601     90.0        4
2200604    -90.0        8
2200701     2.8724      1
2200702     2.5654      3
2200703     2.0980      4
2200704    -2.0980      5
2200705    -2.5654      7
2200706    -2.8724      8
2200801    1.524-6      0.0196      8
2200901     0.0         0.0         3
2200902     0.006       0.0         4
2200903     0.006       0.006       5
2200904     0.0         0.006       6
2200905     0.0         0.0         7
2201001     00          8
2201101     0000        7
*2201201   0         15646205. 1389454.1 2444401.5 0.0         0.0        1
2201201 003         15646205.   596.83  0.  0.  0.  1
*2201202   0         15626456. 1341291.4 2444868.0 0.0         0.0        2
2201202 003         15626456.   593.17  0.  0.  0.  2
*2201203   0         15607430. 1309854.4 2445317.9 0.0         0.0        3
2201203 003         15607430.   589.50  0.  0.  0.  3
*2201204   0         15589925. 1291367.9 2445732.2 0.0         0.0        4
2201204 003         15589925.   585.83  0.  0.  0.  4
*2201205   0         15589288. 1278668.1 2445747.3 0.0         0.0        5
2201205 003         15589288.   582.17  0.  0.  0.  5
*2201206   0         15605534. 1269039.8 2445362.7 0.0         0.0        6
2201206 003         15605534.   578.50  0.  0.  0.  6
*2201207   0         15623494. 1262856.0 2444938.0 0.0         0.0        7
2201207 003         15623494.   574.83  0.  0.  0.  7
*2201208   0         15642582. 1258768.9 2444487.0 0.0         0.0        8
2201208 003         15642582.  571.17   0.  0.  0.  8
2201300   0
2201301   .81588998 .81588998 0.0       1              * 24.199823
2201302   .79384485 .79384485 0.0       2              * 24.199820
2201303   .78062354 .78062354 0.0       3              * 24.199823
```

```
2201304    .77326379 .77326379 0.0       4                    * 24.199828
2201305    .76829604 .76829604 0.0       5                    * 24.199833
2201306    .76462686 .76462686 0.0       6                    * 24.199839
2201307    .76231250 .76231250 0.0       7                    * 24.199844
*
*************************************************************************
2210000      npsgout     sngljun
2210101      220010000   224000000    0.0425      0.0    0.0    0100
2210201   0          .76079645 .76079645 0.0                  * 24.199848
*
*************************************************************************
2240000      npsgfbo     snglvol
2240101      0.0   1.1035   0.2323    0.0  -90.0  -1.1035   4.57e-5
2240102      0.4474   00
*2240200   0           15656792. 1258767.5 2444151.6 0.0
2240200 003            15656792.  567.5
*
*************************************************************************
2250000      npsgfbj     sngljun
2250101      224010000   228000000    0.2093      0.0    0.0    0000
2250201   0          .15448286 .15448286 0.0                  * 24.199869
*
*****************************************************************
2280000      npsgout     snglvol
2280101      0.0   0.706   0.125   0.0  -90.0  -0.706   4.57e-5
2280102      0.377   00
*2280200   0           15663429. 1258765.9 2443995.0 0.0
2280200 003            15663429.    567.5
*
*************************************************************************
2290000      npcrsleg    sngljun
2290101      228010000   232000000    0.0222      0.0   0.0     0100
2290201   0          1.4564407 1.4564407 0.0                  * 24.199885
*
*******************************************************************
2320000      npcrsleg    pipe
2320001       5
2320101      0.0222   5
2320301      0.516    1
2320302      1.2422   4
2320303      1.1919   5
2320601      -50.0    1
2320602      -90.0    4
2320603       0.0     5
2320701      -0.3953  1
2320702      -1.2422  4
2320703       0.0     5
2320801      4.57e-5  0.1682    5
2320901      0.036    0.036     1
2320902      0.0      0.0       3
2320903      0.065    0.065     4
```

```
2321001     00        5
2321101     0000      4
*2321201   0           15666371. 1258765.7 2443925.6 0.0       0.0       1
2321202  003         15666371.   567.5  0.  0.  0.  1
*2321202   0           15672314. 1258765.3 2443785.5 0.0       0.0       2
2321202 003            15672314.   567.5  0.  0.  0.  2
*2321203   0           15681337. 1258765.0 2443572.8 0.0       0.0       3
2321203 003            15681337.   567.5  0.  0.  0.  3
*2321204   0           15690360. 1258764.6 2443360.3 0.0       0.0       4
2321204 003            15690360.  567.5  0.  0.  0.  4
*2321205   0           15694826. 1258764.2 2443255.1 0.0       0.0       5
2321205 003            15694826.   567.5  0.  0.  0.  5
2321300   0
2321301   1.4564352 1.4564352 0.0       1                 * 24.199886
2321302   1.4564240 1.4564240 0.0       2                 * 24.199890
2321303   1.4564071 1.4564071 0.0       3                 * 24.199894
2321304   1.4563903 1.4563903 0.0       4                 * 24.199899
*
*******************************************************************
2330000   npfcv     valve
2330101   232010000   236000000   0.0222   0.0  0.0  0100
2330201   0         1.4563819 1.4563819 0.0               * 24.199903
2330300   mtrvlv
2330301   536       537       1.4200000 1.0000000 0
*
*******************************************************************
2360000     npcrslgu   pipe
2360001     4
2360101     0.0222   4
2360301     1.3202   1
2360302     1.1222   2
2360303     1.1417   3
2360304     1.1222   4
2360601      0.0     1
2360602      90.0    4
2360701      0.0     1
2360702      1.1222  4
2360801     4.57e-5  0.1682   4
2360901     0.065    0.065    1
2360902     0.0      0.0      3
2361001     00       4
2361101     0000     3
*2361201   0         15694735. 1258763.5 2443257.2 0.0       0.0       1
2361201 003         15694735.  567.5  0.  0.  0.  1
*2361202   0         15690528. 1258762.9 2443356.3 0.0       0.0       2
2361202 003          15690528. 567.5  0.  0.  0.  2
*2361203   0         15682206. 1258762.1 2443552.4 0.0       0.0       3
2361203 003         15682206.  567.5  0.  0.  0.  3
*2361204   0         15673883. 1258761.3 2443748.5 0.0       0.0       4
2361204 003         15673883.  567.5  0.  0.  0.  4
2361300   0
```

```
2361301   1.4563819 1.4563819 0.0      1                 * 24.199907
2361302   1.4563895 1.4563895 0.0      2                 * 24.199912
2361303   1.4564048 1.4564048 0.0      3                 * 24.199916
*
*********************************************************************
2400000     nprcpump    pump
2400101     0.0   0.802   0.0235   0.0   90.0   0.351   0
2400108     236010000   0.0222     0.0   0.0   0000
2400109     244000000   0.0337     0.0525 0.0525  0000
*2400200  0          15673807. 1258785.4 2443750.3 0.0
2400200 003          15673807.  567.5
2400201   0          1.4564201 1.4564201 0.0                 * 24.199921
2400202   0          .95943350 .95943350 0.0                 * 24.199925
2400301    0    0     0    -1    0    0    0
2400302   188.50000 .424116  .05400000 10.000000 55.200000
2400303     0.54        750.0      0.0   0.0   0.0   0.0   0.0
*
* single phase head and torque data from 1stf sys. description
*
2401100  1  1  0.00  1.36  0.10  1.38  0.24  1.42  0.40  1.41
2401101        0.60  1.32  0.80  1.19  1.00  1.00
2401200  1  2  0.00  -0.97  0.20  -0.68  0.50  -0.20  0.65   0.07
2401201        0.80   0.40  1.00   1.00
2401300  1  3  -1.0  3.20  -0.90  2.80  -0.80  2.46  -0.60  1.94
2401301        -0.40 1.57  -0.20  1.41   0.00  1.36
2401400  1  4  -1.00  3.20  -0.80  2.76  -0.60  2.41  -0.40  2.09
2401401        -0.20  1.81   0.00  1.58
2401500  1  5  0.00   0.00  1.00  0.00
2401600  1  6  0.00   0.00  1.00  0.00
2401700  1  7  -1.00  0.00  0.00  0.00
2401800  1  8  -1.00  0.00  0.00  0.00
*
*  torque data
*
2401900  2  1  0.00  0.36  0.12  0.38  0.20  0.44  0.30  0.58
2401901        0.50  0.73  0.70  0.81  1.00  1.00
2402000  2  2  0.00  -1.26  0.10  -0.88  0.30  -0.31  0.50   0.09
2402001        0.65   0.30  0.86   0.63  1.00   1.00
2402100  2  3  -1.00  2.40  -0.85  1.70  -0.65  1.12  -0.50  0.84
2402101        -0.40  0.69  -0.20  0.59   0.00  0.36
2402200  2  4  -1.00  2.40  -0.80  2.12  -0.60  1.80  -0.30  1.32
2402201         0.00  0.80
2402300  2  5  0.00  0.00   1.00  0.00
2402400  2  6  0.00  0.00   1.00  0.00
2402500  2  7  -1.00  0.00  0.00  0.00
2402600  2  8  -1.00  0.00  0.00  0.00
*
*  two phase multiplier tables for head of rc pump 240
*
2403000      0      0.0   0.0
2403001             0.10  0.0
```

```
2403002           0.15  0.05
2403003           0.24  0.80
2403004           0.30  0.96
2403005           0.40  0.98
2403006           0.60  0.97
2403007           0.80  0.90
2403008           0.90  0.80
2403009           0.96  0.50
2403010           1.00  0.0
*
*  two phase multiplier tables for torque of rc pump 240
*
2403100     0     0.0   0.0
2403101           1.0   0.0
*
* two-phase diff curves from r5 built-in data
*  head difference curves
*
2404100  1  1  0.00  0.00  0.10  0.83  0.20  1.09  0.50  1.02
2404101        0.70  1.01  0.90  0.94  1.00  1.00
2404200  1  2  0.00  0.00  0.10  -0.40  0.20  0.00  0.30  0.10
2404201        0.40  0.21  0.80   0.67  0.90  0.80  1.00  1.00
2404300  1  3  -1.00  -1.16  -0.90  -1.24  -0.80  -1.77  -0.70  -2.36
2404301        -0.60  -2.79  -0.50  -2.91  -0.40  -2.67  -0.25  -1.69
2404302        -0.10  -0.50   0.00   0.00
2404400  1  4  -1.00  -1.16  -0.90  -0.78  -0.80  -0.50  -0.70  -0.31
2404401        -0.60  -0.17  -0.50  -0.08  -0.35   0.00  -0.20   0.05
2404402        -0.10   0.08   0.00   0.11
2404500  1  5  0.00  0.00  1.00  0.00
2404600  1  6  0.00  0.00  1.00  0.00
2404700  1  7  -1.00  0.00  0.00  0.00
2404800  1  8  -1.00  0.00  0.00  0.00
*
*  torque difference curves
*
2404900  2  1  0.0  0.0  0.0  0.0
2405000  2  2  0.0  0.0  0.0  0.0
2405100  2  3  0.0  0.0  0.0  0.0
2405200  2  4  0.0  0.0  0.0  0.0
2405300  2  5  0.0  0.0  0.0  0.0
2405400  2  6  0.0  0.0  0.0  0.0
2405500  2  7  0.0  0.0  0.0  0.0
2405600  2  8  0.0  0.0  0.0  0.0
*
*   pump coastdown data
*
2406100     501                * norm speed
2406101      0.0      82.93    *
2406102     14.0     160.22    *
2406103     16.0     160.85    *
2406104     17.0     160.22    *
```

```
2406105     30.0      74.14   *
2406106     32.0      72.26   *
2406107     45.0      48.69   *
2406108     60.0      34.68   *
2406109     80.0      24.82   *
2406110    100.0      19.29   *
2406111    130.0      14.45   *
2406112    163.0       9.74   *
2406113    200.0       9.93   *
2406114    230.0       9.61   *
2406115    266.0       7.10
2406116    268.0       0.
2406117   1000.0       0.
*
*********************************************************************
2440000     npcolleg    branch
2440001   2         0
2440101     0.0337   0.7348   0.0   0.0   0.0   0.0   4.57e-5  0.207 00
*2440200   0         15677656. 1258785.1 2443659.6 0.0
2440200 003         15677656.  567.5
2441101     244010000   248000000   0.0337     0.0   0.0   0000
2442101     790010000   244010000   0.0060     1.0   0.5   0001
2441201   .95942878 .95942878 0.0                     * 24.199929
2442201   .140252-9 .140251-9 0.0                     * .845944-9
*
*********************************************************************
2480000     npcolleg    branch
2480001   1         0
2480101     0.0337     0.9429  0.0  0.0  0.0  0.0  4.57e-5  0.207   00
*2480200   0         15677636. 1258784.7 2443660.1 0.0
2480200 003         15677636.  567.5
2482101     248010000   252000000   0.0337     0.0   0.0   0000
2482201   .95942879 .95942879 0.0                     * 24.199934
*
****************************************************************
2520000     npcolleg       pipe
2520001     2
2520101     0.0337          2
2520301     0.9752          2
2520601     0.0             2
2520701     0.0             2
2520801     4.57e-5  0.207  2
2521001     00              2
2521101     0000            1
*2521201   0         15677611. 1258784.2 2443660.7 0.0       0.0       1
2521201 003         15677611.  567.5  0.  0.  0.  1
*2521202   0         15677584. 1258783.8 2443661.3 0.0       0.0       2
2521202 003         15677584.  567.5  0.  0.  0.  2
2521300   0
2521301   .95942883 .95942883 0.0       1                 * 24.199940
*
```

```
**********************************************************************
*
*  secondary loop for the broken loop
*
*********************************************************************
3000000     npstgdcm    annulus
3000001     5
3000101     0.0         1
3000102     0.0296      4
3000103     0.0         5
3000201     0.0         3
3000202     0.005281    4
3000301     2.8965      1
3000302     2.0980      2
3000303     2.5654      4
3000304     3.4395      5
3000401     0.3228      1
3000402     0.0         4
3000403     0.1302      5
3000501     0.0         5
3000601    -90.0        5
3000701    -2.0223      1
3000702    -2.0980      2
3000703    -2.5654      4
3000704    -2.5464      5
3000801     4.57e-5   0.3689   1
3000802     4.57e-5   0.0971   4
3000803     4.57e-5   0.0801   5
3000901     0.0       0.0      4
3001001     00          5
3001101     0000        3
3001102     0100        4
*3001201   0        7110719.4 1200517.1 2580791.9 0.0      0.0      1
3001201 003        7310719.   551.  0. 0.  0.  1
*3001202   0        7125934.5 1200526.7 2580629.2 0.0      0.0      2
3001202 003        7325934.   551.  0.  0.  0.  2
*3001203   0        7143272.8 1200530.5 2580444.0 0.0      0.0      3
3001203 003        7343272.   551.  0.  0.  0.  3
*3001204   0        7162349.3 1200527.5 2580240.7 0.0      0.0      4
3001204 003        7362349.   551.  0.  0.  0.  4
*3001205   0        7171666.9 1202251.3 2580141.6 0.0      0.0      5
3001205 003         7371666.  551.  0.  0.  0.  5
3001300    0
3001301    .61390359 .61390359 0.0       1             * 13.834317
3001302    .61389325 .61389325 0.0       2             * 13.834278
3001303    .61387866 .61387866 0.0       3             * 13.834214
3001304    .61386007 .61386007 0.0       4             * 13.834133
*
*******************************************************************
3010000     npstgdcm    sngljun
3010101     300010000   304000000   0.0     100.0   100.0     0000
```

```
3010201   0         .48038520 .69708130 0.0                * 13.833941
*
*********************************************************************
3040000     blsteamg    pipe
3040001      5
3040101     0.2293      3
3040102     0.0         5
3040201     0.2293      2
3040202     0.2323      3
3040203     0.3138      4
* 3040201     0.0712      3
* 3040202     0.0         4
3040301     2.5464      1
3040302     2.5654      3
3040303     2.0980      4
3040304     2.0223      5
3040401     0.0         3
3040402     0.4951      4
3040403     0.7979      5
3040501     0.0         5
3040601     90.0        5
3040701     2.5464      1
3040702     2.5654      3
3040703     2.0980      4
3040704     2.0223      5
3040801     4.57e-5     0.036      4
3040802     4.57e-5     0.219      5
3040901     1.435   1.435   4
3041001     00          5
3041101     0000        3
3041102     0000        4
3041201   0         7360485.9 1261112.3 2580244.6 .14219192 0.0       1
3041202   0         7347036.6 1264931.2 2580399.8 .28828728 0.0       2
3041203   0         7334704.9 1264683.5 2580530.3 .28643954 0.0       3
3041204   0         7323302.6 1264128.3 2580649.9 .27887377 0.0       4
3041205   0         7313423.5 1263801.8 2580702.3 .27518532 0.0       5
3041300     0
3041301   .09940788 .37087476 0.0       1                  * 13.810074
3041302   .11458638 .49504010 0.0       2                  * 13.804585
3041303   .10794204 .71300003 0.0       3                  * 13.802420
3041304   .09899163 .87128853 0.0       4                  * 13.799040
3041401   0.036     1.0     1.0     1.0     3
3041402   0.1258    1.0     1.0     1.0     4
*
*****************************************************************
3080000     npsepar     separatr
3080001   3    0
3080101   0.0   2.120   0.572   0.0   90.0   2.120   4.57e-5
3080102   0.2134   00
3080200   0         7304590.2 1263471.6 2580768.1 .50638217
3081101   308010000   316000000   0.0615   0.0   0.0   0100 0.2
```

```
3082101   308000000   300000000   0.03964 100.0 100.0   0000
3083101   304010000   308000000   0.1986   0.0   0.0   0000
3081201   -.3840036 .27406855 0.0                     * 2.7469745
3082201   .37743398 -1.777076 0.0                     * 11.041964
3083201   .11701332 1.0458935 0.0                     * 13.801835
*
******************************************************************
3120000   npsgspbp    branch
3120001   2           0
3120101   0.0   2.120   0.6288   0.0   90.0   2.120   4.57e-5
3120102   0.1242   00
3120200   0          7301893.0 1236857.5 2584233.4 .87891994
3121101   300000000   312000000   0.3164    0.0   0.0   0000
3122101   312010000   316000000   0.0392    1.5   1.5   0000
3121201   30.0480-6 1.1555824 0.0                     * 7.23798-3
3122201   -42.50990 -1.5229-3 0.0                     * -2.6126-3
*
******************************************************************
3160000   stmdome    snglvol
3160101   0.0   3.7778   2.0288   0.0   90.0   3.7778   4.57e-5
3160102   0.7696    00
3160200   0          7299946.7 1262926.9 2580859.5 .99999968
*
******************************************************************
*   blsg steam line
******************************************************************
3200000   blstmln1    branch
3200001   2           0
3200101   0.0286    5.286  0.0    0.0    0.0    0.0    4.57e-5
3200102   0.1909    00
3200200   0          7299057.2 1262882.9 2580880.3 .99999786
3201101   316010000   320000000   0.0286    0.0   0.0   0100
3202101   320010000   324000000   0.0286    0.0   0.0   0000
3201201   2.4791454 2.5876488 0.0                     * 2.7470311
3202201   2.4234202 2.5881767 0.0                     * 2.7472440
*
******************************************************************
3240000   blstmln2    branch
3240001   1           0
3240101   0.0286    9.9213  0.0    0.0    0.0    0.0    4.57e-5
3240102   0.1909    00
3240200   0          7298966.1 1262878.4 2580896.2 .99999675
3241101   324010000   328000000   0.00429   0.0   0.0   0000
3241201   14.028836 17.257852 0.0                     * 2.7477108
*
******************************************************************
3280000   blstmln3    snglvol
3280101   0.00429   8.3215   0.0    0.0    0.0    0.0    4.57e-5
3280102   0.0739    00
3280200   0          7288063.0 1262339.0 2580962.3 .99998690
*
```

```
*********************************************************************
3290000   blmsiv    valve
3290101   328010000   332000000   0.00429   0.0  0.0  0100
3290201   0         12.637699 17.284590 0.0               * 2.7477202
3290300   mtrvlv
3290301   568       501       2.0000000 1.0000000 0
*
*********************************************************************
3320000   vlvtovlv   snglvol
3320101   0.00429   6.446   0.0   0.0   0.0   0.0   4.57e-5
3320102   0.0739    00
3320200   0         7278346.0 1261857.2 2581064.5 .99997696
*
*********************************************************************
3330000   blchkvl    valve
3330101   332010000   804000000   0.00429   0.0   0.0  0000
3330201   0         10.389571 17.310434 0.0               * 2.7477882
3330300   chkvlv
3330310   0    0     0.0   0.0
*
*********************************************************************
3500000     auxfed       tmdpvol
3500101     8.0          5.0   0.0   0.0   0.0   0.0   0.0   0     00
3500200     3
3500201     0.0          5.95300e+6        313.0
*
*********************************************************************
3510000     auxfed       tmdpjun
3510101     350000000    300000000   0.004
3510200     1   623
3510201     0.0    0.0   0.0   0.0
3510202     0.01   1.168 0.0   0.0
3510203   5000.0   1.168 0.0   0.0
*********************************************************************
3600000     npstegfw     tmdpvol
3600101     0.139        5.0   0.0   0.0   0.0   0.0   0.0   0     00
3600200     3
3600201     0.0          5.83400e+6        495.35
*
*********************************************************************
3610000     npstegfw     tmdpjun
3610101     360000000    300000000   4.00e-3
3610200     1    550    cntrlvar   361
3610201     0.0    0.0      0.0  0.0
3610202     5.0    5.0      0.0  0.0
3610203     7.0    7.0      0.0  0.0
3610204  1000.0    7.0      0.0  0.0
*
*********************************************************************
* secondary relief and safety valves, intact loop
*********************************************************************
```

```
*
3690000   blsgrv    valve
3690101   320010000   370000000   2.96e-4   0.0149   0.0   0100
3690201   0           0.0         0.0       0.0              * 0.0
3690300   trpvlv
3690301   609
*
*********************************************************************
3700000   contain    tmdpvol
3700101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
3700200   3
3700201   0.0   1.01325e+5   293.15
*
*********************************************************************
3790000   blsgsv    valve
3790101   324010000   380000000   0.00195   0.00055   0.0   0100
3790201   0           0.0         0.0       0.0              * 0.0
3790300   trpvlv
3790301   612
*
*********************************************************************
3800000   contain    tmdpvol
3800101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
3800200   3
3800201   0.0   1.01325e+5   293.15
*
*********************************************************************
*  loop with pressurizer (intact loop)
*****************************************************************
*
4000000    wphotleg   snglvol
4000101    0.0337  1.3246  0.0  0.0  0.0  0.0  4.57e-5 0.207  00
*4000200    0          15671308. 1462950.6 2443809.2 0.0
4000200 003           15671308.  600.5
*
*****************************************************************
4020000   ilhlbyps     branch
4020001   1           0
4020101   3.53e-4  2.65   0.0  0.0  0.0  0.0  4.57e-5  0.0     00
*4020200    0          15671269. 1462952.3 2443810.1 0.0
4020200 003           15671269.  600.5
4021101     104010000   402000000   3.53e-4   0.0    0.0    0100
4021201   0.0   0.0    0.0
*
*********************************************************************
4030000   blhlbyp   valve
4030101   402010000   404000000  3.53e-4 27.6 27.6 0100
4030201   0     0.913 0.913 0.0
4030300   srvvlv
4030301   403
*
```

```
*****************************************************************
4040000   blhlbyps     branch
4040001   1          0
4040101   3.53e-4  1.66   0.0   0.0 90.0  0.30  4.57e-5  0.0     00
*4040200   0          15671269. 1462952.3 2443810.1 0.0
4040200 003          15671269.  600.5
4041101     404010000   400000000   3.53e-4   0.0   0.0   0101
4041201   0.0   0.0    0.0
*
*****************************************************************
4060000     wphotleg    branch
4060001   3          0
4060101   0.0337  1.3195  0.0   0.0   0.0   0.0  4.57e-5  0.207  00
*4060200   0          15671270. 1462955.0 2443810.1 0.0
4060200 003          15671270.  600.5
4062101     400010000   406000000   0.0337      0.0    0.0    0000
4063101     406010000   408000000   0.0337      0.0    0.0    0000
4064101     600010000   406010000   0.00352     1.0    0.5    0001
4062201   1.0782911 1.0782911 0.0                         * 24.199021
4063201   1.0783730 1.0783730 0.0                         * 24.200785
4064201   791.393-6 791.393-6 0.0                         * 1.80819-3
*
*****************************************************************
4080000     wphotleg      pipe
4080001     2
4080101     0.0337         2
4080301     0.7043         1
4080302     0.5278         2
4080601     0.0            1
4080602    50.0            2
4080701     0.0            1
4080702     0.4043         2
4080801     4.57e-5  0.207  2
4080901     0.05     0.05   1
4081001     00             2
4081101   100000           1
*4081201   0          15671238. 1462956.0 2443810.9 0.0        0.0       1
4081201 003          15671238.  600.5  0.   0.   0.  1
*4081202   0          15669897. 1462956.5 2443842.5 0.0        0.0       2
4081202 003          15669897.  600.5  0.   0.   0.  2
4081300   0
4081301   1.0783725 1.0783725 0.0        1                    * 24.200756
4081401     0.     0.     0.55     0.785     1
*
*********************************************************************
4090000     wphotleg    sngljun
4090101     408010000   412000000   0.0337      0.0    0.0    0100
4090201   0          1.0783754 1.0783754 0.0                  * 24.200738
*
*****************************************************************
4120000     wpsgin      snglvol
```

```
4120101     0.0   0.706   0.125   0.0   90.0   0.706   4.57e-5
4120102     0.377   00
*4120200   0          15666381. 1462960.3 2443925.4 0.0
4120200 003          15666381.  600.5
*
*********************************************************************
4130000     wpsgfbj    sngljun
4130101     412010000  416000000   0.2093      0.0   0.0   0000
4130201   0          .17363340 .17363340 0.0               * 24.200627
*
***************************************************************
4160000     wpsgfb     snglvol
4160101     0.0   1.1035   0.2323   0.0   90.0   1.1035   4.57e-5
4160102     0.4474   00
*4160200   0          15660476. 1462959.7 2444064.7 0.0
4160200 003          15660476.  600.5
*
*********************************************************************
4170000     wpsgin     sngljun
4170101     416010000  420000000   0.0425      0.0   0.0 100100
4170110     0.    0.    0.725    1.
4170201   0          .85510074 .85510074 0.0               * 24.200519
*
***************************************************************
4200000     wpsgtube   pipe
4200001           8
4200101     0.0425      8
4200301     2.8724      1
4200302     2.5654      3
4200303     2.1728      5
4200304     2.5654      7
4200305     2.8724      8
4200601     90.0        4
4200604    -90.0        8
4200701     2.8724      1
4200702     2.5654      3
4200703     2.0980      4
4200704    -2.0980      5
4200705    -2.5654      7
4200706    -2.8724      8
4200801    1.524-6      0.0196      8
4200901     0.0         0.0         3
4200902     0.006       0.0         4
4200903     0.006       0.006       5
4200904     0.0         0.006       6
4200905     0.0         0.0         7
4201001     00          8
4201101     0000        7
*4201201   0          15646206. 1389520.4 2444401.5 0.0        0.0        1
4201201 003          15646206.  596.83 0.  0.  0.  1
*4201202   0          15626457. 1341397.7 2444868.0 0.0        0.0        2
```

```
4201202 003         15626457.  593.17  0.  0.  0.  2
*4201203   0         15607432. 1309986.5 2445317.8 0.0        0.0        3
4201203 003         15607432.  589.5   0.  0.  0.  3
*4201204   0         15589928. 1291513.4 2445732.1 0.0        0.0        4
4201204 003         15589928. 585.83  0.  0.  0.  4
*4201205   0         15589291. 1278822.6 2445747.2 0.0        0.0        5
4201205 003         15589291. 582.17  0.  0.  0.  5
*4201206   0         15605536. 1269201.1 2445362.7 0.0        0.0        6
4201206 003         15605536.  578.5  0.  0.  0.  6
*4201207   0         15623494. 1263021.7 2444938.0 0.0        0.0        7
4201207 003         15623494. 574.83  0.  0.  0.  7
*4201208   0         15642580. 1258938.1 2444487.1 0.0        0.0        8
4201208 003         15642580. 571.17  0.  0.  0.  8
4201300   0
4201301    .81594545 .81594545 0.0       1                  * 24.200508
4201302    .79391451 .79391451 0.0       2                  * 24.200513
4201303    .78069927 .78069927 0.0       3                  * 24.200523
4201304    .77334428 .77334428 0.0       4                  * 24.200534
4201305    .76837805 .76837805 0.0       5                  * 24.200545
4201306    .76470999 .76470999 0.0       6                  * 24.200557
4201307    .76239639 .76239639 0.0       7                  * 24.200568
*
***********************************************************************
4210000     wpsgout     sngljun
4210101     420010000   424000000   0.0425      0.0    0.0    0100
4210201   0          .76088108 .76088108 0.0                * 24.200579
*
***********************************************************************
4240000     wpsgfbo     snglvol
4240101     0.0   1.1035   0.2323   0.0  -90.0  -1.1035   4.57e-5
4240102     0.4474   00
*4240200   0          15656790. 1258936.4 2444151.7 0.0
4240200 003          15656790.  567.5
*
***********************************************************************
4250000     wpsgfbj     sngljun
4250101     424010000   428000000   0.2093      0.0    0.0    0000
4250201   0          .15450004 .15450004 0.0                * 24.200600
*
*****************************************************************
4280000     wpsgout     snglvol
4280101     0.0   0.706   0.125   0.0  -90.0  -0.706   4.57e-5
4280102     0.377   00
*4280200   0          15663426. 1258934.9 2443995.1 0.0
4280200 003          15663426.  567.5
*
***********************************************************************
4290000     wpcrsleg    sngljun
4290101     428010000   432000000   0.0222      0.0   0.0     0100
4290201   0          1.4566026 1.4566026 0.0                * 24.200614
*
```

```
*******************************************************************
4320000     wpcrsleg    pipe
4320001      5
4320101     0.0222   5
4320301     0.516    1
4320302     1.2422   4
4320303     1.1919   5
4320601     -50.0    1
4320602     -90.0    4
4320603      0.0     5
4320701     -0.3953  1
4320702     -1.2422  4
4320703      0.0     5
4320801     4.57e-5  0.1682   5
4320901     0.036    0.036    1
4320902     0.0      0.0      3
4320903     0.065    0.065    4
4321001     00       5
4321101     0000     4
*4321201   0         15666368. 1258934.7 2443925.7 0.0       0.0       1
4321201  003         15666368.  567.5  0.  0.  0.  1
*4321202   0         15672310. 1258934.3 2443785.6 0.0       0.0       2
4321202  003         15672310.  567.5  0.  0.  0.  2
*4321203   0         15681332. 1258934.0 2443573.0 0.0       0.0       3
4321203  003         15681332.  567.5  0.  0.  0.  3
*4321204   0         15690354. 1258933.7 2443360.4 0.0       0.0       4
4321204  003         15690354.  567.5  0.  0.  0.  4
*4321205   0         15694820. 1258933.3 2443255.2 0.0       0.0       5
4321205  003         15694820.  567.5  0.  0.  0.  5
4321300   0
4321301   1.4565970 1.4565970 0.0      1                  * 24.200615
4321302   1.4565858 1.4565858 0.0      2                  * 24.200619
4321303   1.4565689 1.4565689 0.0      3                  * 24.200622
4321304   1.4565520 1.4565520 0.0      4                  * 24.200625
*
*******************************************************************
4330000   wpfcv     valve
4330101   432010000   436000000   0.0222   0.0  0.0  0100
4330201   0         1.4565435 1.4565435 0.0               * 24.200629
4330300   mtrvlv
4330301   538       539       1.4200000 1.0000000 0
*
*******************************************************************
4360000     wpcrslgu   pipe
4360001     4
4360101     0.0222   4
4360301     1.1919   1
4360302     1.1222   2
4360303     1.1763   3
4360304     1.1222   4
4360601      0.0     1
```

```
4360602      90.0   4
4360701      0.0    1
4360702      1.1222 4
4360801     4.57e-5 0.1682   4
4360901     0.065   0.065    1
4360902     0.0     0.0      3
4361001     00      4
4361101     0000    3
*4361201  0         15694729. 1258932.7 2443257.4 0.0       0.0       1
4361201 003         15694729.  567.5  0.  0.  0.  1
*4361202  0         15690523. 1258932.1 2443356.4 0.0       0.0       2
4361202 003         15690523.  567.5  0.  0.  0.  2
*4361203  0         15682201. 1258931.4 2443552.5 0.0       0.0       3
4361203 003         15682201.  567.5  0.  0.  0.  3
*4361204  0         15673879. 1258930.6 2443748.6 0.0       0.0       4
4361204 003         15673879.  567.5  0.  0.  0.  4
4361300   0
4361301   1.4565435 1.4565435 0.0      1                 * 24.200632
4361302   1.4565512 1.4565512 0.0      2                 * 24.200635
4361303   1.4565664 1.4565664 0.0      3                 * 24.200639
*
*******************************************************************
4400000      wprcpump    pump
4400101      0.0   0.802   0.0235   0.0   90.0   0.351   00
4400108      436010000   0.0222      0.0   0.0   0000
4400109      444000000   0.0337      0.0525 0.0525 0000
*4400200   0          15673801. 1258954.9 2443750.5 0.0
4400200 003           15673801.  567.5
4400201   0           1.4565817 1.4565817 0.0              * 24.200642
4400202   0           .95953995 .95953995 0.0              * 24.200645
4400301   240   240   240    -1    0    0    0
4400302   188.50000 .424116  .05400000 10.000000 55.200000
4400303     0.54         750.0       0.0   0.0   0.0   0.0   0.0
*
*   pump coastdown data
*
4406100      501                * norm speed
4406101       0.0    82.9
4406102      14.0   157.71
4406103      16.0   160.22
4406104      17.0   157.71
4406105      23.0   126.29
4406106      35.0    57.68
4406107      50.0    42.10
4406108      55.0    37.38
4406109      60.0    34.05
4406110      70.0    28.71
4406111      85.0    23.06
4406112     100.0    19.16
4406113     125.0    14.95
4406114     150.0    12.25
```

```
4406115    165.0   10.81
4406116    200.0   10.05
4406117    230.0    9.86
4406118    266.0    8.61
4406119    267.0    0.
4406120   1000.0    0.
*
*************************************************************************
4440000     wpcolleg    snglvol
4440101     0.0337   1.0562   0.0   0.0   0.0   0.0   4.57e-5  0.207 00
*4440200   0          15677643. 1258954.6 2443659.9 0.0
4440200 003          15677643.  567.5
*
*************************************************************************
4480000     wpcolleg    branch
4480001   3          0
4480101     0.0337   1.1945   0.0   0.0   0.0   0.0   4.57e-5  0.207 00
*4480200   0          15677614. 1258954.2 2443660.6 0.0
4480200 003          15677614.  567.5
4481101     444010000   448000000   0.0337     0.0   0.0   0000
4482101     448010000   452000000   0.0337     0.0   0.0   0000
4483101     740010000   448010000   0.0060     1.0   0.5   0001
4481201   .95953524 .95953524 0.0                        * 24.200649
4482201   .95953528 .95953528 0.0                        * 24.200653
4483201   .394788-9 .394777-9 0.0                        * 2.38120-9
*
*************************************************************************
4520000     wpcolleg    snglvol
4520101     0.0337   1.3125   0.0   0.0   0.0   0.0   4.57e-7 0.207  00
*4520200   0          15677585. 1258953.9 2443661.3 0.0
4520200 003          15677585.  567.5
*
*************************************************************************
*
*  secondary loop for the primary loop with pressurizer
*
*************************************************************************
5000000     wpstgdcm    annulus
5000001     5
5000101     0.0         1
5000102     0.0296      4
5000103     0.0         5
5000201     0.0         3
5000202     0.005281    4
5000301     2.8965      1
5000302     2.0980      2
5000303     2.5654      4
5000304     3.4395      5
5000401     0.3228      1
5000402     0.0         4
5000403     0.1302      5
```

```
5000501    0.0        5
5000601   -90.0       5
5000701   -2.0223     1
5000702   -2.0980     2
5000703   -2.5654     4
5000704   -2.5464     5
5000801    4.57e-5   0.3689   1
5000802    4.57e-5   0.0971   4
5000803    4.57e-5   0.0801   5
5000901    0.0       0.0      4
5001001    00         5
5001101    0000       3
5001102    0100       4
5001201  0          7314312.9 1200751.2 2580753.5 0.0       0.0       1
5001202  0          7329527.0 1200829.9 2580590.8 0.0       0.0       2
5001203  0          7346864.0 1200899.7 2580405.7 0.0       0.0       3
5001204  0          7365938.6 1200941.7 2580202.5 0.0       0.0       4
5001205  0          7375253.0 1202649.1 2580103.4 0.0       0.0       5
5001300    0
5001301  .61387739 .61387739 0.0       1                  * 13.832253
5001302  .61388537 .61388537 0.0       2                  * 13.832171
5001303  .61388694 .61388694 0.0       3                  * 13.832038
5001304  .61387788 .61387788 0.0       4 .                * 13.831877
*
******************************************************************
5010000    wpstgdcm    sngljun
5010101    500010000   504000000   0.0     100.0   100.0    0000
5010201  0          .48039121 .69720931 0.0               * 13.831555
*
******************************************************************
5040000    wpsteamg    pipe
5040001     5
5040101    0.2293      3
5040102    0.0         5
5040201    0.2293      2
5040202    0.2293      3
5040203    0.3138      4
* 5040201    0.0712      3
* 5040202    0.0         4
5040301    2.5464      1
5040302    2.5654      3
5040303    2.0980      4
5040304    2.0223      5
5040401    0.0         3
5040402    0.4951      4
5040403    0.7979      5
5040501    0.0         5
5040601    90.0        5
5040701    2.5464      1
5040702    2.5654      3
5040703    2.0980      4
```

```
5040704     2.0223     5
5040801     4.57e-5    0.036     4
5040802     4.57e-5    0.219     5
5040901     1.5   1.5   4
5041001     00         5
5041101     0100       3
5041102     0000       4
5041201   0         7364072.6 1261303.5 2580206.5 .14246717 0.0      1
5041202   0         7350625.7 1265108.6 2580362.4 .28828137 0.0      2
5041203   0         7338293.4 1264860.6 2580492.4 .28643270 0.0      3
5041204   0         7326890.7 1264305.8 2580611.9 .27887426 0.0      4
5041205   0         7317011.3 1263978.6 2580664.8 .27519078 0.0      5
5041300     0
5041301   .09947453 .37096577 0.0       1              * 13.814456
5041302   .11462864 .49520300 0.0       2              * 13.809526
5041303   .10797253 .71294955 0.0       3              * 13.805859
5041304   .09902432 .87101253 0.0       4              * 13.802399
5041401   0.036     1.0     1.0     1.0     3
5041402   0.1258    1.0     1.0     1.0     4
*
***************************************************************
5080000     wpsepar    separatr
5080001   3   0
5080101   0.0   2.120   0.572   0.0   90.0   2.120   4.57e-5
5080102   0.2134   00
5080200   0         7308284.2 1263648.5 2580734.6 .52097025
5081101   508010000   516000000   0.0715   0.0   0.0   0100 0.2
5082101   508000000   500000000   0.03964 100.0 100.0   0000
5083101   504010000   508000000   0.1986   0.0   0.0   0000
5081201   -.4037061 .27393586 0.0                      * 2.7472266
5082201   .37739895 -1.743057 0.0                      * 11.039985
5083201   .11699245 1.0455258 0.0                      * 13.799421
*
*****************************************************************
5120000   wpsgspbp    branch
5120001   2       0
5120101   0.0   2.120   0.6288   0.0   90.0   2.120   4.57e-5
5120102   0.1242   00
5120200   0         7305583.4 1236787.3 2582575.1 .89235283
5121101   500000000   512000000   0.3164    0.0   0.0   0000
5122101   512010000   516000000   0.0392    1.5   1.5   0000
5121201   30.5398-6 1.3297404 0.0                      * 7.35566-3
5122201   -46.00500 -1.6715-3 0.0                      * -2.8209-3
*
*****************************************************************
5160000   stmdome    snglvol
5160101   0.0   3.7778   2.0288   0.0   90.0   3.7778   4.57e-5
5160102   0.7696    00
5160200   0         7303731.5 1263114.0 2580824.8 .99999971
*
******************************************************************
```

```
*   ilsg steam line
*********************************************************************
5200000   ilstmln1    branch
5200001   2           0
5200101   0.0286    5.282  0.0    0.0    0.0    0.0    4.57e-5
5200102   0.1909    00
5200200   0           7302807.7 1263069.3 2580824.5 .99991553
5201101   516010000   520000000   0.0286     0.0   0.0   0100
5202101   520010000   524000000   0.0286     0.0   0.0   0000
5201201   1.8244014 2.5842639 0.0                           * 2.7450542
5202201   .27793749 2.5848676 0.0                           * 2.7455870
*
*********************************************************************
5240000   ilstmln2    branch
5240001   1           0
5240101   0.0286    8.5867  0.0    0.0    0.0    0.0    4.57e-5
5240102   0.1909    00
5240200   0           7302699.9 1263063.4 2580835.0 .99967266
5241101   524010000   528000000   0.00429    0.0   0.0   0000
5241201   1.5658958 17.236995 0.0                           * 2.7466368
*
*********************************************************************
5280000   ilstmln3    snglvol
5280101   0.00429   10.9965   0.0    0.0    0.0    0.0    4.57e-5
5280102   0.0739    00
5280200   0           7290393.8 1262454.1 2580955.8 .99988240
*
*********************************************************************
5290000   ilmsiv    valve
5290101   528010000   532000000   0.00429   0.0  0.0  0100
5290201   0          5.7878014 17.263954 0.0                * 2.7467386
5290300   mtrvlv
5290301   578        501        2.0000000 1.0000000 0
*
*********************************************************************
5320000   vlvtovlv    snglvol
5320101   0.00429   5.5275   0.0    0.0    0.0    0.0    4.57e-5
5320102   0.0739    00
5320200   0          7278376.3 1261858.7 2581063.9 .99978697
*
*********************************************************************
5330000   ilchkvl     valve
5330101   532010000   800000000   0.00429   0.0   0.0  0000
5330201   0          3.7947922 17.296149 0.0                * 2.7468079
5330300   chkvlv
5330310   0    0      0.0    0.0
*
*********************************************************************
5500000     auxfed       tmdpvol
5500101     8.0          5.0   0.0    0.0    0.0    0.0    0.0    0     00
5500200     3
```

```
5500201     0.0         5.95300e+6        313.0
*
*******************************************************************
5510000     auxfed      tmdpjun
5510101     550000000   500000000   0.004
5510200     1   624
5510201     0.0   0.0   0.0   0.0
5510202     0.01  1.168 0.0   0.0
5510203  5000.0   1.168 0.0   0.0
*******************************************************************
5600000     wpstegfw    tmdpvol
5600101     0.139       5.0   0.0   0.0   0.0   0.0   0.0   0     00
5600200     3
5600201     0.0         5.83400e+6        495.35
*
*******************************************************************
5610000     wpstegfw    tmdpjun
5610101     560000000   500000000   4.00e-3
5610200     1   550    cntrlvar    561
5610201     0.0   0.0     0.0  0.0
5610202     5.0   5.0     0.0  0.0
5610203     7.0   7.0     0.0  0.0
5610204  1000.0   7.0     0.0  0.0
*
*******************************************************************
* secondary relief and safety valves, intact loop
*******************************************************************
*
5690000   ilsgrv    valve
5690101   520010000   570000000   2.96e-4   0.0164   0.0   0100
5690201   0          0.0        0.0        0.0                * 0.0
5690300   trpvlv
5690301   603
*
*******************************************************************
5700000   contain    tmdpvol
5700101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
5700200   3
5700201   0.0   1.01325e+5   293.15
*
*******************************************************************
5790000   ilsgsv    valve
5790101   524010000   580000000   0.00195   0.00050   0.0   0100
5790201   0          0.0        0.0        0.0                * 0.0
5790300   trpvlv
5790301   606
*
*******************************************************************
5800000   contain    tmdpvol
5800101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
5800200   3
```

```
5800201   0.0   1.01325e+5   293.15
*
*
*********************************************************************
* pressurizer
*********************************************************************
*
6000000     prssurgl    pipe
6000001     3
6000101     3.515e-3    3
6000301     6.7788      1
6000302     9.245       2
6000303     5.4221      3
6000401     0.0         3
6000601     -90.0       3
6000701     -4.4077     1
6000702     -4.995      2
6000703     -2.5768     3
6000801     4.57e-5   0.0669   3
6001001     00          3
6001101     0000        2
6001201  0         15610474. 1556744.0 2444245.8 0.0       0.0       1
6001202  0         15639376. 1533202.1 2444562.7 0.0       0.0       2
6001203  0         15663068. 1499159.9 2444003.5 0.0       0.0       3
6001300  0
6001301  794.073-6 794.073-6 0.0       1                 * 1.73199-3
6001302  793.544-6 793.544-6 0.0       2                 * 1.76418-3
*
*********************************************************************
6030000     prssurgl    sngljun
6030101     610010000   600000000   3.515e-3   0.0   0.0   0100
6030201  0         794.821-6 -7.2196-3 0.0               * 1.70555-3
*
*********************************************************************
6100000     prsrizer    pipe
6100001     8
6100101     0.0         1
6100102     0.2827      6
6100103     0.2731      8
6100201     0.0         7
6100301     0.201       1
6100302     0.470       3
6100303     0.600       4
6100304     0.682       6
6100305     0.5375      8
6100401     0.0325      1
6100402     0.0         8
6100501     0.0         8
6100601     -90.0       8
6100701     -0.201      1
6100702     -0.470      3
```

```
6100703    -0.6          4
6100704    -0.682        6
6100705    -0.5375       8
6100801     4.57e-5   0.3187   1
6100802     4.57e-5   0.600    6
6100803     4.57e-5   0.2949   8
6101001     00           8
6101101     0000         7
6101201   0          15500000. 1607801.4 2445974.9 .99999877 0.0       1
6101202   0          15580442. 1607813.9 2445975.3 .99999675 0.0       2
6101203   0          15580921. 1607831.5 2446061.4 .99999994 0.0       3
6101204   0          15581858. 1596982.5 2446633.1 0.12      0.0       4
6101205   0          15584581. 1584708.6 2445858.7 1.02448-9 0.0       5
6101206   0          15588636. 1581616.9 2445762.7 712.940-9 0.0       6
6101207   0          15592261. 1581131.6 2445676.8 16.3771-6 0.0       7
6101208   0          15595460. 1575430.8 2445601.1 11.8471-6 0.0       8
6101300   0
6101301   .05232152 34.2199-6 0.0       1                * 574.912-6
6101302   .02728026 19.2080-6 0.0       2                * 573.057-6
6101303   2.5326376 18.8555-6 0.0       3                * 572.780-6
6101304   22.5335-6 -3.544149 0.0       4                * 1.03481-3
6101305   6.04839-6 -6.1795-3 0.0       5                * 1.03511-3
6101306   6.39100-6 -.0391352 0.0       6                * 1.04155-3
6101307   8.43805-6 -.0518302 0.0       7                * 1.38226-3
*
*********************************************************************
*6190000    spryin     sngljun
*6190101    444010000    620000000    0.0    0.0    0.0    00102
*6190201    0      0.0      0.0      0.0
*
*************************************************************************
*6200000      prsspryl     pipe
*6200001      2
*6200101      3.53e-4      2
*6200301      22.43        2
*6200601     90.0          2
*6200701      8.07975      2
*6200801      4.57e-5      0.0        2
*6201001      00            2
*6201101      0000          1
*6201201    0          15598294. 1258472.7 2445534.0 0.0        0.0       1
*6201202    0          15539928. 1258581.6 2446917.6 0.0        0.0       2
*6201300    0
*6201301    0.0  0.0     0.0        1
*
*************************************************************************
*6210000      prsspryl     tmdpjun
*6210101      620010000    610000000      0.0
*6210200    1          524        p       610010000
*6210201     0.0       0.0      0.0      0.0
*6210202    15.68e6    0.0      0.0      0.0
```

```
*6210203   16.03e6   0.98   0.0    0.0
*
*******************************************************************
6500000      porvout      tmdpvol
6500101      1.0e+1       10.0  0.0   0.0   0.0   0.0   0.0   0     00
6500200      3
6500201      0.0          1.01325e+5       293.15
*
*******************************************************************
6510000      porv         valve
6510101      610000000    650000000   3.66e-5   0.0251   0.0   0100
6510201   0         0.0         0.0        0.0                 * 0.0
6510300      trpvlv
6510301      615
*
*******************************************************************
6600000      prsfvout     tmdpvol
6600101      1.0e+8       10.0  0.0   0.0   0.0   0.0   0.0   0     00
6600200      3
6600201      0.0          1.01325e+5       293.15
*
*******************************************************************
6610000      prsfvalv     valve
6610101      610000000    660000000   1.54e-4   0.2052  0.0   0100
6610201   0         0.0         0.0        0.0                 * 0.0
6610300      trpvlv
6610301      522
*
***************************************************************
* eccs
***************************************************************
* accumulators not updated
*******************************************************************
7000000      wpacc        accum
*  vol of accum eq. 1/2 vol of single 1stf accum, full ht.
7000101      0.0   6.6   4.8  0.0  90.0  6.6  3.333e-5  0.0  00
7000200      4.51e+6  320.00
7001101      448000000  7.277e-3   12.674 12.674  0
7002200      0.0  5.76  22.04  2.478  5.2e-2  0  7820.  493.73   0
*
*******************************************************************
7100000      npacc        accum
* vol of accum eq. 1/2 of single 1stf accum, full ht.
7100101      0.0   6.6   4.8  0.0  90.0  6.6  3.333e-5  0.0   00
7100200      4.51e+6   320.00
7101101      244000000  1.764e-3  10.107  10.107  0
7102200      0.0  6.43  13.24  2.478  5.2e-2  0  7820.  493.73   0
*
*******************************************************************
7200000      ilsi         tmdpvol
7200101      4.375        10.0  0.0   0.0   0.0   0.0   0.0   0.0   00
```

```
7200200     3
7200201     0.0         1.013e+5    310.00
*
***********************************************************************
* eccs flows from zion deck, assume even flow split betwen loops
***********************************************************************
*
7210000     ilsi    tmdpjun
7210101     720000000   740000000   2.552e-3
7210200     1   506    p   448010000
7210201     -1.0       0.0    0.0    0.0
7210202      0.0       0.0    0.0    0.0
7210203      0.0        0.5965  0.0    0.0
7210204      0.103e+6   0.5965  0.0    0.0
7210205      0.262e+6   0.5900  0.0    0.0
7210206      2.282e+6   0.5245  0.0    0.0
7210207      5.619e+6   0.3935  0.0    0.0
7210208      8.094e+6   0.2620  0.0    0.0
7210209      9.666e+6   0.1310  0.0    0.0
7210210     10.342e+6   0.0     0.0    0.0
7210211     20.684e+6   0.0     0.0    0.0
*
***********************************************************************
*7300000     ilchrg      tmdpvol
*7300101     4.375       10.0  0.0    0.0    0.0    0.0    0.0    0.0    00
*7300200     3
*7300201     0.0         1.013e+5          300.00
*
*******************************************************************
*7310000     ilchrg  tmdpjun
*7310101     730000000   740000000    2.552e-3
*7310200     1    505    p   448010000
*7310201     -1.0        0.0       0.0    0.0
*7310202      0.0        0.0       0.0    0.0
*7310203      0.0         0.5635   0.0    0.0
*7310204      0.103e+6    0.5635   0.0    0.0
*7310205      2.627e+6    0.5245   0.0    0.0
*7310206      6.433e+6    0.4590   0.0    0.0
*7310207      9.660e+6    0.3935   0.0    0.0
*7310208     12.404e+6    0.3275   0.0    0.0
*7310209     14.569e+6    0.2620   0.0    0.0
*7310210     17.209e+6    0.1310   0.0    0.0
*7310211     18.202e+6    0.0      0.0    0.0
*7310212     20.684e+6    0.0      0.0    0.0
*
**********************************************************************
7400000     ileccsln    snglvol
7400101     2.552e-3   16.0   0.0    0.0    0.0    0.0    3.333e-5
7400102     0.0   00
7400200    0         15598371. 83230.665 2445532.2 0.0
*
```

```
**********************************************************************
7700000     blsi        tmdpvol
7700101     4.375       10.0  0.0    0.0    0.0    0.0    0.0    0.0    00
7700200     3
7700201     0.0         1.013e+5     293.15
*
**********************************************************************
* eccs flows from zion deck, assume even flow split betwen loops
**********************************************************************
*
7710000     blsi    tmdpjun
7710101     770000000   790000000   2.552e-3
7710200     1   506   p   248010000
7710201     -1.0        0.0    0.0    0.0
7710202      0.0        0.0    0.0    0.0
7710203      0.0         0.5965  0.0   0.0
7710204      0.103e+6    0.5965  0.0   0.0
7710205      0.262e+6    0.5900  0.0   0.0
7710206      2.282e+6    0.5245  0.0   0.0
7710207      5.619e+6    0.3935  0.0   0.0
7710208      8.094e+6    0.2620  0.0   0.0
7710209      9.666e+6    0.1310  0.0   0.0
7710210     10.342e+6    0.0     0.0   0.0
7710211     20.684e+6    0.0     0.0   0.0
*
*
**********************************************************************
*7800000     blchrg      tmdpvol
*7800101     4.375       10.0  0.0    0.0    0.0    0.0    0.0    0.0    00
*7800200     3
*7800201     0.0         1.013e+5          293.15
*
**********************************************************************
*7810000     blchrg  tmdpjun
*7810101     780000000   790000000   2.552e-3
*7810200     1   505   p   248010000
*7810201     -1.0        0.0      0.0    0.0
*7810202      0.0        0.0      0.0    0.0
*7810203      0.0         0.5635  0.0   0.0
*7810204      0.103e+6    0.5635  0.0   0.0
*7810205      2.627e+6    0.5245  0.0   0.0
*7810206      6.433e+6    0.4590  0.0   0.0
*7810207      9.660e+6    0.3935  0.0   0.0
*7810208     12.404e+6    0.3275  0.0   0.0
*7810209     14.569e+6    0.2620  0.0   0.0
*7810210     17.209e+6    0.1310  0.0   0.0
*7810211     18.202e+6    0.0     0.0   0.0
*7810212     20.684e+6    0.0     0.0   0.0
*
**********************************************************************
7900000     bleccsln    snglvol
```

```
7900101    9.079e-4  16.0   0.0   0.0   0.0   0.0   3.333e-5
7900102    0.0    00
7900200   0         15598401. 83231.356 2445531.5 0.0
*
*******************************************************************
*   common steam header to jet condensor
*******************************************************************
*
8000000   header1    snglvol
8000101   0.00741   3.2   0.0   0.0   0.0   0.0   4.57e-5
8000102   0.0   00
8000200   0         7278063.0 1261843.5 2581117.8 .99983487
*
******************************************************************
8010000   headvlv    valve
8010101   800010000   804000000   0.00741  0.0   0.0   0000
8010201   0         2.8818423 10.014497 0.0                * 2.7468959
8010300   trpvlv
8010301   583
*
*******************************************************************
8030000   trbbpvlv   valve
8030101   800000000   808000000   5.56e-4  0.0   0.0  0100
8030201   0         0.0        0.0        0.0               * 0.0
8030300   srvvlv
8030301   40
*
*******************************************************************
8040000   header2    snglvol
8040101   0.00741   3.2   0.0   0.0   0.0   0.0   4.57e-5
8040102   0.0   00
8040200   0         7270989.5 1261492.4 2581112.5 .99991458
*
*******************************************************************
8050000   thrvlv  valve
8050101   804010000   812000000   0.00741  0.0   0.0  0100
8050201   0         8.6399460 20.055846 0.0                * 5.4949115
8050300   srvvlv
8050301   805
*
*******************************************************************
8080000   trbbpln    snglvol
8080101   0.00741   13.3305   0.0   0.0   0.0   0.0   4.57e-5
8080102   0.0971    00
8080200   0         7288740.0 1262372.2 2580999.5 .99988891
*
******************************************************************
8090000   bplnjc    sngljun
8090101   808010000   816000000   0.00741   0.0     0.0     0100
8090201   0         2.13640-3 -237.33-9 0.0                * 1.23347-6
*
```

```
***********************************************************************
8120000   trbthrln   snglvol
8120101   0.00741    8.730   0.0   0.0   0.0   0.0   4.57e-5
8120102   0.0971     00
8120200   0          7006022.4 1248286.1 2583199.0 .99913646
*
*********************************************************************
8130000   thrlnjc    sngljun
8130101   812010000   820000000   0.00741   0.0     0.0     0100
8130201   0          8.3986178 20.802777 0.0              * 5.4948355
*
**********************************************************************
8160000   jctdvl     tmdpvol
8160101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
8160200   2
8160201   0.0   7.08874e+6   1.0
*
*********************************************************************
8200000   jctdv2     tmdpvol
8200101   1.0e+8   10.0   0.0   0.0   0.0   0.0   0.0   0.0   00
8200200   2
8200201   0.0   7.0e+6   1.0
*
***********************************************************************
* containment volume for environmental heat losses
***********************************************************************
9000000     envsink     tmdpvol
9000101     2000.      100.    0.0   0.0   0.0   0.0   0.0   0     10
9000200   4
9000201   0.0     1.034e5     322.   1.
*
*********************************************************************
*  break point  - 5% break area
**********************************************************************
9150000     npcolbrv     valve
9150101     248010000    920000000    3.976e-4    0.0   0.0   00100 1.0  1.05
9150201   0          0.0         0.0         0.0             * 0.0
9150300     trpvlv
9150301     535
*
**********************************************************************
9200000     npcolleg     tmdpvol
9200101     1.0e+8       10.0  0.0   0.0   0.0   0.0   0.0   0     00
9200200     3
9200201     0.0          1.01325e+5        293.15
*
*********************************************************************
*   boundary system for steady state
*********************************************************************
*
9900000    bdryvol    tmdpvol
```

```
9900101     0.255  0.69  0.0  0.0  0.0  0.0  0.0  0.0  0000
9900200     2
9900201     0.0  1.556e+7     1.0
*
9890000     bdryvlv    valve
9890101     990000000  610000000  1.0  0.0  0.0  0000
9890201   0         1.62936-3 5.59379-6 0.0               * 575.018-6
9890300     trpvlv
9890301     599
*
*******************************************************************
*  reactor vessel heat structures
******************************************************************
*
******************************************************************
* 100-1; vessel wall above nozzles, below upper head flange
******************************************************************
*
11001000    1     7     2     1     0.320
11001100    0     1
*
*  mesh interval
*
11001101    1     0.323
11001102    4     0.476
11001103    1     0.601
*
*  heat structure composition
*
11001201    5     1
11001202    6     5
11001203    9     6
*
*  heat source distribution
*
11001301    0.0   6
*
*  initial temperature flag
*
11001400    0
11001401    562.2      7
*
*  left boundary condition
*
11001501      100010000       0   1     1     0.823     1
*
*  right boundary condition
*
11001601      900010000       0   1     1    0.823     1
*
*  heat source
```

```
*
11001701    0    0    0    0    1
*
*  additional left boundary condition
*
11001801    0. 10.0  10.0    0.0 0. 0. 0. 1.    1
*
*  additional right boundary condition
*
11001901    0. 10.0  10.0    0.0 0. 0. 0. 1.    1
*
*********************************************************************
* 104-1; reactor vessel wall below nozzles
*********************************************************************
*
11041000    12    7    2    1    0.320
11041100    0     1
*
*  mesh interval
*
11041101    1     0.323
11041102    4     0.381
11041103    1     0.506
*
*  heat structure composition
*
11041201    5     1
11041202    6     5
11041203    9     6
*
*  heat source distribution
*
11041301    0.0   6
*
*  initial temperature flag
*
11041400    0
11041401    562.2      7
*
*  left boundary condition
*
11041501     104010000        0   1    1     0.600    1
11041502     108010000        0   1    1     0.677    2
11041503     108020000        0   1    1     0.867    3
11041504     108030000    10000   1    1     0.610    9
11041510     108090000        0   1    1     1.2588  10
11041511     112010000        0   1    1     0.445   11
11041512     116010000        0   1    1     0.4762  12
*
*  right boundary condition
*
```

```
11041601      900010000      0   1     1     0.600    1
11041602      900010000      0   1     1     0.677    2
11041603      900010000      0   1     1     0.867    3
11041604      900010000      0   1     1     0.610    9
11041610      900010000      0   1     1     1.2588  10
11041611      900010000      0   1     1     0.445   11
11041612      900010000      0   1     1     0.4762  12
*
*  heat source
*
11041701     0     0     0     0     12
*
*  additional left boundary condition
*
11041801     0. 10.0  10.0    0.0  0. 0. 0. 1. 12
*
*  additional right boundary condition
*
11041901     0. 10.0  10.0    0.0 0. 0. 0. 1.     12
*
*******************************************************************
* 112-1: vessel bottom and flange
*******************************************************************
*
11121000    1     7     1     1     0.0
11121100    0     1
*
*  mesh interval
*
11121101    1     0.003
11121102    4     0.724
11121103    1     0.849
*
*  heat structure composition
*
11121201    5     1
11121202    6     5
11121203    9     6
*
*  heat source distribution
*
11121301    0.0   6
*
*  initial temperature flag
*
11121400    0
11121401    562.2       7
*
*  left boundary condition
*
11121501      112010000      0   1     0     0.686    1
```

```
*
*  right boundary condition
*
11121601     900010000      0   1    1    0.686     1
*
*  heat source
*
11121701     0     0     0     0 .   1
*
*  additional left boundary condition
*
11121801     0. 10.0  10.0    0.0 0. 0. 0. 1.       1
*
*  additional right boundary condition
*
11121901     0. 10.0  10.0    0.0 0. 0. 0. 1.       1
*
*********************************************************************
*  112-2: heater rods, below heated section
********************************************************************
*
11122000    3     4     2     1     0.0
11122100    0     1
*
*  mesh interval
*
11122101    1     0.002
11122102    1     0.00295
11122103    1     0.00375
*
*  heat structure composition
*
11122201    3     1
11122202    1     2
11122203    4     3
*
*  heat source distribution
*
11122301    0.0   3
*
*  initial temperature flag
*
11122400    0
11122401    562.2       4
*
*  left boundary condition
*
11122501             0       0   0     1   731.2   1
11122502             0       0   0     1   556.2   2
11122503             0       0   0     1  1470.3   3
*
```

```
*  right boundary condition
*
11122601     112010000       0   1    1   731.2   1
11122602     116010000       0   1    1   556.2   2
11122603     120010000       0   1    1  1470.3   3
*
*  heat source
*
11122701     0     0     0     0     3
*
*  additional right boundary condition
*
11122901     0. 10.0    10.0    0.0 0. 0. 0. 1.       3
*
*******************************************************************
* 120-1: core barrel
******************************************************************
*
11201000    12    5     2     1     0.257
11201100    0     1
*
*  mesh interval
*
11201101    4     0.267
*
*  heat structure composition
*
11201201    5     4
*
*  heat source distribution
*
11201301    0.0   4
*
*  initial temperature flag
*
11201400    0
11201401    562.2       5
*
*  left boundary condition
*
11201501      120010000       0   1     1      1.2588   1
11201502      124010000   10000   1     1      0.610    7
11201503      128010000       0   1     1      0.867    8
11201504      132010000       0   1     1      0.677    9
11201505      136010000       0   1     1      0.600    10
11201506      140010000       0   1     1      0.3674   11
11201507      144010000       0   1     1      0.897    12
*
*  right boundary condition
*
11201601      108090000       0   1     1      1.2588   1
```

```
11201602      108080000  -10000  1     1     0.6100   7
11201603      108020000       0  1     1     0.867    8
11201604      108010000       0  1     1     0.677    9
11201605      104010000       0  1     1     0.600   10
11201606      100010000       0  1     1     0.3674  11
11201607      100010000       0  1     1     0.897   12
*
*  heat source
*
11201701    0     0     0     0     12
*
*  additional left boundary condition
*
11201801    0. 10.0    10.0     0.0  0. 0. 0. 1.     12
*
*  additional right boundary condition
*
11201901     0. 10. 10.    0.0     0.  0.  0.0  1.  12
*
******************************************************************
* 124-1: heated section of heater rods
******************************************************************
*
11241000    6     9     2     1     0.0
11241100    0     1
*
*  fuel rod mesh interval
*
11241101    2     0.00200
11241102    2     0.00260
11241103    2     0.00375
11241104    2     0.00475
*
*  heat structure composition
*
11241201    7     2
11241202    2     4
11241203    1     6
11241204    4     8
*
*  heat source distribution
*
11241301    0.0   2
11241302    1.0   4
11241303    0.0   8
*
*  initial temperature flag
*
11241400    0
*
*  initial temperature
```

```
*
11241401    614.6       9
*
*  left boundary condition
*
11241501            0       0   0    1     649.00     6
*
*  right boundary condition
*
11241601    124010000  10000  1      1     649.00     6
*
*  heat source
*
11241701    888   0.08568     0.0   0.0   1
11241702    888   0.17532     0.0   0.0   2
11241703    888   0.23900     0.0   0.0   3
11241704    888   0.23900     0.0   0.0   4
11241705    888   0.17532     0.0   0.0   5
11241706    888   0.08568     0.0   0.0   6
*
*  additional right boundary conditions
*
11241901    0.    0.305     3.355   0.  0.    0.   0. 1.0  1
11241902    0.    0.915     2.745   0.  0.    0.   0. 1.0  2
11241903    0.    1.525     2.135   0.  0.    0.   0. 1.0  3
11241904    0.    2.135     1.525   0.  0.    0.   0. 1.0  4
11241905    0.    2.745     0.915   0.  0.    0.   0. 1.0  5
11241906    0.    3.355     0.305   0.  0.    0.   0. 1.0  6
*
*******************************************************************
* 124-2: unheated instrument rods
*******************************************************************
*
11242000    6     6      2      1      0.0
11242100    0     1
*
*  fuel rod mesh interval
*
11242101    3     0.00432
11242102    2     0.00612
*
*  heat structure composition
*
11242201    1     2
11242202    5     5
*
*  heat source distribution
*
11242301    0.0   5
*
*  initial temperature flag
```

```
*
11242400    0
*
*  initial temperature
*
11242401    614.6       6
*
*  left boundary condition
*
11242501             0     0   0     1     63.44      6
*
*  right boundary condition
*
11242601    124010000  10000  1     1     63.44      6
*
*  heat source
*
11242701    0      0        0       0     6
*
*  additional right boundary conditions
*
11242901    0.   10.0        10.0 0. 0.   0.0 0. 1.   6
*
*********************************************************************
* 128-1: upper plenum internals
*********************************************************************
*
11281000    1     5     1     1     0.0
11281100    0     1
*
*  mesh interval
*
11281101    4     0.023
*
*  heat structure composition
*
11281201    5     4
*
*  heat source distribution
*
11281301    0.0   4
*
*  initial temperature flag
*
11281400    0
11281401    598.2       5
*
*  left boundary condition
*
11281501     128010000       0   1     0     0.773    1
*
```

```
*  right boundary condition
*
11281601     128010000      0   1     0     0.773    1
*
*  heat source
*
11281701     0     0     0     0     1
*
*  additional left boundary condition
*
11281801     0. 10.0  10.0 0. 0.0 0.. 0. 1. 1
*
*  additional right boundary condition
*
11281901     0. 10.0  10.0 0. 0.0 0. 0. 1.  1
*
**************************************************************
* 132-1; guide tubes
**************************************************************
*
11321000    5     4     2     1     0.04405
11321100    0     1
*
*  fuel rod mesh interval
*
11321101    3     0.04655
*
*  heat structure composition
*
11321201    5     3
*
*  heat source distribution
*
11321301    0.0   3
*
*  initial temperature flag
*
11321400    0
*
*  initial temperature
*
11321401    614.6        4
*
*  left boundary condition
*
11321501    156020000     0  1     1     5.406      1
11321502    156020000     0  1     1     4.800      2
11321503    156010000     0  1     1     2.939      3
11321504    156010000     0  1     1     7.176      4
11321505    156010000     0  1     1     5.800      5
*
```

```
*  right boundary condition
*
11321601    132010000    0 1    1    5.406    1
11321602    136010000    0 1    1    4.800    2
11321603    140010000    0 1    1    2.939    3
11321604    144010000    0 1    1    7.176    4
11321605    148010000    0 1    1    5.800    5
*
*  heat source
*
11321701    0    0    0    0    5
*
*  additional left boundary conditions
*
11321801    0.   10.0      10.0  0. 0.  0.0 0. 1.   5
*
*  additional right boundary conditions
*
11321901    0.   10.0      10.0  0. 0.  0.0 0. 1.   5
*
*******************************************************************
* 144-1: upper core support plate
*******************************************************************
*
11441000    1    9    1    1    0.0
11441100    0    1
*
*  mesh interval
*
11441101    8    0.304
*
*  heat structure composition
*
11441201    5    8
*
*  heat source distribution
*
11441301    0.0   8
*
*  initial temperature flag
*
11441400    0
11441401    562.2     9
*
*  left boundary condition
*
11441501    144010000    0  1    0    0.156    1
*
*  right boundary condition
*
11441601    140010000    0  1    0    0.156    1
```

```
*
*  heat source
*
11441701     0     0     0     0     1
*
*  additional left boundary condition
*
11441801     0. 10.0  10.0 0. 0.0 0. 0. 1.  1
*
*  additional right boundary condition
*
11441901     0. 10.0  10.0 0. 0.0 0. 0. 1.  1
*
*******************************************************************
* 148-1; reactor vessel wall above upper plenum flange
******************************************************************
*
11481000    1     7     2     1     0.320
11481100    0     1
*
*  mesh interval
*
11481101    1     0.323
11481102    4     0.522
11481103    1     0.647
*
*  heat structure composition
*
11481201    5     1
11481202    6     5
11481203    9     6
*
*  heat source distribution
*
11481301    0.0   6
*
*  initial temperature flag
*
11481400    0
11481401    562.2       7
*
*  left boundary condition
*
11481501     148010000       0   1     1     0.404    1
*
*  right boundary condition
*
11481601     900010000       0   1     1     0.404    1
*
*  heat source
*
```

```
11481701     0     0     0     0     1
*
*  additional left boundary condition
*
11481801     0. 10.0  10.0 0. 0.0 0. 0. 1. 1
*
*  additional right boundary condition
*
11481901     0. 10.0  10.0 0. 0.0 0. 0. 1. 1
*
*******************************************************************
* 152-1; reactor vessel upper head
*******************************************************************
*
11521000    1     7     3     1     0.320
11521100    0     1
*
*  mesh interval
*
11521101    1     0.324
11521102    4     0.354
11521103    1     0.479
*
*  heat structure composition
*
11521201    5     1
11521202    6     5
11521203    9     6
*
*  heat source distribution
*
11521301    0.0   6
*
*  initial temperature flag
*
11521400    0
11521401    562.2       7
*
*  left boundary condition
*
11521501     152010000       0   1     1     0.5      1
*
*  right boundary condition
*
11521601     900010000       0   1     1     0.5      1
*
*  heat source
*
11521701     0     0     0     0     1
*
*  additional left boundary condition
```

```
*
11521801     0. 10.0  10.0 0. 0.0 0. 0. 1. 1
*
*  additional right boundary condition
*
11521901     0. 10.0  10.0 0. 0.0 0. 0. 1. 1
*
******************************************************************
*
*  loop heat structures
*
$======================================================================$
$                  ht str no. 212-1   blsg inlet/outlet plnm hemisph
*----------------------------------------------------------------------*
*htstr    ht strs  m pts  geom  init  l.coord    refl  b.vol  axl. incr
12121000    2       6      3     1     0.377      0
*
*htstr          mesh locn       mesh fmt
12121100           0               1
*
*htstr          intervals       rt. coord
12121101           1              0.380
12121102           2              0.430
12121103           2              0.555
*
*htstr          compxn no.      interval
12121201           5               1
12121202           6               3
12121203           9               5
*
*htstr          source          interval
12121301         0.0               5
*
*htstr                          temp flg
12121400                           -1
*
*htstr           temperature distribution for heat structure 01
12121401      597.000     597.000     597.000     597.000     597.000
+             597.000
*htstr           temperature distribution for heat structure 02
12121402      557.000     557.000     557.000     557.000     557.000
+             557.000
*
*htstr     left vol     incr  b.cond   sa code  area/factor   ht str no.
12121501   212010000    0      1        1         0.1872         1
12121502   228010000    0      1        1         0.1872         2
*
*htstr     right vol    incr  b.cond   sa code  area/factor   ht str no.
12121601   900010000    0      1        1         0.1872         2
*
*htstr       s. type      s. mult      left heat  right heat   ht str no.
```

```
12121701        0        0          0         0         2
*
12121801        0.       10.0   10.0 0.  0.   0.    0.  1.      2
*
12121901        0.       10.0   10.0 0.  0.   0.    0.  1.      2
*
$====================================================================$
$                ht str no. 212-2   blsg inlet/outlet plnm walls
*--------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
12122000   4       6     2     1     0.365     0
*
*htstr          mesh locn       mesh fmt
12122100          0                1
*
*htstr          intervals       rt. coord
12122101          1               0.368
12122102          2               0.434
12122103          2               0.559
*
*htstr          compxn no.      interval
12122201          5                1
12122202          6                3
12122203          9                5
*
*htstr          source          interval
12122301          0.0              5
*
*htstr                          temp flg
12122400                           -1
*
*htstr           temperature distribution for heat structure 01
12122401        597.000     597.000     597.000     597.000     597.000
+               597.000
*htstr           temperature distribution for heat structure 02
12122402        557.000     557.000     557.000     557.000     557.000
+               557.000
*
*htstr           temperature distribution for heat structure 03
12122403        597.000     597.000     597.000     597.000     597.000
+               597.000
*htstr           temperature distribution for heat structure 04
12122404        557.000     557.000     557.000     557.000     557.000
+               557.000
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
12122501   212010000   0     1       1        0.4237         1
12122502   228010000   0     1       1        0.4237         2
12122503   216010000   0     1       1        1.1035         3
12122504   224010000   0     1       1        1.1035         4
*
```

```
*htstr     right vol    incr  b.cond  sa code  area/factor   ht str no.
12122601   900010000    0      1        1       0.4237        2
12122602   900010000    0      1        1       1.1035        4
*
*htstr      s. type      s. mult      left heat  right heat   ht str no.
12122701      0            0            0          0            4
*
12122801      0.        10.0   10.0    0.  0.     0.  0. 1.    2
12122802      0.        10.0   10.0    0.  0.     0.  0. 1.    4
*
12122901      0.         10.0  10.0    0.  0.     0.  0. 1.    4
*
***********************************************************************
$                   ht str no. 220-2   blsg inlet/outlet tube sheet
*---------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  1.coord   refl  b.vol  axl. incr
12202000   2        4     2     1     0.0098    0
*
*htstr         mesh locn       mesh fmt
12202100         0               1
*
*htstr         intervals       rt. coord
12202101         3               0.0163
*
*htstr         compxn no.      interval
12202201         5               3
*
*htstr         source          interval
12202301        0.0              3
*
*htstr                         temp flg
12202400                         -1
*
*htstr          temperature distribution for heat structure 01
12202401     597.000     597.000     597.000     597.000
*htstr          temperature distribution for heat structure 02
12202402     557.000     557.000     557.000     557.000
*
*htstr     left vol     incr  b.cond  sa code  area/factor   ht str no.
12202501   220010000    0      1        1       45.40         1
12202502   220080000    0      1        1       45.40         2
*
*htstr     right vol    incr  b.cond  sa code  area/factor   ht str no.
12202601   0            0      0        1       45.40         2
*
*htstr      s. type      s. mult      left heat  right heat   ht str no.
12202701      0            0            0          0            2
*
12202801      0.        10.0   10.0  0. 0. 0.      0.    1.     2
*
*********************************************************************
```

```
*  steam generator in the loop without pressurizer
*****************************************************************
*
12201000    8     8     2     1     0.00980
12201100    0     1
*
*  tube mesh interval
*
12201101    7     0.0127
*
*  heat structure composition
*
12201201     5    7
*
*  heat source distribution
*
12201301    0.0   7
*
*  initial temperature flag
*
12201400    0
12201401    562.4       8
*
*  left boundary condition
*
12201501    220010000    0    1    1    359.04        1
12201502    220020000  10000  1    1    361.72        3
12201503    220040000  10000  1    1    306.36        5
12201504    220060000  10000  1    1    361.72        7
12201505    220080000    0    1    1    359.04        8
*
*  right boundary condition
*
12201601    304010000    0    1    1    359.04        1
12201602    304020000  10000  1    1    361.72        3
12201603    304040000    0    1    1    306.36        5
12201604    304030000 -10000  1    1    361.72        7
12201605    304010000    0    1    1    359.04        8
*
*  heat source
*
12201701    0     0     0     0     8
*
*  additional left boundary conditions
*
12201801    0.   10.0   10.0  0.0  0.     0.0   0.   1.    8
*
*  additional right boundary conditions
*
12201901    0.   10.0   10.0  0.0  0.     0.0   0.   1.    8
*
```

```
$                    ht str no. 300-1   blsg external dc pipe to environ
*-------------------------------------------------------------------------*
*htstr    ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13001000    5        5      2     1    0.0486    0
*
*htstr          mesh locn        mesh fmt
13001100           0                1
*
*htstr          intervals        rt. coord
13001101           2               0.0572
13001102           2               0.1572
*
*htstr          compxn no.       interval
13001201           5                2
13001202           9                4
*
*htstr          source           interval
13001301         0.0                4
*
*htstr          temp             mesh pt.
13001401        564.0               5
*
*htstr      left vol    incr  b.cond  sa code  area/factor   ht str no.
13001501    300010000   0      1        1        9.0016         1
13001502    300020000   0      1        1        8.3920         2
13001503    300030000   10000  1        1        10.2616        4
13001504    300050000   0      1        1        10.2380        5
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
13001601    900010000   0      1        1        9.0016         1
13001602    900010000   0      1        1        8.3920         2
13001603    900010000   0      1        1        10.2616        4
13001604    900010000   0      1        1        10.2380        5
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13001701       0           0           0          0             5
*
13001801       0.       10.0    10.0    0.   0.    0.   0.  1.  5
*
13001901       0.        10.0   10.0    0.   0.    0.   0.  1.  5
*
$=========================================================================$
$                    ht str no. 300-2   blsg upper dc to separator
*-------------------------------------------------------------------------*
*htstr    ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13002000    2        2      2     1    0.2514    0
*
*htstr          mesh locn        mesh fmt
13002100           0                1
*
*htstr          intervals        rt. coord
```

```
13002101         1            0.2554
*
*htstr        compxn no.      interval
13002201         5               1
*
*htstr        source          interval
13002301       0.0               1
*
*htstr                        temp flg
13002400                         0
*
*htstr        temp            mesh pt.
13002401      560.               2
*
*htstr     left vol   incr  b.cond  sa code  area/factor  ht str no.
13002501   304050000  0     1       1        0.6461       1
13002502   308010000  0     1       1        2.120        2
*
*htstr     right vol  incr  b.cond  sa code  area/factor  ht str no.
13002601   300010000  0     1       1        0.6461       1
13002602   308010000  0     1       1        2.120        2
*
*htstr      s. type    s. mult     left heat  right heat  ht str no.
13002701      0          0           0          0           2
*
13002801      0.       10.0  10.0    0.   0.    0.   0.  1.  2
*
13002901      0.       10.0  10.0    0.   0.    0.   0.  1.  1
13002902      0.       10.0  10.0    0.   0.    0.   0.  1.  2
*
$==================================================================$
$                  ht str no. 300-3   blsg upper sg shell to environ
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13003000   4        6     2     1    0.4375    0
*
*htstr        mesh locn       mesh fmt
13003100         0               1
*
*htstr        intervals       rt. coord
13003101         1              0.4405
13003102         2              0.4785
13003103         2              0.6035
*
*htstr        compxn no.      interval
13003201         5               1
13003202         6               3
13003203         9               5
*
*htstr        source          interval
13003301       0.0               5
```

```
*
*htstr                     temp flg
13003400                     0
*
*htstr        temp         mesh pt.
13003401      530.            6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
13003501   300010000   0     1       1        0.6461        1
13003502   304050000   0     1       1        1.0104        2
13003503   312010000   0     1       1        2.120         3
13003504   316010000   0     1       1        3.4278        4
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
13003601   900010000   0     1       1        0.6461        1
13003602   900010000   0     1       1        1.0104        2
13003603   900010000   0     1       1        2.120         3
13003604   900010000   0     1       1        3.4278        4
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13003701      0           0            0          0           4
*
13003801      0.        10.0  10.0    0.   0.    0.   0.   1.  1
13003802      0.        10.0  10.0    0.   0.    0.   0.   1.  2
13003803      0.        10.0  10.0    0.   0.    0.   0.   1.  3
13003804      0.        10.0  10.0    0.   0.    0.   0.   1.  4
*
13003901      0.         10.0 10.0    0.   0.    0.   0.   1.  4
*
$==================================================================$
$                 ht str no. 300-4   blsg lower sg dc to boiler
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13004000   1        2      2     1    0.345     0
*
*htstr        mesh locn      mesh fmt
13004100         0              1
*
*htstr        intervals      rt. coord
13004101         1             0.351
*
*htstr        compxn no.     interval
13004201         5              1
*
*htstr        source         interval
13004301       0.0              1
*
*htstr                       temp flg
13004400                        0
*
*htstr        temp           mesh pt.
```

```
13004401        560.              2
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
13004501   304010000   0     1       1        1.0637        1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
13004601   300050000   0     1       1        1.0637        1
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13004701      0           0           0          0            1
*
13004801      0.        10.0  10.0    0.   0.    0.  0.  1.   1
*
13004901      0.        10.0  10.0    0.   0.    0.  0.  1.   1
*
$==================================================================$
$                  ht str no. 300-5  blsg lower sg dc wall to environ
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13005000  1        6      2     1     0.370     0
*
*htstr          mesh locn       mesh fmt
13005100           0              1
*
*htstr          intervals       rt. coord
13005101           1              0.373
13005102           2              0.405
13005103           2              0.530
*
*htstr          compxn no.      interval
13005201           5              1
13005202           6              3
13005203           9              5
*
*htstr          source          interval
13005301        0.0               5
*
*htstr                          temp flg
13005400                          0
*
*htstr          temp            mesh pt.
13005401        530.              6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
13005501   300050000   0     1       1        1.2637        1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
13005601   900010000   0     1       1        1.2637        1
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13005701      0           0           0          0            1
```

```
*
13005801      0.        10.0    10.0    0.    0.    0.  0.    1.  1
*
13005901      0.         10.0   10.0    0.    0.    0.  0.    1.  1
*
$==================================================================$
$                  ht str no. 304-1   blsg boiler wall to environ
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13041000   5        6      2     1    0.347     0
*
*htstr        mesh locn       mesh fmt
13041100        0               1
*
*htstr        intervals       rt. coord
13041101        1               0.350
13041102        2               0.380
13041103        2               0.505
*
*htstr        compxn no.      interval
13041201        5               1
13041202        6               3
13041203        9               5
*
*htstr        source          interval
13041301       0.0              5
*
*htstr                        temp flg
13041400                        0
*
*htstr        temp            mesh pt.
13041401      550.              6
*
*htstr     left vol    incr   b.cond   sa code   area/factor   ht str no.
13041501   304010000   0      1        1          1.2827          1
13041502   304020000   10000  1        1          2.5654          3
13041503   304040000   0      1        1          2.098           4
13041504   304050000   0      1        1          0.3658          5
*
*htstr     right vol   incr   b.cond   sa code   area/factor   ht str no.
13041601   900010000   0      1        1          1.2827          1
13041602   900010000   0      1        1          2.5654          3
13041603   900010000   0      1        1          2.098           4
13041604   900010000   0      1        1          0.3658          5
*
*htstr      s. type     s. mult      left heat   right heat   ht str no.
13041701      0           0            0           0            5
*
13041801      0.        10.0    10.0    0.    0.    0.    0.  1.  4
13041802      0.        10.0    10.0    0.    0.    0.    0.  1.  5
*
```

```
13041901       0.        10.0   10.0    0.   0.     0.   0.  1.  5
*
$=====================================================================$
$                   ht str no. 312-1   blsg separator to sep bypass
*---------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13121000   1        2      2     1    0.2982    0
*
*htstr         mesh locn       mesh fmt
13121100          0              1
*
*htstr         intervals       rt. coord
13121101          1              0.3012
*
*htstr         compxn no.      interval
13121201          5              1
*
*htstr         source          interval
13121301        0.0              1
*
*htstr                         temp flg
13121400                         0
*
*htstr         temp            mesh pt.
13121401       550.              2
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
13121501   308010000   0      1        1        1.7886         1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
13121601   312010000   0      1        1        1.7886         1
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13121701      0           0            0          0            1
*
13121801       0.       10.0     10.0    0.   0.     0.  0.  1.   1
*
13121901       0.       10.0     10.0    0.   0.     0.  0.  1.   1
*
$=====================================================================$
$                   ht str no. 316-1   blsg hemisph top to environ
*---------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
13161000   1        6      3     1    0.447     0
*
*htstr         mesh locn       mesh fmt
13161100          0              1
*
*htstr         intervals       rt. coord
13161101          1              0.451
13161102          2              0.473
```

```
13161103          2             0.598
*
*htstr          compxn no.     interval
13161201          5              1
13161202          6              3
13161203          9              5
*
*htstr          source         interval
13161301         0.0             5
*
*htstr                         temp flg
13161400                         0
*
*htstr          temp           mesh pt.
13161401        550.             6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
13161501   316010000   0      1        1        0.391          1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
13161601   900010000   0      1        1        0.391          1
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
13161701      0           0            0          0            1
*
13161801      0.        10.0    10.0    0.   0.    0.   0.  1.  1
*
13161901      0.        10.0    10.0    0.   0.    0.   0.  1.  1
*
*-----------------------------------------------------------------*
$    primary loop piping heat structures                          $
*-----------------------------------------------------------------*
$                  ht str no. 400-1   il + bl hl heat struct
*-----------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14001000    8       5      2     1    0.1035    0
*
*htstr          mesh locn      mesh fmt
14001100          0              1
*
*htstr          intervals      rt. coord
14001101          2              0.1981
14001102          2              0.3231
*
*htstr          compxn no.     interval
14001201          5              2
14001202          9              4
*
*htstr          source         interval
14001301         0.0             4
*
```

```
*htstr                     temp flg
14001400                      0
*
*htstr        temp         mesh pt.
14001401      597.0           5
*
*htstr     left vol   incr  b.cond  sa code  area/factor  ht str no.
14001501   400010000  0     1       1        1.3246       1
14001502   404010000  0     1       1        1.2668       2
14001503   408010000  0     1       1        0.5968       3
14001504   408020000  0     1       1        0.5278       4
14001505   200010000  0     1       1        1.3246       5
14001506   204010000  0     1       1        1.2668       6
14001507   208010000  0     1       1        0.5968       7
14001508   208020000  0     1       1        0.5278       8
*
*htstr     right vol  incr  b.cond  sa code  area/factor  ht str no.
14001601   900010000  0     1       1        1.3246       1
14001602   900010000  0     1       1        1.2668       2
14001603   900010000  0     1       1        0.5968       3
14001604   900010000  0     1       1        0.5278       4
14001605   900010000  0     1       1        1.3246       5
14001606   900010000  0     1       1        1.2668       6
14001607   900010000  0     1       1        0.5968       7
14001608   900010000  0     1       1        0.5278       8
*
*htstr      s. type    s. mult    left heat  right heat  ht str no.
14001701      0          0          0          0           8
*
14001801      0.       10.0  10.0   0.   0.    0.   0.  1.  8
*
14001901      0.       10.0  10.0   0.   0.    0.   0.  1.  8
*
$=================================================================$
$                ht str no. 400-2   il + bl col heat struct
*-----------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14002000   18      5      2     1    0.0841     0
*
*htstr        mesh locn      mesh fmt
14002100        0              1
*
*htstr        intervals      .rt. coord
14002101        2              0.1219
14002102        2              0.2469
*
*htstr        compxn no.     interval
14002201        5              2
14002202        9              4
*
*htstr        source         interval
```

```
14002301        0.0              4
*
*htstr                        temp flg
14002400                         0
*
*htstr          temp          mesh pt.
14002401        557.             5
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
14002501   432010000   0       1        1        0.516         1
14002502   432020000   10000   1        1        1.2422        4
14002503   432050000   0       1        1        1.1919        5
14002504   436010000   0       1        1        1.1919        6
14002505   436020000   10000   1        1        1.1222        9
14002506   232010000   0       1        1        0.516         10
14002507   232020000   10000   1        1        1.2422        13
14002508   232050000   0       1        1        1.1919        14
14002509   236010000   0       1        1        1.1919        15
14002510   236020000   10000   1        1        1.1222        18
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
14002601   900010000   0       1        1        0.516         1
14002602   900010000   0       1        1        1.2422        4
14002603   900010000   0       1        1        1.1919        6
14002604   900010000   0       1        1        1.1222        9
14002605   900010000   0       1        1        0.516         10
14002606   900010000   0       1        1        1.2422        13
14002607   900010000   0       1        1        1.1919        15
14002608   900010000   0       1        1        1.1222        18
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
14002701      0           0            0          0            18
*
14002801      0.        10.0    10.0    0.   0.    0.   0.  1.  18
*
14002901      0.         10.0   10.0    0.   0.    0.   0.  1.  18
*
$==================================================================$
$==================================================================$
$                  ht str no. 400-3   i1 + b1 cl heat struct
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14003000   7        5     2     1    0.1035    0
*
*htstr         mesh locn       mesh fmt
14003100          0              1
*
*htstr         intervals       rt. coord
14003101          2              0.1937
14003102          2              0.3187
*
```

```
*htstr       compxn no.     interval
14003201         5              2
14003202         9              4
*
*htstr       source         interval
14003301      0.0               4
*
*htstr                      temp flg
14003400                        0
*
*htstr        temp          mesh pt.
14003401     557.0              5
*
*htstr     left vol   incr  b.cond  sa code  area/factor   ht str no.
14003501   444010000  0       1        1       1.0562          1
14003502   448010000  0       1        1       1.1067          2
14003503   452010000  0       1        1       1.3125          3
14003504   244010000  0       1        1       0.647           4
14003505   248010000  0       1        1       0.878           5
14003506   252010000  10000   1        1       0.9752          7
*
*htstr     right vol  incr  b.cond  sa code  area/factor   ht str no.
14003601   900010000  0       1        1       1.0562          1
14003602   900010000  0       1        1       1.1067          2
14003603   900010000  0       1        1       1.3125          3
14003604   900010000  0       1        1       0.647           4
14003605   900010000  0       1        1       0.878           5
14003606   900010000  0       1        1       0.9752          7
*
*htstr      s. type     s. mult     left heat  right heat    ht str no.
14003701     0           0            0          0              7
*
14003801     0.        10.0   10.0    0.    0.    0.    0.   1.   7
*
14003901     0.         10.0  10.0    0.    0.    0.    0.   1.   7
*
$==================================================================$
$                 ht str no. 412-1   ilsg inlet/outlet plnm hemisph
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14121000   2        6      3     1    0.377     0
*
*htstr       mesh locn      mesh fmt
14121100       0               1
*
*htstr       intervals      rt. coord
14121101       1              0.380
14121102       2              0.430
14121103       2              0.555
*
*htstr       compxn no.     interval
```

```
14121201        5            1
14121202        6            3
14121203        9            5
*
*htstr        source        interval
14121301        0.0          5
*
*htstr                      temp flg
14121400                     -1
*
*htstr       temperature distribution for heat structure 01
14121401    597.000    597.000    597.000    597.000    597.000
+           597.000
*htstr       temperature distribution for heat structure 02
14121402    557.000    557.000    557.000    557.000    557.000
+           557.000
*
*htstr    left vol   incr  b.cond  sa code  area/factor   ht str no.
14121501  412010000  0      1        1        0.1872        1
14121502  428010000  0      1        1        0.1872        2
*
*htstr    right vol  incr  b.cond  sa code  area/factor   ht str no.
14121601  900010000  0      1        1        0.1872        2
*
*htstr     s. type    s. mult     left heat  right heat   ht str no.
14121701     0           0           0          0            2
*
14121801      0.       10.0   10.0   0.   0.    0.   0.  1.  2
*
14121901      0.        10.0  10.0   0.   0.    0.   0.  1.  2
*
$==================================================================$
$                 ht str no. 412-2   ilsg inlet/outlet plnm walls
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14122000    4       6     2     1     0.365     0
*
*htstr         mesh locn      mesh fmt
14122100          0              1
*
*htstr         intervals      rt. coord
14122101          1             0.368
14122102          2             0.434
14122103          2             0.559
*
*htstr         compxn no.     interval
14122201          5              1
14122202          6              3
14122203          9              5
*
*htstr         source         interval
```

```
14122301        0.0              5
*
*htstr                          temp flg
14122400                          -1
*
*htstr          temperature distribution for heat structure 01
14122401     597.000     597.000     597.000     597.000     597.000
+            597.000
*htstr          temperature distribution for heat structure 02
14122402     557.000     557.000     557.000     557.000     557.000
+            557.000
*htstr          temperature distribution for heat structure 03
14122403     597.000     597.000     597.000     597.000     597.000
+            597.000
*htstr          temperature distribution for heat structure 04
14122404     557.000     557.000     557.000     557.000     557.000
+            557.000
*
*
*htstr     left vol    incr  b.cond  sa code  area/factor  ht str no.
14122501   412010000   0      1        1        0.4237         1
14122502   428010000   0      1        1        0.4237         2
14122503   416010000   0      1        1        1.1035         3
14122504   424010000   0      1        1        1.1035         4
*
*htstr     right vol   incr  b.cond  sa code  area/factor  ht str no.
14122601   900010000   0      1        1        0.4237         2
14122602   900010000   0      1        1        1.1035         4
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
14122701      0           0            0           0            4
*
14122801      0.       10.0     10.0    0.    0.     0.    0.   1.  2
14122802      0.       10.0     10.0    0.    0.     0.    0.   1.  4
*
14122901      0.        10.0    10.0    0.    0.     0.    0.   1.  4
*
$=================================================================$
*****************************************************************
*       ht str no. 420-1 intact loop sg tubes
*****************************************************************
*
14201000    8     8     2     1     0.00980
14201100    0     1
*
*  tube mesh interval
*
14201101    7     0.0127
*
*  heat structure composition
*
```

```
14201201     5    7
*
*  heat source distribution
*
14201301    0.0   7
*
*  initial temperature flag
*
14201400    0
14201401    562.4      8
*
*  left boundary condition
*
14201501    420010000    0   1    1    359.04          1
14201502    420020000 10000  1    1    361.72          3
14201503    420040000 10000  1    1    306.36          5
14201504    420060000 10000  1    1    361.72          7
14201505    420080000    0   1    1    359.04          8
*
*  right boundary condition
*
14201601    504010000    0   1    1    359.04          1
14201602    504020000 10000  1    1    361.72          3
14201603    504040000    0   1    1    306.36          5
14201604    504030000 -10000 1    1    361.72          7
14201605    504010000    0   1    1    359.04          8
*
*  heat source
*
14201701    0     0     0     0    8
*
*  additional left boundary conditions
*
14201801    0.   10.0   10.0  0.0   0.    0.0   0.  1.     8
*
*  additional right boundary conditions
*
14201901    0.   10.0   10.0  0.0   0.    0.0   0.  1.     8
*
*=================================================================
$                 ht str no. 420-2   ilsg inlet/outlet tube sheet
*---------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
14202000    2       4     2     1     0.0098    0
*
*htstr         mesh locn        mesh fmt
14202100          0                1
*
*htstr         intervals        rt. coord
14202101          3               0.0163
*
```

```
*htstr        compxn no.      interval
14202201         5                3
*
*htstr        source          interval
14202301       0.0                3
*
*htstr                        temp flg
14202400                          -1
*
*htstr          temperature distribution for heat structure 01
14202401     597.000     597.000     597.000     597.000
*htstr          temperature distribution for heat structure 02
14202402     557.000     557.000     557.000     557.000
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
14202501   420010000   0       1        1        45.40          1
14202502   420080000   0       1        1        45.40          2
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
14202601   0           0       0        1        45.40          2
*
*htstr       s. type      s. mult      left heat  right heat   ht str no.
14202701       0            0              0          0             2
*
14202801       0.        10.0     10.0     0.    0.     0.   0.   1.   2
*
*---------------------------------------------------------------------*
$                 ht str no. 500-1   ilsg external dc pipe to environ
*---------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15001000   5        5     2     1     0.0486    0
*
*htstr        mesh locn       mesh fmt
15001100         0                1
*
*htstr        intervals       rt. coord
15001101         2              0.0572
15001102         2              0.1572
*
*htstr        compxn no.      interval
15001201         5                2
15001202         9                4
*
*htstr        source          interval
15001301       0.0                4
*
*htstr        temp            mesh pt.
15001401     564.0                5
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
15001501   500010000   0       1        1        9.0016         1
```

```
15001502    500020000   0       1       1       8.3920        2
15001503    500030000   10000   1       1       10.2616       4
15001504    500050000   0       1       1       10.2380       5
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
15001601    900010000   0       1       1       9.0016        1
15001602    900010000   0       1       1       8.3920        2
15001603    900010000   0       1       1       10.2616       4
15001604    900010000   0       1       1       10.2380       5
*
*htstr       s. type      s. mult      left heat  right heat   ht str no.
15001701       0            0            0          0            5
*
15001801       0.         10.0      10.0   0.   0.    0.   0.  1.  5
*
15001901       0.          10.0    10.0   0.   0.    0.   0.  1.  5
*
$=================================================================$
$                  ht str no. 500-2   ilsg upper dc to separator
*-----------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15002000    2       2     2     1    0.2514     0
*
*htstr         mesh locn        mesh fmt
15002100          0                1
*
*htstr         intervals        rt. coord
15002101          1               0.2554
*
*htstr         compxn no.       interval
15002201          5                1
*
*htstr         source           interval
15002301        0.0                1
*
*htstr                          temp flg
15002400                           0
*
*htstr         temp             mesh pt.
15002401       560.                2
*
*htstr      left vol    incr  b.cond  sa code  area/factor   ht str no.
15002501    504050000   0       1       1       0.6461        1
15002502    508010000   0       1       1       2.120         2
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
15002601    500010000   0       1       1       0.6461        1
15002602    508010000   0       1       1       2.120         2
*
*htstr       s. type      s. mult      left heat  right heat   ht str no.
15002701       0            0            0          0            2
```

```
*
15002801       0.        10.0     10.0     0.    0.     0.  0.  1.     2
*
15002901       0.        10.0     10.0     0.    0.     0. 0.   1.   1
15002902       0.        10.0     10.0     0.    0.     0. 0.   1.   2
*
$====================================================================$
$                  ht str no. 500-3   ilsg upper sg shell to environ
*--------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15003000    4       6      2     1    0.4375    0
*
*htstr          mesh locn       mesh fmt
15003100           0               1
*
*htstr          intervals       rt. coord
15003101           1              0.4405
15003102           2              0.4785
15003103           2              0.6035
*
*htstr          compxn no.      interval
15003201           5               1
15003202           6               3
15003203           9               5
*
*htstr          source          interval
15003301         0.0               5
*
*htstr                          temp flg
15003400                           0
*
*htstr          temp            mesh pt.
15003401        530.               6
*
*htstr     left vol    incr  b.cond   sa code   area/factor    ht str no.
15003501   500010000   0       1         1        0.6461           1
15003502   504050000   0       1         1        1.0104           2
15003503   512010000   0       1         1        2.120            3
15003504   516010000   0       1         1        3.4278           4
*
*htstr     right vol   incr  b.cond   sa code   area/factor    ht str no.
15003601   900010000   0       1         1        0.6461           1
15003602   900010000   0       1         1        1.0104           2
15003603   900010000   0       1         1        2.120            3
15003604   900010000   0       1         1        3.4278           4
*
*htstr      s. type     s. mult      left heat  right heat     ht str no.
15003701       0           0            0           0              4
*
15003801       0.        10.0     10.0     0.    0.     0.  0.  1.   1
15003802       0.        10.0     10.0     0.    0.     0.  0.  1.   2
```

```
15003803      0.        10.0   10.0   0.  0.   0.  0.  1.   3
15003804      0.        10.0   10.0   0.  0.   0.  0.  1.   4
*
15003901      0.         10.0  10.0   0.  0.   0.  0.  1.   4
*
$=================================================================$
$                  ht str no. 500-4   ilsg lower sg dc to boiler
*-----------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15004000   1        2     2     1     0.345     0
*
*htstr         mesh locn        mesh fmt
15004100          0                1
*
*htstr         intervals        rt. coord
15004101          1               0.351
*
*htstr         compxn no.       interval
15004201          5                1
*
*htstr         source           interval
15004301        0.0                1
*
*htstr                          temp flg
15004400                           0
*
*htstr         temp             mesh pt.
15004401       560.                2
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
15004501   504010000   0      1       1        1.0637         1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
15004601   500050000   0      1       1        1.0637         1
*
*htstr      s. type      s. mult      left heat  right heat   ht str no.
15004701      0            0             0          0            1
*
15004801      0.       10.0    10.0    0.   0.    0.   0.  1.  1
*
15004901      0.       10.0    10.0    0.   0.    0.   0.  1.  1
*
$=================================================================$
$                  ht str no. 500-5   ilsg lower sg dc wall to environ
*-----------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15005000   1        6     2     1     0.370     0
*
*htstr         mesh locn        mesh fmt
15005100          0                1
*
```

```
*htstr        intervals      rt. coord
15005101          1            0.373
15005102          2            0.405
15005103          2            0.530
*
*htstr        compxn no.     interval
15005201          5             1
15005202          6             3
15005203          9             5
*
*htstr        source         interval
15005301       0.0              5
*
*htstr                       temp flg
15005400                        0
*
*htstr        temp           mesh pt.
15005401      530.              6
*
*htstr    left vol   incr  b.cond  sa code  area/factor  ht str no.
15005501  500050000  0      1        1        1.2637        1
*
*htstr    right vol  incr  b.cond  sa code  area/factor  ht str no.
15005601  900010000  0      1        1        1.2637        1
*
*htstr     s. type    s. mult     left heat  right heat  ht str no.
15005701     0          0            0          0           1
*
15005801     0.       10.0    10.0    0.   0.    0.   0.  1.  1
*
15005901     0.        10.0   10.0    0.   0.    0.   0.  1.  1
*
$==================================================================$
$                  ht str no. 504-1   ilsg boiler wall to environ
*------------------------------------------------------------------*
*htstr  ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15041000   5       6     2     1    0.347      0
*
*htstr        mesh locn       mesh fmt
15041100          0              1
*
*htstr        intervals       rt. coord
15041101          1             0.350
15041102          2             0.380
15041103          2             0.505
*
*htstr        compxn no.      interval
15041201          5              1
15041202          6              3
15041203          9              5
*
```

```
*htstr        source          interval
15041301       0.0               5
*
*htstr                        temp flg
15041400                         0
*
*htstr        temp            mesh pt.
15041401      550.               6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
15041501   504010000   0      1        1        1.2827         1
15041502   504020000   10000  1        1        2.5654         3
15041503   504040000   0      1        1        2.098          4
15041504   504050000   0      1        1        0.3658         5
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
15041601   900010000   0      1        1        1.2827         1
15041602   900010000   0      1        1        2.5654         3
15041603   900010000   0      1        1        2.098          4
15041604   900010000   0      1        1        0.3658         5
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
15041701      0            0            0          0            5
*
15041801      0.        10.0     10.0  0.   0.    0.  0.  1.  4
15041802      0.        10.0     10.0  0.   0.    0.  0.  1.  5
*
15041901      0.         10.0   10.0   0.   0.    0.  0.  1.  5
*
$===================================================================$
$                  ht str no. 512-1   ilsg separator to sep bypass
*-------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15121000   1        2     2     1    0.2982     0
*
*htstr        mesh locn       mesh fmt
15121100         0               1
*
*htstr        intervals       rt. coord
15121101         1              0.3012
*
*htstr        compxn no.      interval
15121201         5               1
*
*htstr        source          interval
15121301       0.0               1
*
*htstr                        temp flg
15121400                         0
*
*htstr        temp            mesh pt.
```

```
15121401       550.              2
*
*htstr      left vol    incr  b.cond  sa code  area/factor   ht str no.
15121501    508010000   0       1        1        1.7886         1
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
15121601    512010000   0       1        1        1.7886         1
*
*htstr       s. type     s. mult     left heat  right heat   ht str no.
15121701       0           0            0          0      .      1
*
15121801       0.        10.0      10.0   0.    0.     0.    0. 1.   1
*
15121901       0.        10.0      10.0   0.    0.     0.    0. 1.   1
*
$=================================================================$
$                  ht str no. 516-1   ilsg hemisph top to environ
*-----------------------------------------------------------------*
*htstr    ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
15161000    1        6     3     1     0.447     0
*
*htstr         mesh locn       mesh fmt
15161100.          0               1
*
*htstr         intervals       rt. coord
15161101           1             0.451
15161102           2             0.473
15161103           2             0.598
*
*htstr         compxn no.      interval
15161201           5               1
15161202           6               3
15161203           9               5
*
*htstr         source          interval
15161301.       0.0                5
*
*htstr                         temp flg
15161400                           0
*
*htstr         temp            mesh pt.
15161401       550.                6
*
*htstr      left vol    incr  b.cond  sa code  area/factor   ht str no.
15161501    516010000   0       1        1        0.391          1
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
15161601    900010000   0       1        1        0.391          1
*
*htstr       s. type     s. mult     left heat  right heat   ht str no.
15161701       0           0            0          0             1
```

```
*
15161801       0.        10.0     10.0    0.    0.     0.    0.  1.  1
*
15161901       0.         10.0    10.0    0. .  0.     0.    0.  1.  1
*
*-------------------------------------------------------------------*
$                 ht str no. 610-1   prizer wall heat struct
*-------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  1.coord   refl  b.vol  axl. incr
16101000   7        6      2     1    0.300     0
*
*htstr        mesh locn      mesh fmt
16101100         0              1
*
*htstr        intervals      rt. coord
16101101         1              0.303
16101102         2              0.360
16101103         2              0.485
*
*htstr        compxn no.     interval
16101201         5              1
16101202         6              3
16101203         9              5
*
*htstr        source         interval
16101301       0.0              5
*
*htstr                       temp flg
16101400                        0
*
*htstr        temp           mesh pt.
16101401      650.              6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
16101501   610020000   10000  1        1        0.475          2
16101502   610040000   0      1        1        0.600          3
16101503   610050000   10000  1        1        0.682          5
16101504   610070000   10000  1        1        0.5375         7
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
16101601   900010000   0      1        1        0.475          2
16101602   900010000   0      1        1        0.600          3
16101603   900010000   0      1        1        0.682          5
16101604   900010000   0      1        1        0.5375         7
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
16101701      0            0           0          0            7
*
16101801      0.        10.0     10.0    0.    0.     0.    0.  1.  5
16101802      0.        10.0     10.0    0.    0.     0.    0.  1.  7
*
```

```
16101901       0.        10.0  10.0   0.   0.    0.   0.  1.  7
*
$==================================================================$
$                  ht str no. 610-2   prizer top (hemisph) heat struct
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
16102000   1       6      3     1     0.323     0
*
*htstr          mesh locn        mesh fmt
16102100          0                1
*
*htstr          intervals        rt. coord
16102101          1                0.326
16102102          2                0.383
16102103          2                0.508
*
*htstr          compxn no.       interval
16102201          5                1
16102202          6                3
16102203          9                5
*
*htstr          source           interval
16102301         0.0               5
*
*htstr                           temp flg
16102400                           0
*
*htstr          temp             mesh pt.
16102401        650.               5
16102402        650.               6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
16102501   610010000   0      1        1        0.311          1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
16102601   900010000   0      1        1        0.311          1
*
*htstr      s. type     s. mult     left heat  right heat   ht str no.
16102701      0           0           0          0             1
*
16102801       0.       10.0    10.0   0.   0.    0.   0. 1.   1
*
16102901       0.        10.0    10.0  0.   0.    0.   0. 1.   1
*
$==================================================================$
$                  ht str no. 610-3   prizer bot (flange) heat struct
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
16103000   1       6      1     1     0.0       0
*
*htstr          mesh locn        mesh fmt
```

```
16103100           0             1
*
*htstr         intervals       rt. coord
16103101           1             0.003
16103102           2             0.8374
16103103           2             0.9624
*
*htstr         compxn no.      interval
16103201           5             1
16103202           6             3
16103203           9             5
*
*htstr         source          interval
16103301        0.0              5
*
*htstr                         temp flg
16103400                         0
*
*htstr         temp            mesh pt.
16103401       650.              6
*
*htstr     left vol    incr  b.cond  sa code  area/factor   ht str no.
16103501   610080000   0      1        1        0.2731         1
*
*htstr     right vol   incr  b.cond  sa code  area/factor   ht str no.
16103601   900010000   0      1        1        0.2731         1
*
*htstr      s. type      s. mult     left heat  right heat   ht str no.
16103701       0           0             0          0            1
*
16103801       0.        10.0    10.0    0.   0.    0.   0.  1.  1
*
16103901       0.         10.0   10.0    0.   0.    0.   0.  1.  1
*
$==================================================================$
$                  ht str no. 610-4   prizer htrs (prop+bkup) ht struct
*------------------------------------------------------------------*
*htstr   ht strs  m pts  geom  init  l.coord   refl  b.vol  axl. incr
16104000   2        3     2     1     0.0       0
*
*htstr         mesh locn       mesh fmt
16104100           0             1
*
*htstr         intervals       rt. coord
16104101           2             0.0115
*
*htstr         compxn no.      interval
16104201           2             1
16104202           5             2
*
*htstr         source          interval
```

```
16104301        1.0             1
16104302        0.0             2
*
*htstr                          temp flg
16104400                        0
*
*htstr        temp              mesh pt.
16104401      650.              3
*
*htstr      left vol    incr  b.cond  sa code  area/factor   ht str no.
16104501    0           0     0       0        0             2
*
*htstr      right vol   incr  b.cond  sa code  area/factor   ht str no.
16104601    610070000   10000  1      1        0.5375        2
*
*htstr       s. type     s. mult     left heat  right heat   ht str no.
16104701     10606        0.5         0.0        0.0          2
*
16104901       0.       10.0    10.0   0.   0.    0.  0.  1.   2
*
*********************************************************************
*  thermal properties
*
*********************************************************************
*
20100100    tbl/fctn    1     1  * mgo
20100200    tbl/fctn    1     1  * nicr
20100300    tbl/fctn    1     1  * copper
20100400    tbl/fctn    1     1  * inconel
20100500    tbl/fctn    1     1  * stainless steel
20100600    c-steel              * carbon steel
20100700    tbl/fctn    1     1  * al2o3
20100900    tbl/fctn    1     1  * rockwool insulation
*
*  thermal conductivity
*
*  mgo
*
20100101    293.2   0.814  1273.2  1.047
*
*  nicr heater
*
20100201    293.15  8.78   573.15  11.3    773.15  13.81  1073.15  18.83
20100202    1273.15  22.18  1473.15  25.52  10000.0  25.52
*
*  copper
*
20100301    373.15  379.  473.15  374.  573.15  369.
20100302    673.15  363.  873.15  353.
*
*  inconel 600
```

```
*
20100401    373.15  15.8   573.15  18.9   873.15  23.8  1173.15  29.3
*
*
*stainless steel
20100501   273.15  12.98  1199.82  25.1  10000.0  25.1
*
*  aluminum oxide
*
20100701    373.15  25.122 473.15  20.935 573.15 16.748 773.15 12.561
20100702   1073.15  8.374 1473.15  8.374
*
*  rockwool insulation
*
20100901    311.15  0.1192  422.15  0.1681  533.15  0.2166
20100902    811.15  0.3448
*
*
*  volumetric heat capacity
*
*  mgo
20100151    293.15  2.88e6  373.15  3.04e6  473.15  3.15e6
20100152    573.15  3.20e6  673.15  3.25e6  773.15  3.29e6
20100153    873.15  3.34e6  973.15  3.44e6 1073.15  3.53e6
20100154   1173.15  3.63e6
*
*  nicr heater
*
20100251    373.15  3.23e+6   573.15  3.62e+6    773.15  4.10e+6
20100252   1073.15  4.61e+6  1173.15  4.73e+6   1273.15  4.95e+6
20100253   1473.15  5.29e+6  10000.0  5.29e+6
*  copper
*
20100351    3.43e6
*
*  inconel 600
*
20100451    373.15  3.94e+6   573.15  4.18e+6   873.15   4.71e+6
20100452   1173.15  5.17e+6
*
*stainless steel
20100551   273.15  3.83e+6  366.5  3.83e+6  477.59  4.19e+6
20100552   588.59  4.336e+6  699.82  4.504e+6  810.93  4.639e+6
20100553   922.04  4.773e+6  1144.26  5.076e+6  1366.5  5.376e+6
20100554   1477.59  5.546e+6   10000.0  5.546e+6
*
*  aluminum oxide
*
20100751    373.15 3.015e+6   473.15 3.482e+6   573.15  3.796e+6
20100752    673.15 3.946e+6   773.15 4.093e+6   873.15  4.239e+6
20100753    973.15 4.384e+6  1073.16 4.373e+6  1173.16  4.529e+6
```

```
20100754    1373.16 4.529e+6  1473.16 4.685e+6
*
*  rockwool
20100951     1.36e+5
*
$===================================================================$
********************************************************************
*  core power
********************************************************************
*
20288800    power    501
20288801        -1.0     10.00e+6
20288802         0.0     10.00e+6
20288803        37.0     10.00e+6
20288804        38.0      9.84e+6
20288805        51.0      8.61e+6
20288806        66.0      7.44e+6
20288807        91.0      5.97e+6
20288808       110.0      5.13e+6
20288809       156.0      3.68e+6
20288810       205.0      2.90e+6
20288811       291.0      2.42e+6
20288812       405.0      1.80e+6
20288813       491.0      1.71e+6
20288814       591.0      1.60e+6
20288815       791.0      1.51e+6
20288816       991.0      1.45e+6
*
********************************************************************
*  pressurizer heater power
********************************************************************
*
20260000    reac-t                    * backup heaters
20260001        15.34e6    1.125e5
20260002        15.40e6    1.125e5
20260003        15.40e6    0.0
*
20260100    reac-t                    * proportional heaters
20260101        15.41e6    7.5e3
20260102        15.62e6    0.0
*
**********************************************
*    plot variables
**********************************************
*
*
*
********************************************************************
*    control systems
********************************************************************
*
```

```
**************************************************************
*  calculate time step
**************************************************************
*
20500100  "time stp"       sum      1.0000000 .20000000 1
20500101   0.0      1.0   time    0
20500102           -1.0   cntrlvar  2
*
20500200  "old time"       mult     1.0000000   0.0     1
20500201   time     0
*
*************************************************
*   control system turbine bypass valve control
*   during loca calcualtions
*   based on mean primary temperature control
*************************************************
*
**************************************************************
*   calculate il + bl mean temperature and select the larger
**************************************************************
*
20503000  "ilmtemp"        sum      1.0000000 580.37388 1
20503001   0.0      0.5   tempf  452010000
20503002            0.5   tempf  400010000
*
20503100  "blmtemp"        sum      1.0000000 580.35764 1
20503101   0.0      0.5   tempf  252010000
20503102            0.5   tempf  200010000
*
20503200  "ilmtempl"        tripunit  1.0000000 1.0000000 1
20503201   514
*
20503300  "blmtempl"        tripunit  1.0000000 0.0       1
20503301   516
*
20503400  "cilmtmp "        mult      1.0000000 580.37388 1
20503401   cntrlvar  32    cntrlvar   30
*
20503500  "blmtempl"        mult      1.0000000 0.0       1
20503501   cntrlvar  33    cntrlvar   31
*
20503600  "pmtemp  "        sum       1.0000000 580.37388 1
20503601   0.0      1.0   cntrlvar   34
20503602            1.0   cntrlvar   35
*
*******************************************************************
*   input to tb valve control after core trip-pmt setpt = 564.9 k
*******************************************************************
*
20503700  "pmterra "        sum       -.0902500 1.1456230 1
20503701   566.3     -1.0   cntrlvar  36
```

```
*
*****************************
*   check for reactor scram
*****************************
*
20503800  "arcttrp "       tripunit  1.0000000 0.0       1
20503801   501
*
20503900  "arcttrpc"       mult      1.0000000 0.0       1
20503901   cntrlvar  38    cntrlvar  37
*
*********************
*    tb valve control
*********************
*
20504000  "tbp area"       sum       1.0000000 0.0       1
+                            3         0.0     1.0000000
20504001    0.0         1.0      cntrlvar   39
*
*********************************************************************
* calculate core collapsed liquid level
*********************************************************************
*
20512400  "core lvl"       sum       1.0000000 3.6600000 1
20512401          0.0      0.610          voidf       124010000
20512402                   0.610          voidf       124020000
20512403                   0.610          voidf       124030000
20512404                   0.610          voidf       124040000
20512405                   0.610          voidf       124050000
20512406                   0.610          voidf       124060000
*********************************************************************
* calculate core collapsed liquid level ---vessel---
*********************************************************************
*
20512500  "core lvl"       sum       1.0000000 5.8027000 1
20512501          0.0      0.610          voidf       124010000
20512502                   0.610          voidf       124020000
20512503                   0.610          voidf       124030000
20512504                   0.610          voidf       124040000
20512505                   0.610          voidf       124050000
20512506                   0.610          voidf       124060000
20512507                   0.867          voidf       128010000
20512508                   0.6757         voidf       132010000
20512509                   0.6            voidf       136010000
*
*
*********************************************************************
* calculate core heat input
*********************************************************************
*
20512600  "coreheat"       sum       1.00000-6 9.8651798 1
```

```
20512601          0.0      1.0          q          124010000
20512602                   1.0          q          124020000
20512603                   1.0          q          124030000
20512604                   1.0          q          124040000
20512605                   1.0          q          124050000
20512606                   1.0          q          124060000
*
************************************************************************
* calculate vessel dc collapsed level
************************************************************************
*
20510900  "vsldclvl"        sum      1.0000000 3.6600000 1
20510901  0.0   0.610       voidf   108030000
20510902        0.610       voidf   108040000
20510903        0.610       voidf   108050000
20510904        0.610       voidf   108060000
20510905        0.610       voidf   108070000
20510906        0.610       voidf   108080000
*
*******************************************
* energy transferred to generators
*******************************************
*
20530000  "blsgheat"        sum      1.00000-6 4.9783641 1
20530001   0.0    1.0      q        304010000
20530002          1.0      q        304020000
20530003          1.0      q        304030000
20530004          1.0      q        304040000
*
20550000  "ilsgheat"        sum      1.00000-6 4.9752834 1
20550001   0.0    1.0      q        504010000
20550002          1.0      q        504020000
20550003          1.0      q        504030000
20550004          1.0      q        504040000
*
$***********************************************************************
$calculate sg recirculation ratios
$***********************************************************************
*
20530100  "recircbl"        div      1.0000000 5.0243769 1
20530101     mflowj   308010000    mflowj   301000000
*
20550100  "recircil"        div      1.0000000 5.0230369 1
20550101     mflowj   508010000    mflowj   501000000
*
*******************************************
* calculate narrow range sg liquid levels
*******************************************
*
20530800  "ilsgll  "        sum      .15390000 .13184474 1
20530801   0.0    0.600   voidf    300010000
```

```
20530802          2.12    voidf    312010000
20530803          3.7778  voidf    316010000
*
20550800  "blsgll  "      sum       .15390000 .12746200 1
20550801  0.0     0.600   voidf    500010000
20550802          2.12    voidf    512010000
20550803          3.7778  voidf    516010000
*
************************************************************
* set bl main feedwater on 9.5 m wide range sg level
************************************************************
*
20535900  "bl lv er"       sum        1.000000  0.       1
20535901     2570.         -1.0   cntrlvar  309
*
20536100  "bl feed "       sum      1.0000000 2.8000000 1
20536101  0.0      0.5   mflowj 805000000
20536102           2.0   cntrlvar  359
*
************************************************************
* set il main feedwater on 9.6 m wide range sg level
************************************************************
*
20555900  "il lv er"       sum        1.000000   0.      1
20555901     2570.         -1.0   cntrlvar  509
*
*
20556100  "il feed "       sum      1.0000000 2.8000000 1
20556101  0.0      0.5   mflowj 805000000
20556102           2.0   cntrlvar  559
*
$***********************************************************************
$ pressurizer heater power
$***********************************************************************
*
20560000  "pbkuphtr"       function  1.0000000 0.0       1
20560001  p    610010000    600
*
20560100  "pprohtr "       function  1.0000000 836.59446 1
20560101  p    610010000    601
*
20560200  "bkphtrtp"       tripunit  1.0000000 0.0       1
20560201  634
*
20560300  "bkphtrpw"       mult      1.0000000 0.0       1
20560301  cntrlvar   600     cntrlvar   602
*
20560400  "pzrhtrpw"       sum       1.0000000 836.59446 1
20560401  0.0          1.0   cntrlvar   601
20560402               1.0   cntrlvar   603
*
```

```
20560500  "pzhtrtp"        tripunit  1.0000000 0.0        1
20560501   633
*
20560600  "pzhtrpw"        mult      1.0000000 0.0        1
20560601   cntrlvar   604     cntrlvar   605
*
$***********************************************************************
$calculate collapsed prssurizer liquid level
$***********************************************************************
*
20561000  "pzr lev "        sum       1.00000000            2.594213   1
20561001          0.0       0.201          voidf       610010000
20561002                    0.470          voidf       610020000
20561003                    0.470          voidf       610030000
20561004                    0.600          voidf       610040000
20561005                    0.682          voidf       610050000
20561006                    0.682          voidf       610060000
20561007                    0.5375         voidf       610070000
20561008                    0.5375         voidf       610080000
*
$***********************************************************************
$calculate broken loop steam generator mass
$***********************************************************************
*
20530900  "sgb mass"        sum       1.0000000 2860.9843 1
20530901          0.0       0.3228           rho       300010000
20530902                    0.0621           rho       300020000
20530903                    0.0759           rho       300030000
20530904                    0.0759           rho       300040000
20530905                    0.1302           rho       300050000
20530906                    0.5839           rho       304010000
20530907                    0.5882           rho       304020000
20530908                    0.5882           rho       304030000
20530909                    0.4951           rho       304040000
20530910                    0.7979           rho       304050000
20530911                    0.5720           rho       308010000
20530912                    0.6288           rho       312010000
20530913                    2.0288           rho       316010000
*
$***********************************************************************
$calculate intact loop steam generator mass
$***********************************************************************
*
20550900  "sga mass"        sum       1.0000000 2848.8553 1
20550901          0.0       0.3228           rho       500010000
20550902                    0.0621           rho       500020000
20550903                    0.0759           rho       500030000
20550904                    0.0759           rho       500040000
20550905                    0.1302           rho       500050000
20550906                    0.5839           rho       504010000
20550907                    0.5882           rho       504020000
```

```
20550908                        0.5882          rho        504030000
20550909                        0.4951          rho        504040000
20550910                        0.7979          rho        504050000
20550911                        0.5720          rho        508010000
20550912                        0.6288          rho        512010000
20550913                        2.0288          rho        516010000
*
************************************************************
$******************************************************************
$calculate intact primary loop mass
$******************************************************************
*
20570000  "ihl mass"       sum       1.0000000 2848.8553 1
20570001           0.0     0.04463902         rho        400010000
20570002                   0.00093545         rho        402010000
20570003                   0.00058598         rho        404010000
20570004                   0.04446715         rho        406010000
20570005                   0.02373491         rho        408010000
20570006                   0.01778686         rho        408020000
20570007                   0.1250             rho        412010000
20570008                   0.2323             rho        416010000
*
20570100  "isg mass"       sum       1.000000  2500.0   1
20570101          0.0      0.122077           rho        420010000
20570102                   0.109029           rho        420020000
20570103                   0.109029           rho        420030000
20570104                   0.092344           rho        420040000
20570105                   0.092344           rho        420050000
20570106                   0.109029           rho        420060000
20570107                   0.109029           rho        420070000
20570108                   0.122077           rho        420080000
*
20570200  "ils mass"       sum       1.000000  2500.0    1
20570201          0.0      0.2323             rho        424010000
20570202                   0.125              rho        428010000
20570203                   0.0114552          rho        432010000
20570204                   0.02757684         rho        432020000
20570205                   0.02757684         rho        432030000
20570206                   0.02757684         rho        432040000
20570207                   0.02646018         rho        432050000
20570208                   0.02646018         rho        436010000
20570209                   0.02491284         rho        436020000
20570210                   0.02611386         rho        436030000
20570211                   0.02491284         rho        436040000
*
20570300  "icl mass"       sum       1.000000    2500.0    1
20570301         0.0       0.0235             rho        440010000
20570302                   0.03559394         rho        444010000
20570303                   0.04025465         rho        448010000
20570304                   0.04423125         rho        452010000
20570305                   0.040832           rho        740010000
```

```
*
20570400  "pr mass"      sum        1.000000 2500.0   1
20570401       0.0       0.0325              rho      610010000
20570402                 0.132869            rho      610020000
20570403                 0.132869            rho      610030000
20570404                 0.169620            rho      610040000
20570405                 0.192801            rho      610050000
20570406                 0.192801            rho      610060000
20570407                 0.146791            rho      610070000
20570408                 0.146791            rho      610080000
20570409                 0.02382748          rho      600010000
20570410                 0.03249617          rho      600020000
20570411                 0.01905868          rho      600030000
*20570412                 0.00791779          rho      620010000
*20570413                 0.00791779            rho    620020000
*
20570500  "il mass"      sum          1.000000  2500.0  1
20570501       0.0       1.0                 cntrlvar  700
20570502                 1.0                 cntrlvar  701
20570503                 1.0                 cntrlvar  702
20570504                 1.0                 cntrlvar  703
20570505                 1.0                 cntrlvar  704
*
$******************************************************************
$calculate broken primary loop mass
$******************************************************************
*
20570600  "bhl mass"     sum      1.0000000 2848.8553 1
20570601        0.0      0.04463902          rho      200010000
20570602                 0.00093545          rho      202010000
20570603                 0.00058598          rho      204010000
20570604                 0.04665091          rho      206010000
20570605                 0.02373491          rho      208010000
20570606                 0.01778686          rho      208020000
20570607                 0.1250              rho      212010000
20570608                 0.2323              rho      216010000
*
20570700  "bsg mass"     sum      1.000000  2500.0   1
20570701       0.0       0.122077            rho      220010000
20570702                 0.109029            rho      220020000
20570703                 0.109029            rho      220030000
20570704                 0.092344            rho      220040000
20570705                 0.092344            rho      220050000
20570706                 0.109029            rho      220060000
20570707                 0.109029            rho      220070000
20570708                 0.122077            rho      220080000
*
20570800  "bls mass"     sum      1.000000  2500.0    1
20570801       0.0       0.2323              rho      224010000
20570802                 0.125               rho      228010000
20570803                 0.0114552           rho      232010000
```

```
20570804                        0.02757684      rho        232020000
20570805                        0.02757684      rho        232030000
20570806                        0.02757684      rho        232040000
20570807                        0.02646018      rho        232050000
20570808                        0.02930844      rho        236010000
20570809                        0.02491284      rho        236020000
20570810                        0.02534574      rho        236030000
20570811                        0.02491284      rho        236040000
*
20570900  "bcl mass"            sum       1.000000  2500.0   1
20570901        0.0             0.0235          rho        240010000
20570902                        0.02476276      rho        244010000
20570903                        0.03177573      rho        248010000
20570904                        0.03286424      rho        252010000
20570905                        0.03286424      rho        252020000
20570906                        0.0145264       rho        790010000
*
20571000  "bl mass"             sum          1.000000  2500.0   1
20571001        0.0             1.0             cntrlvar   706
20571002                        1.0             cntrlvar   707
20571003                        1.0             cntrlvar   708
20571004                        1.0             cntrlvar   709
*
*******************************************************************
*       pressure vessel mass
******************************************************************
*
20571100  "pvd mass"            sum       1.000000  2500.0   1
20571101        0.0             0.136090        rho        100010000
20571102                        0.054250        rho        104010000
20571103                        0.06604292      rho        108010000
20571104                        0.08474058      rho        108020000
20571105                        0.0596214       rho        108030000
20571106                        0.0596214       rho        108040000
20571107                        0.0596214       rho        108050000
20571108                        0.0596214       rho        108060000
20571109                        0.0596214       rho        108070000
20571110                        0.0596214       rho        108080000
20571111                        0.123035        rho        108090000
*
20571200  "pvlpmass"            sum       1.000000  2500.0   1
20571201        0.0             0.1661          rho        112010000
20571202                        0.0943          rho        116010000
*
20571300  "pvc mass"            sum       1.000000  2500.0   1
20571301        0.0             0.1821          rho        120010000
20571302                        0.07312         rho        124010000
20571303                        0.07312         rho        124020000
20571304                        0.07312         rho        124030000
20571305                        0.07312         rho        124040000
20571306                        0.07312         rho        124050000
```

```
20571307                    0.07312          rho        124060000
20571308                    0.15220          rho        128010000
20571309                    0.10600          rho        132010000
20571310                    0.09389          rho        136010000
20571311                    0.04450          rho        140010000
20571312                    0.06209          rho        156010000
20571313                    0.06288          rho        156020000
*
20571400  "pvupmass"        sum      1.000000   2500.0   1
20571401        0.0         0.1655           rho        144010000
20571402                    0.1970           rho        148010000
20571403                    0.1475           rho        152010000
*
20571500  "pv mass"         sum         1.000000  2500.0   1
20571501        0.0         1.0              cntrlvar   711
20571502                    1.0              cntrlvar   712
20571503                    1.0              cntrlvar   713
20571504                    1.0              cntrlvar   714
*
*******************************************************************
*   primary mass
*******************************************************************
*
20572000  "pv mass"         sum         1.000000  2500.0   1
20572001        0.0         1.0              cntrlvar   705
20572002                    1.0              cntrlvar   710
20572003                    1.0              cntrlvar   715
*
*******************************************************************
*  differential pressure calculations
*******************************************************************
*
20575000 "dp050d"           sum         1.00000   80000.   1
20575001        0.0         1.0              p   416010000
20575002                   -1.0              p   420040000
*
20575100 "dp060d"           sum         1.00000   80000.   1
20575101        0.0         1.0              p   424010000
20575102                   -1.0              p   420050000
*
20575200 "dpe070"           sum         1.00000   45000.   1
20575201        0.0         1.0              p   424010000
20575202                   -1.0              p   436010000
*
20575300 "dpe080"           sum         1.00000   266000.  1
20575301        0.0         1.0              p   436010000
20575302                   -1.0              p   440010000
*
20575400 "dp190d"           sum         1.00000   80000.   1
20575401        0.0         1.0              p   216010000
20575402                   -1.0              p   220040000
```

```
*
20575500 "dp200d"          sum       1.00000   80000.   1
20575501          0.0      1.0             p   224010000
20575502                  -1.0             p   220050000
*
20575600 "dpe210"          sum       1.00000   45000.   1
20575601          0.0      1.0             p   224010000
20575602                  -1.0             p   236010000
*
20575700 "dpe220"          sum       1.00000   266000.  1
20575701          0.0      1.0             p   236010000
20575702                  -1.0             p   240010000
*
* 20575800 "dpe360"          sum       1.00000   61000.   1
* 20575801          0.0      1.0             p   100010000
* 20575802                  -1.0             p   112010000
*
20575900 "dpe280"          sum       1.00000   12000.   1
20575901          0.0      1.0             p   112010000
20575902                  -1.0             p   120010000
*
20576000 "dpe290"          sum       1.00000    1200.   1
20576001          0.0      1.0             p   120010000
20576002                  -1.0             p   124010000
*
20576100 "dpe300"          sum       1.00000   32000.   1
20576101          0.0      1.0             p   124010000
20576102                  -1.0             p   128010000
*
*0576200 "dpe310"          sum       1.00000    1900.   1
*0576201          0.0      1.0             p   124060000
*0576202                  -1.0             p   128010000
*
20576300 "dpe320"          sum       1.00000   13000.   1
20576301          0.0      1.0             p   128010000
20576302                  -1.0             p   140010000
*
20576400 "dpe330"          sum       1.00000   25000.   1
20576401          0.0      1.0             p   140010000
20576402                  -1.0             p   152010000
*
20577400 "dpe040"          sum       1.00000    8000.   1
20577401          0.0      1.0             p   416010000
20577402                  -1.0             p   920010000
*
20577500 "dpe090"          sum       1.00000    8000.   1
20577501          0.0      1.0             p   440010000
20577502                  -1.0             p   436040000
*
*
******************************************************************
```

```
* control steam valve to give sg pressure of 7.10 mpa.
************************************************************
*
20580300  "pres err"        sum       100.000-9 -5.3342-6 1
+                            3          -.05      .05
20580301     -7.10e6         1.0   p         316010000
*
20580400  "del area"        mult      1.0000000 -1.0668-6 1
20580401   cntrlvar   1      cntrlvar  803
*
20580500  "vlv area"        sum       1.0000000 .2300     1
+                            3          0.0       1.0000000
20580501   0.0      1.0   cntrlvar  805
*
****************************************
* calculate wide range sg liquid levels
****************************************
*
20531200  "blsglwde"        sum       1.0000000 8.9221049 1
20531201   0.0     2.5464   voidf    304010000
20531202           2.5654   voidf    304020000
20531203           2.5654   voidf    304030000
20531204           2.0980   voidf    304040000
20531205           2.0223   voidf    304050000
20531206           2.1200   voidf    308010000
20531207           3.7778   voidf    316010000
*
20551200  "ilsglwde"        sum       1.0000000 8.8904978 1
20551201   0.0     2.5464   voidf    504010000
20551202           2.5654   voidf    504020000
20551203           2.5654   voidf    504030000
20551204           2.0980   voidf    504040000
20551205           2.0223   voidf    504050000
20551206           2.1200   voidf    508010000
20551207           3.7778   voidf    516010000
*
****************************************************
* set rcp speed to control to loop flow of 24.2 kg/s
****************************************************
*
20523800  "spd err "        sum       2.0000000 158.365-6 1
+                            3          -5.000000 5.0000000
20523801    24.2      -1.0      mflowj    240010000
*
20523900  "delspeed"        mult      1.0000000 31.6731-6 1
20523901    cntrlvar   1    cntrlvar   238
*
20524000  "rcpspeed"        sum       1.0000000 89.403724 1
20524001    0.0       1.0   cntrlvar   239
20524002              1.0   cntrlvar   240
*
```

```
****************************************************
* set hot leg bypass valve areas to 0.0
****************************************************
*
20520300  "blhtlbyp"   constant  0.0985
*
20540300  "ilhtlbyp"   constant  0.0985
*
****************************************
* calculate heat transfer from core, sgs, pressurizer & system
****************************************
*
20584000  "corehttr"        sum        1.0000000 10000000. 1
20584001   0.0 19.37068    htrnr     124100101
20584002       19.37068    htrnr     124100201
20584003       19.37068    htrnr     124100301
20584004       19.37068    htrnr     124100401
20584005       19.37068    htrnr     124100501
20584006       19.37068    htrnr     124100601
*
20584200  "ilsghttr"        sum        1.0000000 5000000.  1
20584201   0.0    28.6501  htrnr     420100101
20584202          28.8640  htrnr     420100201
20584203          28.8640  htrnr     420100301
20584204          24.4464  htrnr     420100401
20584205          24.4464  htrnr     420100501
20584206          28.8640  htrnr     420100601
20584207          28.8640  htrnr     420100701
20584208          28.6501  htrnr     420100801
*
20584400  "blsghttr"        sum        1.0000000 5000000.  1
20584401   0.0    28.6501  htrnr     220100101
20584402          28.8640  htrnr     220100201
20584403          28.8640  htrnr     220100301
20584404          24.4464  htrnr     220100401
20584405          24.4464  htrnr     220100501
20584406          28.8640  htrnr     220100601
20584407          28.8640  htrnr     220100701
20584408          28.6501  htrnr     220100801
*
20584600  "preshttr"        sum        1.0000000        0.  1
20584601   0.0    0.03884  htrnr     610400101
20584602          0.03884  htrnr     610400201
*
20584800  "netht tr"        sum        1.0000000        0.  1
20584801   0.0    1.       cntrlvar 840
20584802         -1.       cntrlvar 842
20584803         -1.       cntrlvar 844
20584804          1.       cntrlvar 846
20584805         -1.       q         900010000
*
```

```
****************************************
* calculate net flow to secondary
****************************************
*
20585000  "netsecfl"     sum     1.0000000     0.  1
20585001   0.0     1.    mflowj  361000000
20585002           1.    mflowj  351000000
20585003           1.    mflowj  561000000
20585004           1.    mflowj  551000000
20585005          -1.    mflowj  805000000
20585006          -1.    mflowj  803000000
20585007          -1.    mflowj  369000000
20585008          -1.    mflowj  379000000
20585009          -1.    mflowj  569000000
20585010          -1.    mflowj  579000000
*
*****************************************************************
* calculate the overall pressure vessel liquid level
*****************************************************************
*
20512800  "uh level"     sum     1.000000    10.657100    1
20512801    0.0          0.626     voidf     112010000
20512802                 0.4762    voidf     116010000
20512803                 1.2588    voidf     120010000
20512804                 0.610     voidf     124010000
20512805                 0.610     voidf     124020000
20512806                 0.610     voidf     124030000
20512807                 0.610     voidf     124040000
20512808                 0.610     voidf     124050000
20512809                 0.610     voidf     124060000
20512810                 0.867     voidf     128010000
20512811                 0.6757    voidf     132010000
20512812                 0.600     voidf     136010000
20512813                 0.3674    voidf     140010000
20512814                 0.897     voidf     144010000
20512815                 0.725     voidf     148010000
20512816                 0.504     voidf     152010000
*
*****************************************************************
* calculate the steam generator liquid level
*****************************************************************
*
20551600  "sga lvl"      sum     1.000000    17.695300    1
20551601    0.0          2.5464    voidf     504010000
20551602                 2.5654    voidf     504020000
20551603                 2.5654    voidf     504030000
20551604                 2.0980    voidf     504040000
20551605                 2.0223    voidf     504050000
20551606                 2.120     voidf     508010000
20551607                 3.7778    voidf     516010000
*
```

```
20531600   "sgb lvl"      sum      1.000000    17.695300   1
20531601    0.0         2.5464     voidf     304010000
20531602                2.5654     voidf     304020000
20531603                2.5654     voidf     304030000
20531604                2.0980     voidf     304040000
20531605                2.0223     voidf     304050000
20531606                2.120      voidf     308010000
20531607                3.7778     voidf     316010000
*
*****************************************************************
* calculate the steam generator level in the boiler section
*****************************************************************
*
20550400   "sga blvl"     sum      1.000000    11.797500   1
20550401    0.0         2.5464     voidf     504010000
20550402                2.5654     voidf     504020000
20550403                2.5654     voidf     504030000
20550404                2.0980     voidf     504040000
20550405                2.0223     voidf     504050000
*
20530400   "sgb blvl"     sum      1.000000    11.797500   1
20530401    0.0         2.5464     voidf     304010000
20530402                2.5654     voidf     304020000
20530403                2.5654     voidf     304030000
20530404                2.0980     voidf     304040000
20530405                2.0223     voidf     304050000
*
*****************************************************************
* calculate the vapor flow rate in the loop seals
*****************************************************************
*
20543600   "lsa vflo"       mult     0.0222      24.4       1
20543601   velgj    436020000       rhogj     436020000
20543602   voidgj   436020000
*
20523600   "lsb vflo"       mult     0.0222      24.4       1
20523601   velgj    236020000       rhogj     236020000
20523602   voidgj   236020000
*
*****************************************************************
* calculate the vapor and liquid flow rates in the hot and cold legs
*****************************************************************
*
20513600   "hla vflo"       mult     0.05520     24.4       1
20513601   velgj    136020000       rhogj     136020000
20513602   voidgj   136020000
*
20513700   "hla fflo"       mult     0.05520     24.4       1
20513701   velfj    136020000       rhofj     136020000
20513702   voidfj   136020000
*
```

```
20513800    "hlb vflo"          mult      0.05520       24.4          1
20513801     velgj    136010000           rhogj     136010000
20513802     voidgj    136010000
*
20513900    "hlb fflo"          mult      0.05520       24.4          1
20513901     velfj    136010000           rhofj     136010000
20513902     voidfj   136010000
*
20510400    "cla vflo"          mult      0.03365       24.4          1
20510401     velgj    104040000           rhogj     104040000
20510402     voidgj   104040000
*
20510500    "cla fflo"          mult      0.03365       24.4          1
20510501     velfj    104040000           rhofj     104040000
20510502     voidfj    104040000
*
20510600    "clb vflo"          mult      0.03365       24.4          1
20510601     velgj    104030000           rhogj     104030000
20510602     voidgj   104030000
*
20510700    "clb fflo"          mult      0.03365       24.4          1
20510701     velfj    104030000           rhofj     104030000
20510702     voidfj   104030000
*
*******************************************************************
* core power
*******************************************************************
*
20588800    "core pow"    function     1.000000      10.020e+6    1
20588801     time      0         888
*
*******************************************************************
* calculate time-integrated break mass flow
*******************************************************************
*
20591500    "int bflo"    integral     1.000000      0.000000     1
20591501     mflowj    915000000
*
*******************************************************************
* calculate accumulator mass
*******************************************************************
*
20572500    "acca ms"          mult      1.000000    4312.069515    1
20572501     rhof      700010000         acvliq      700
*
20573000    "accb ms"          mult      1.000000    4659.297808    1
20573001     rhof      710010000         acvliq      710
*
*******************************************************************
* calculate the mass error
*******************************************************************
```

```
*
20574000   "mass err"      sum        1.000000   0.000000   1
20574001    -14560.577     1.0        cntrlvar   720
20574002                   1.0        cntrlvar   725
20574003                   1.0        cntrlvar   730
20574004                   1.0        cntrlvar   915
*
*****************************************************************
* calculate the time-integrated break energy flow
*****************************************************************
*
20591600   "br eflof"      mult       3.976e-4   0.000000   1
20591601   ufj    915000000    velfj    915000000
20591602   rhofj  915000000    voidfj   915000000
*
20591700   "br eflov"      mult       3.976e-4   0.000000   1
20591701   ugj    915000000    velgj    915000000
20591702   rhogj  915000000    voidgj   915000000
*
20591800   "br eflo"       sum        1.000000   0.000000   1
20591801    0.0            1.0        cntrlvar   916
20591802                   1.0        cntrlvar   917
*
20592000   "int bflo"    integral   1.000000   0.000000   1
20592001   cntrlvar    918
*
*****************************************************************
* differential pressure calculations
*****************************************************************
*
20575800   "dpe360"        sum        1.000000   61000.     1
20575801     0.0           1.0        p          112010000
20575802                  -1.0        p          100010000
*
20576500   "dpe140"        sum        1.000000   5000.      1
20576501     0.0           1.0        p          104010000
20576502                  -1.0        p          136010000
*
20576600   "dpe056"        sum        1.000000   11000.     1
20576601     0.0           1.0        p          412010000
20576602                  -1.0        p          416010000
*
20576700   "dpe196"        sum        1.000000   11000.     1
20576701     0.0           1.0        p          212010000
20576702                  -1.0        p          216010000
*
20576800   "dpe055"        sum        1.000000   2000.      1
20576801     0.0           1.0        p          416010000
20576802                  -1.0        p          424010000
*
20576900   "dpe195"        sum        1.000000   2000.      1
```

```
20576901     0.0          1.0       p          216010000
20576902                 -1.0       p          224010000
*
20577000    "dpe090"      sum       1.000000   5000.        1
20577001     0.0          1.0       p          444010000
20577002                 -1.0       p          440010000
*
20577100    "dpe230"      sum       1.000000   5000.        1
20577101     0.0          1.0       p          244010000
20577102                 -1.0       p          240010000
*
20577200    "dpe180"      sum       1.000000   3000.        1
20577201     0.0          1.0       p          208010000
20577202                 -1.0       p          212010000
*
20577300    "dpe180a"     sum       1.000000   3000.        1
20577301     0.0          1.0       p          408010000
20577302                 -1.0       p          412010000
*
******************************************************************
* calculate the accumulator liquid levels
******************************************************************
*
20578000    "acca lvl"    sum       1.375001   5.760        1
+            1         0.0
20578001    -0.160385     1.0       acvliq     700
*
20579000    "accb lvl"    sum       1.375001   6.430        1
+            1         0.0
20579001    -0.092247     1.0       acvliq     710
*
*
. zzz
```

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11. ABSTRACT (200 words or less)

5% cold leg break test, run SB-CL-18, conducted at the Large Scale Test Facility (LSTF) was analyzed using RELAP5/MOD2 Cycle 36.04 and RELAP5/MOD3 Version 5m5 codes.

The test was conducted with the main objective being the investigation of thermal-hydraulic mechanisms responsible for early core uncovery, including manometric effect due to an asymmetric coolant holdup in the steam generator upflow and downflow side.

The present analysis, carried out with RELAP5/MOD2 and MOD3 codes, demonstrates the code's capability to predict, with sufficient accuracy, the main phenomena occurring in the depressurization transient, both from a qualitative and quantitative point of view. Nevertheless, several differences regarding the evolution of phenomena and affecting the timing order have to be pointed out in the base calculations.

The sensitivity study on the break flow and the nodalization study in the components of the steam generator U-tubes and the cross-over legs were also carried out. The RELAP5/MOD3 calculation with the nodalization change resulted in good predictions of the major thermal-hydraulic phenomena and their timing order.

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