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Assessment of RELAP5/MOD3 Using BETHSY 6.2TC 6-Inch Cold Leg Side Break Comparative Test

Prepared by
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ABSTRACT

This report presents the results of the RELAP5/MOD3 Version 7j assessment on BETHSY 6.2TC. BETHSY 6.2TC test corresponding to a six inch cold leg break LOCA of the Pressurizer Water Reactor(PWR). The primary objective of the test was to provide reference data of two facilities of different scales (BETHSY and LSTF facility). On the other hand, the present calculation aims at analysis of RELAP5/MOD3 capability on the small break LOCA simulation. The results of calculation have shown that the RELAP5/MOD3 reasonably predicts occurrences as well as trends of the major phenomena such as primary pressure, timing of loop seal clearing, liquid hold up, etc. However, some disagreements also have been found in the predictions of loop seal clearing, collapsed core water level after loop seal clearing, and accumulator injection behaviors. For better understanding of discrepancies in same predictions, several sensitivity calculations have been performed as well. These include the changes of two- phase discharge coefficient at the break junction and some corrections of the interphase drag term. As result, change of a single parameter has not improved the overall predictions and it has been found that the interphase drag model has still large uncertainties.

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SUMMARY

This report describes the assessment of RELAP5/MOD3 Version 7j using BETHSY 6.2TC, simulating intermediate break Loss Of Coolant Accident (LOCA) in PWR.

BETHSY test 6.2TC simulating a 6 inch cold leg break LOCA of PWR has been performed to find the effect of different scales of two facilities, i.e. BETHSY and LSTF facilities. The initial power is 2860 kw, and the primary cooling system pressure is 15.4 MPa. Core inlet and outlet liquid temperatures are 557 K and 588 K, respectively. The objective of the present assessment is to provide systematic assessment of RELAP5/MOD3 code, contributing to code development, improvement, and enhancement of user guidelines.

In this study, the simulation begins with break open. Then, primary coolant saturation, loop seal clearing, core heatup, and activation of emergency core cooling system are followed sequentially. The calculation terminates with experimental criteria.

Generally, major phenomena observed in BETHSY 6.2TC test are predicted by the RELAP5/MOD3, however, some disagreements in the predictions also have been found. These include loop seal clearing, core water collapsed level after loop seal clearing, temperature excursions of heater rods, liquid holdup in the upward part of crossover leg and accumulator injection behaviors. In order to investigate sensitivities of some modeling and the option, the break junction discharge coefficient and interphase drag model have been examined. The results indicate limited influence to the overall system behaviors.

1. INTRODUCTION

The results of an assessment study using RELAP5/MOD3 are documented in this report for contribution to the overall code assessment efforts, which is coordinated within the Code Application and Maintenance Program (CAMP) sponsored by the U.S. Nuclear Regulatory Commission (NRC).

The objective of the CAMP is known to provide qualitative assessments of the major thermal-hydraulic computer codes for code improvement as well as code development. This report contains results and conclusions of the assessment study conducted using RELAP5/MOD3 version 7j on the loss of coolant experiment, BETHSY 6.2TC. The experiment BETHSY 6.2TC [1] was performed as a part of the Large Scale Test Facility (LSTF) counterpart test to investigate the behaviors of two facilities of different scales in the course of an intermediate cold leg break transient.

A RELAP5/MOD3 model for the simulation of the experiment, BETHSY 6.2TC, is developed for the standard case study of BETHSY facility following the information provided by the Idaho National Engineering Laboratory (INEL)[2].

The prime objective of the present study is to analyze the overall capabilities of the code on small break loss-of-coolant-accident (LOCA) simulations. Physical phenomena of concern are two phase critical flow, depressurization, core water level depression, loop seal clearing, liquid hold up, etc.

The rest of this report is organized as follows; Chapter 2 gives a brief description of the test. The input model used in this simulation is described in Chapter 3. In Chapter 4, the calculation results comparing with the test data are presented and discussed. Computational efficiency is given in Chapter 5. Finally, some conclusions obtained from this study are presented in Chapter 6.

A listing of the RELAP5/MOD3 input deck for the BETHSY 6.2TC simulation is provide in Appendix A.

2. TEST FACILITY AND DESCRIPTION

2.1 BETHSY Facility

BETHSY is a scaled down model of a three loop 900 MWe FRAMATOME pressurized water reactor (PWR) designed for the study of accident management [3]. With reference to the reactor, the volumetric scaling factor is 1/100. Since flow patterns in the primary coolant system (PCS) are often gravity dominant under most of accident conditions, the elevations and heights of all the components are preserved.

The primary cooling system, as shown in Figure 1, consists of the pressure vessel containing electrically heated rods and an external downcomer, and three identical loops each equipped with a reactor coolant pump(RCP) and a steam generator(SG). The pressurizer is connected to hot leg of either loop 1 or 2. The maximum operating pressure and temperature of primary coolant system are 17.2 MPa and 673 K and the secondary side was designed to operate up to 8 MPa at saturation temperature.

The reactor core is composed of 428 full length indirectly heated rods and 29 guide thimbles arranged according to the 17x17 reactor bundle design as shown in Figure 2. It is powered with 3 MW electric supply which corresponds to the decay heat level in the BETHSY facility. The rods represent average rod behavior, i.e., the radial peaking factor of one. And the axial power profile represent a stepwise cosine shape with an axial peaking factor of 1.6. The downcomer, links the three cold legs to the lower plenum, is made up of two different geometry parts; The upper part consists of an external tube to avoid the significant distortions of the annular downcomer. The lower part is an annulus so as to make uniform flow distribution at the core inlet. Such a configuration has been chosen in BETHSY, for better simulation of hydraulic head in both the downcomer and the upflow side of crossover legs, to preserve the elevation of the lower bound of cold leg nozzles as shown in Figure 3.

Concerning hot leg nozzles, no particular criterion has been appeared to be more important than another and they have been positioned in such a way that their axes are at the same elevation as the PWR hot leg nozzle axis.

All bypass flow paths except "cold to hot leg path" are properly modeled. Each RCP operate at the scaled conditions; the head is 1/1 scaled and the flow rate 1/100.

The secondary coolant system is composed of three steam generators, steam pipe lines, a spray condenser, main feedwater and auxiliary feedwater systems. The general configuration of steam generator is similar to that of the steam generators of the reference plant. Each steam generator contains 34 inverted-U tubes of the same radial dimension and height stepping as those of the reference steam generator, thus providing a scaled heat transfer area between primary and secondary sides.

The safety injection system has the same capabilities of the reference PWR, which consists of high pressure safety injection system, accumulators, and low pressure safety injection system. In addition, a trace heating system is installed to compensate for increased environmental heat losses and modified structure-to-fluid heat transfer characteristics in comparison with the reference plant. More than 1000 channels over the facility were used to measure transient parameters [4].

To simulate BETHSY 6.2TC, the upper head to downcomer bypass was modified to take into account of the LSTF loop specifications and the accumulator on the cold leg 1 is isolated.

2.2 BETHSY 6.2TC Transient Description

BETHSY test 6.2TC was performed in the BETHSY facility on July 5 1989. The experiment simulates intermediate break loss-of-coolant accident involving 5% break area of the cold leg in PWR. This test duplicated, as closely as possible, the test of LSTF SB-CL-21 performed in September 1989 [5].

The initial power was 2860 KW, initial pressure 15.38 MPa, and accumulators pressure 4.2 MPa. The bypass flow rate from the upper head to the downcomer was adjusted to be 0.28 % of the total flow of the 3-loops to simulate LSTF bypass flow rate.

The primary objective of this test is to compare the behaviors of the two facilities of different scales in the course of an intermediate cold leg break transient. A particular attention is paid to core liquid level depression before loop seal clearing to analyze the physical phenomena during small break LOCA.

Initial experiment conditions are listed in Table 1. Side-oriented break nozzle (D=15.48 mm, L/D=10) is located on the cold leg of the loop 1 where the pressurizer is attached, and the accumulator on the loop 1 is isolated.

Major event chronology of the test is summarized as follows ;

t = 0 s	opening of the break valve, - the trace heating was stopped,
t = 8 s	scram signal occurred (pressurizer pressure < 13.0 MPa), - core power was maintained at 2863 KW for 53 s then followed the JAERI conservative curve [1], - RCPs were stopped, - condenser was stopped, - normal SG supply was stopped, - SG discharge valve setpoint was set to 7.2 MPa,
t = 12 s	safety injection signal occurred (pressurizer pressure < 11.7 MPa), - no action, the HPSI was not operated,
t = 341 s	accumulator opening signal occurred (pressurizer pressure < 4.2 MPa), - opening of accumulators 2 and 3 (with time delay of 4 s),
t = 948 s	accumulator 3 stopped by level criterion,
t = 976 s	accumulator 2 stopped by level criterion,
t = 2179 s	test stopped (pressurizer pressure < 0.7 MPa).

Table 2 lists the major events of the test with compared to the calculation result, which will be discussed at later chapter.

Table 1. Initial Conditions of BETHSY 6.2TC

Parameter	Experiment	RELAP5
Power, kW	2863 ± 30	2863
Pressurizer Pressure, MPa	15.38 ± 0.15	15.38
Pressurizer Level, m	7.45 ± 0.2	7.65
Pump Rotating Speed, rpm	238 ± 6	238
Core Inlet Temperature, K	557.2 ± 0.4	557.7
Core Exit Temperature K	588.2 ± 0.4	588.9
PCS Coolant Inventory, kg	1984 ± 50	1976.0
SG Pressure, MPa	6.84 ± 0.07	6.81
SG Water Level, m	11.1 ± 0.05	10.5
Feedwater Temperature, K	523.1 ± 4	523.2
Downcomer Bypass flow, %	0.28	0.28
Heat Loss, kW	54.82	57.71

Table 2. Chronology of BETHSY 6.2TC Test Major Event

Event	Experiment	RELAP5
Break Open, s	0.0	0.0
Reactor Scram Signal, s	8.0	6.9
Safety Injection Signal, s	12.0	14.5
Loop Seal Clearing, s	134	138
Primary/Secondary Pressure Reversal, s	172	176
Accumulator #2 Injection, s	345 ~ 948	315 ~ 828
Accumulator #3 Injection, s	345 ~ 976	315 ~ 786
Pressurizer Pressure < 0.7 MPa, s	2179	1856

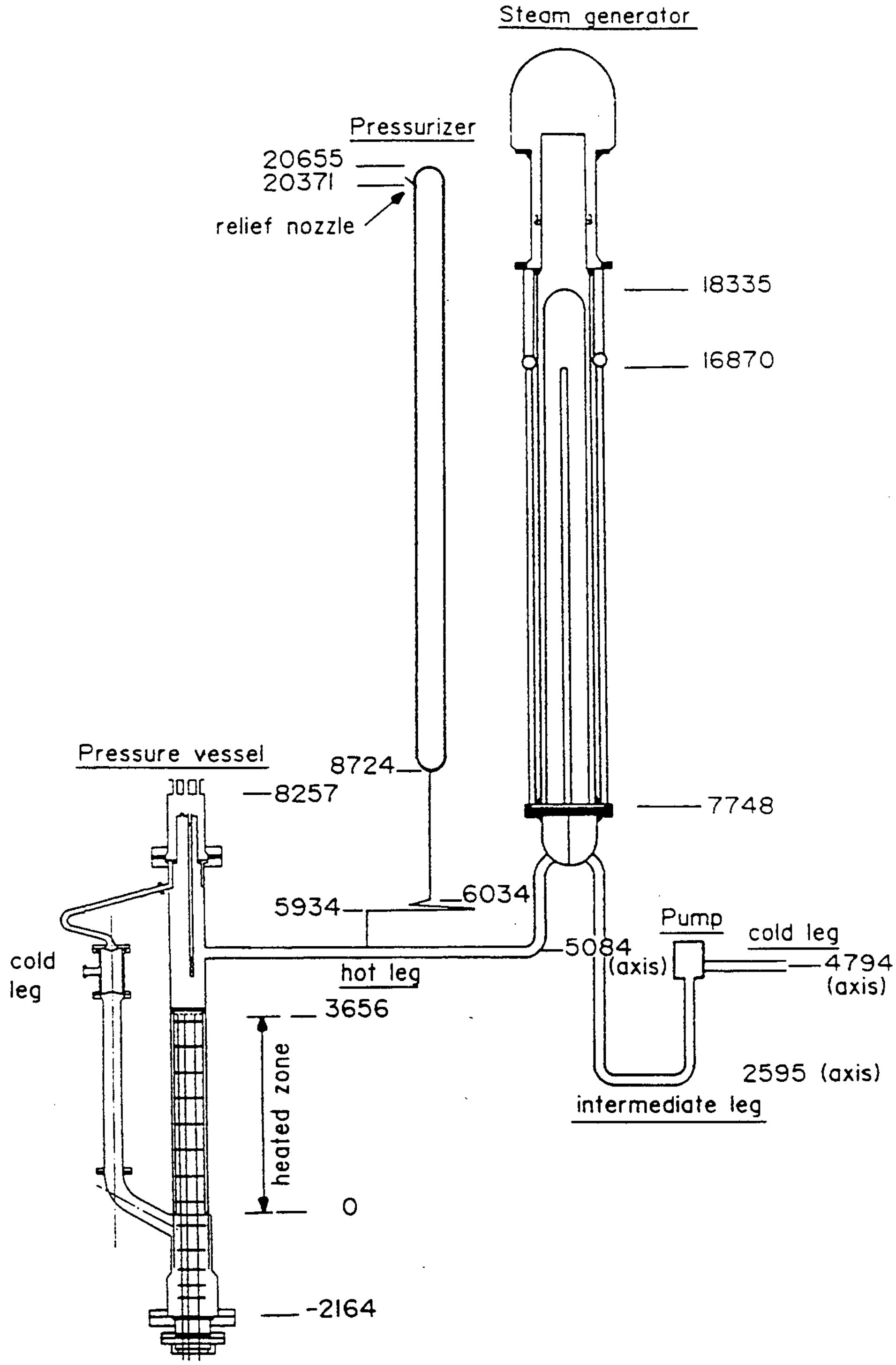

Figure 1 The primary cooling system of BETHSY:
Elevations in mm, Loop 2 and 3 are not shown

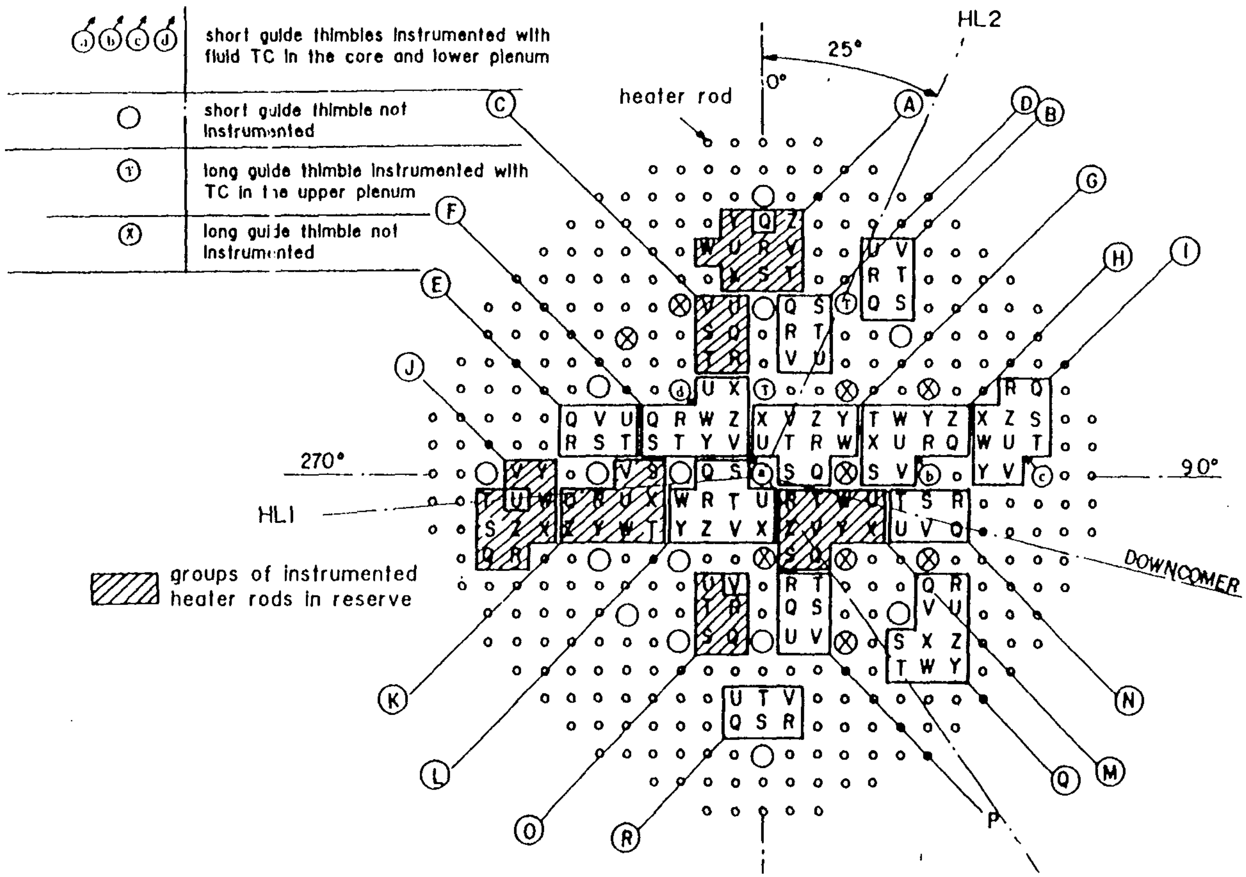

Figure 2 Radial distribution of core in the pressure vessel

(Top view)

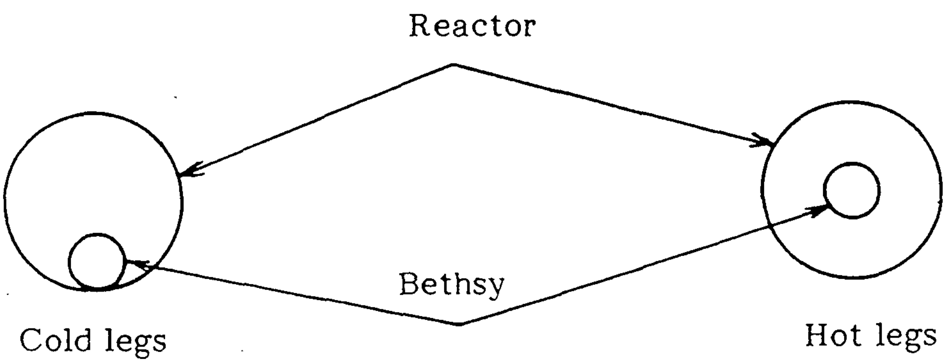

Figure 3 The locations of hot leg and cold leg nozzles of BETHSY

3. CODE AND MODELING DESCRIPTIONS

3.1 Computer code

The RELAP5/MOD3 version 7j computer code is used in the present simulation. RELAP5/MOD3 is a one-dimensional, two-fluid, six-equation, thermal nonequilibrium transient and accident analysis code. This code was developed at INEL for the U.S. Nuclear Regulatory commission (USNRC). Specific application of the code to the experiment BETHSY 6.2TC is discussed in the following sections.

3.2 Modeling and Nodalization

The BETHSY facility[6] is nodalized in detail enough to simulate the important two-phase flow processes, such as core water level depression, loop seal clearing, and transient coolant distribution in the primary cooling system. Since these are chiefly governed by manometric head balance between the reactor vessel and the crossover legs, fine nodalizations are employed for some of the vertical pipings, of which elevations are lower than those of horizontal part of hot legs, in RELAP5 input models. Figure 4 shows hydrodynamic input models for the code. This input model consists of 251 volumes, 258 junctions, and 283 heat structures. Three coolant loops are individually modeled.

3.2.1 Reactor vessel

The reactor core is modeled by sixteen control volumes of equal length covering the active length of the heated core (3.66m). The axial power profile is modeled by fourteen volumes. The equal power applied to 428 electrically heated rods. Also, sixteen control volumes in parallel with core region are used in modeling the bypass channel.

The downcomer inlet part is a branch component which connects the cold leg pipes to the downcomer and the upper head bypass pipe. The lower plenum, upper plenum and upper head are divided into several control volumes and simulated by branch component. Flow resistance and bypass flow through upper head to downcomer is adjusted at the junction between the two control volumes of components. The environmental heat loss components are modeled by a primary coolant volume and an ambient volume. Besides trace power is appropriately modeled.

3.2.2 Loops

Since the accuracy of the break flow calculation is of great importance in prediction of system response, modeling of break loop deserves to attention. In this study , the broken loop is simulated by a series of branch, and pipe components. The break nozzle is simulated by a branch, a pipe, and a time-dependent volume for pressure boundary condition. Modeling of the break geometry is important for accurate calculation of break flow. For the break junction, the discharge coefficients of 0.85, 1.2 and 0.96 are used for subcooled water, saturated two-phase, and single-phase vapor discharge, respectively.

The intact loop modeling includes a hot leg, and intermediate leg, a RCP, a cold leg. These are represented by combinations of branch, single volume, pipe and pump components. Pump characteristics are provided for single phase homologous conditions. A set of two-phase multiplier and two-phase difference curves are used by input data. The moment of inertia of the pump rotor shaft is used to characterize the coastdown behavior of the pump.

To simulate liquid holdup in the steam generator inlet plenum more realistically, counter current flow limitation (CCFL) options are applied to the junctions from the horizontal portion of the hot leg to the vertical portion of the hot leg. The Wallis form of the CCFL equation is used [7,8]: The slope and gas intercept were 0.785 and 0.55, respectively.

And the ECC Mixer model is not employed since it was evaluated to be ineffective in this case [9].

3.2.3 Pressurizer

The pressurizer attached with broken loop is modeled by five volumes because it is not expected to be sensitive to the calculated results. The spray and heater systems in the pressurizer are neglected. The surge line is nodalized with 3 control volumes and 3 junctions.

3.2.4 Steam Generator

The steam generator primary side is represented by pipe component using ten control volumes. For steam generator U-tube, eight volumes are used. Such a modeling was based on the expectation that six inch break is sufficiently large to remove the decay heat through the break and thus the effect of steam generator heat transfer on the primary cooling system is presumed to be less important. Two volumes of each end represent inlet plenum and outlet plenum of steam generator.

The secondary side is represented by a series of feedwater, downcomer, riser, and separator. A time-dependent volume is used to provide pressure boundary condition at the exit. A heat structures representing the U-tubes are added to permit the heat exchange between the primary side and the secondary side in the steam generator.

3.2.5 Emergency Core Cooling System

The emergency core cooling systems (accumulator, high pressure injection system, low pressure injection system) can be modeled in the RELAP5/MOD3. Among them, accumulator component is only used in this modeling according to the experimental conditions. The accumulator component activates at 4.2 MPa of cold leg pressure.

3.3 Initialization Process and Boundary Conditions

The steady state is obtained by calculating a stabilizing null transient of several hundred seconds, of which results are used as initial condition of the transient calculation. In order to achieve the steady state conditions consistent with the experimental data, some input variables of the code are calibrated through repeated calculations as follows:

(i) The bypass flow from downcomer to upper head is very small in the initial RELAP5 results. Thus, the orifice area at the bypass path is increased to attain a flow rate of 0.28 % of total loop flow rate.

(ii) The steam generator heat transfer is underpredicted in the code. It is corrected by decreasing the heated equivalent diameter of U-tube outside [2].

(iii) In order to achieve the pressure condition and the primary mass inventory, a time dependent volume with system initial pressure (15.38 MPa) is connected to the top of pressurizer. A time dependent volume with inflow and outflow is also connected to the bottom of pressurizer (to achieve the initial primary coolant mass of 1984 kg)

The steady state data resulting from the initialization process are listed with measured data in Table 1. The comparison shows acceptable agreement with the experimental data.

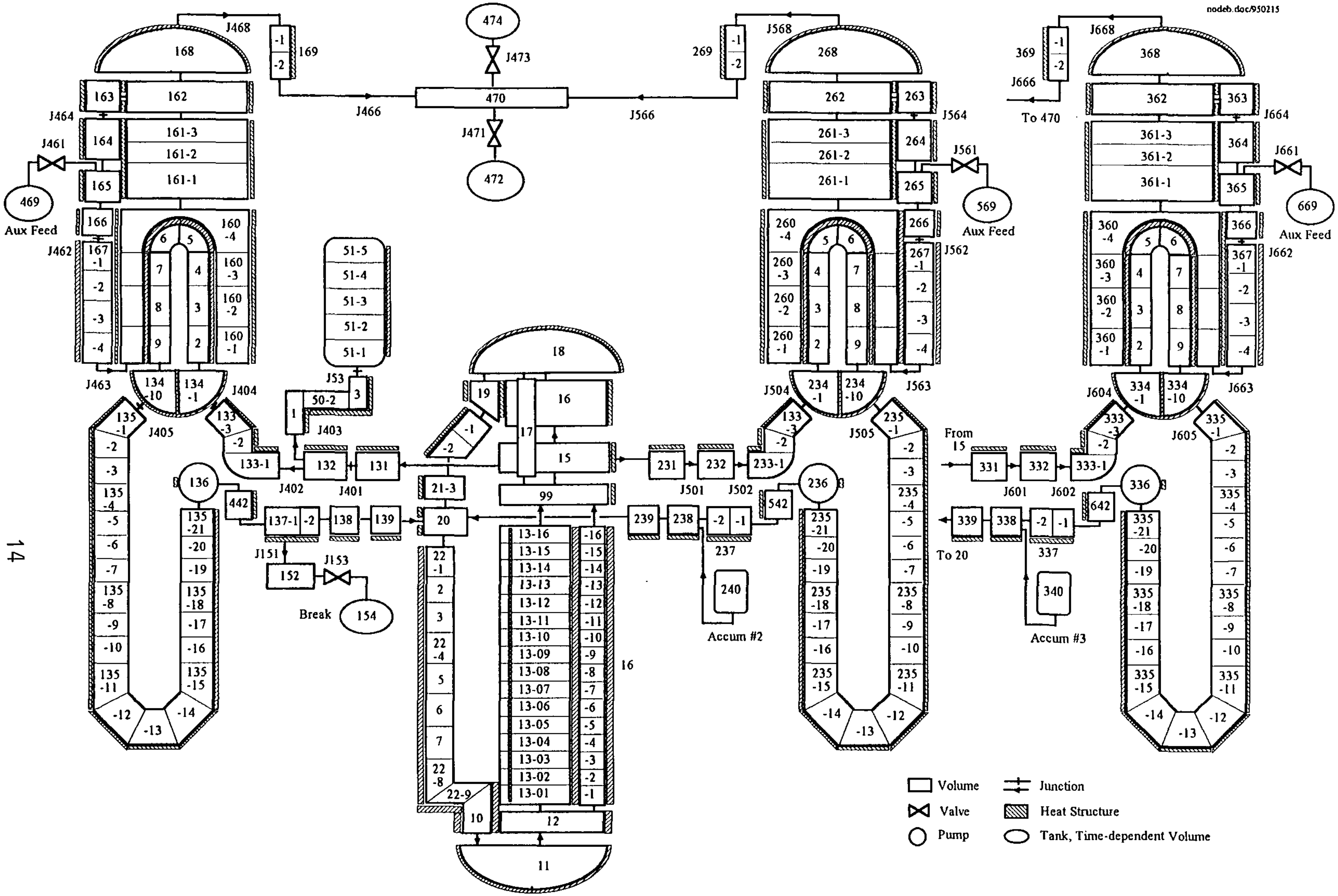

Fig. 4 RELAP5/MOD3 Nodalization for BETHSY Facility

4. RESULTS AND DISCUSSIONS

Transient calculations have been done with the initial conditions described above. Major event chronology is compared with the experimental data in table 2. Figure 5 through 19 show transient behaviors of important parameters. Table 3 lists the important parameters in comparison and their measurement uncertainty [1]. In general, RELAP5 predicts the trends reasonably. As shown in the Figures, the calculations generally show faster evolution. In the following sections, the calculation results of important two-phase processes are compared and discussed. Besides, additional the results of sensitivity studies are also given.

4.1 Base Case Calculation

4.1.1 Depressurization and Break Flow

The pressurizer pressures are compared in Figure 5. Generally, the RELAP5 calculations agree well with the measured data in pressurizer pressure throughout the experiment. But it begins to overpredict the depressurization rate at about 280 s and the discrepancy reaches the maximum about 1.8 MPa around 350 s. This difference can be considered as an overprediction of two-phase break flow.

As shown in Figure 6, the code calculates break flow rates well during single-phase period. However, transition from low quality to high quality in two-phase blowdown is delayed in the calculation and, as a result, the integrated break flow is overpredicted during two-phase period as shown in Figure 7. The deviation of the pressure also begins just after two-phase break flow occurs. Until 300 s, RELAP5 overpredicts the integrated break flow by about 135 kg comparing with that of measured data. This difference corresponds to 6 % of the initial primary cooling system mass inventory and is not changed until the end of experiment. Another tentative reason of the faster depressurization may attribute to poor prediction of core void distribution by RELAP5. As shown in Figure 8, almost the upper one third of the active core is uncovered from 280 s to 320 s in the RELAP5 calculations and thus, steam generation at the core is underpredicted during this period, which in turn evokes the faster depressurization.

4.1.2 Collapsed Core Water Level

Figure 9 shows the collapsed core water level. Core uncovery appears three times both in the experiment and in the simulations. The evolution of collapsed core water level can be divided into four distinct periods;

(i) low-quality two-phase blowdown period until the loop seal clearing (0 ~ 134 sec.)

(ii) high-quality two-phase blowdown period until the beginning of accumulator injection (134 ~ 345 sec.)

(iii) accumulator injection period (345 ~ 945 sec.) , and

(iv) boil-off period until the end of experiment (945 ~ 2000 sec.) .

As shown in Figure 9, RELAP5 predicts some deviations of collapsed core water level after loop seal clearing.

During the first period, the collapsed core water level rapidly decreases due to low-quality two-phase break flow and subsequent flashing of core coolant occurs. Minimum water level is reached just before the loop seal clearing, which is discussed at later section. By manometric head balance between the reactor core and the crossover legs, the minimum level is lower than the bottom of crossover legs. The minimum collapsed water level is predicted to be 1.3 m by RELAP5, which is deeper than the measured level by about 0.3 m. It seems that incomplete loop seal clearing would lead lower minimum level in the RELAP5 calculations.

During the second period, the collapsed core water level of the second is determined by manometric head balance between the downcomer and the core. The Figure 9 shows the RELAP5 underpredicts the collapsed core water level during this period. After the loop seal clearing, the downcomer head pushes fluid back into the core (see Figure 11) and the collapsed core water level increases instantaneously. The pressure difference in Figure 11. is the differential pressure between the vessel inlet nozzle and the downcomer outlet. Drastic depressurization is observed again since the break is uncovered. On the other hand, the collapsed core water level continues to decrease until the actuation of accumulator. During the second period, the code underpredicts the collapsed core water level. It may also be caused by incomplete loop seal clearings likely the first one. That is, the remaining liquid in the upflow side of the crossover legs pressurizes the collapsed core water level. In RELAP5 results, blowout of the remaining liquid occurs at about 340 s, which entails a sudden swell of core water level.

During the third period, the collapsed core water level in the experiment increases due to accumulator injection. In general, the collapsed core water level predicted by RELAP5 shows large deviations from the experiment after accumulator injection. The RELAP5 calculation shows an earlier actuation of accumulator and a larger amount of water delivered, which will be discussed at later section.

The fourth period is characterized by redistribution of coolant, boil-off, and monatomic level decrease. RELAP5 underpredicts the collapsed core water level by 0.5 m. The deviation of 0.5 m in collapsed core water level is equivalent to 20 kg of coolant, approximately. Such a level deviation is considered ad an important contributor to the difference of 135 kg in the integrated break flow, .

4.1.3 Loop Seal Clearing

After the break opens, the upper portion of the primary cooling system gradually fills with steam and eventually liquid seals are left in the crossover legs, in the reactor vessel, and in the downcomer. These liquid seals form a blockage of steam flow along the loop toward the break. As a result, the vessel upper plenum and hot legs are pressurized, which causes manometric depressions both the liquid level in the downflow side of the crossover legs and the reactor vessel. Due to the buildup of pressure in the upper portion, the liquid seal in the downflow side of the crossover leg is pushed downward. When it reaches the bottom of the crossover leg, the water is swept towards the break, and then the liquid seal is completely cleared and after all a steam flow path from the core to the break through the steam generator is established. It is called the loop seal clearing. After the loop seal clearing, the manometric balance of pressure heads throughout the loop is relaxed, resulting in a sudden increase of the core water level.

The loop seal clearings are well illustrated by the differential pressure (DP) behaviors of the downflow and upflow sides of the crossover legs. In the experiment the loop seal clearings of all the loops occurs almost simultaneously at 134 s. Figure 12 and 13 indicate that RELAP5 predicts the initiation of loop sealing clearings at 138 s. The DPs at the upflow side of the crossover leg is the differential pressure between the reactor coolant pump inlet and the crossover leg bottom. On the other hand, DPs at the downflow side of the crossover leg is the differential pressure between the steam generator outlet plenum nozzle and the crossover leg bottom.

All three loops show the same behaviors both in the calculation and in the experiment. In RELAP5 results, the downflow side is completely drained while the upflow side is partially drained as shown in Figure 13. Complete drain is eventually established after about 200 s. This effect is significant in the collapsed core water level because the remaining liquid water level resists against steam flow toward the break until it is completely cleared.

4.1.4 Liquid Holdup at the SG Inlet Plenum

One of phenomena that affect on the water level depression is the liquid holdup in the upper region of the primary cooling system, such as hot legs and steam generator inlet plenums. The liquid in the steam generator inlet plenum and in the upflow side of the U-tubes falls into the reactor vessel by gravity, but the liquid drains against steam flow and thus establishes a counter-current flow. The drain rate may be often limited by the CCFL. Figure 14 shows the measured and calculated differential pressures in the steam generator inlet plenum. The differential pressure has been measured between the steam generator inlet plenum nozzle and the bottom of the steam generator tube sheet. RELAP5 predicts the drain of all water in steam generator inlet plenum just after the loop seal clearing. It may result from the underestimation of the interphase drag. In contrast, a significant liquid holdup is predicted during the accumulator injection period and this result is also observed in the experiment. The code predicts the trends reasonably but the timing and the magnitude on the holdup are not calculated accurately. The deviation of DPs before accumulator injection is likely caused by overprediction of break flow rate.

4.1.5 Accumulator Injection

Due to faster depressurization in the RELAP5 calculations, the accumulator injection begins earlier than in the experiment. Figure 15 shows the integrated accumulator flow. The code predicts intermittent injection behavior rather than the continuous behavior as measured, and the depletion of accumulators are accordingly achieved earlier in the RELAP5 calculation. Time elapsed during 50% injection of the accumulator water in the REALP5 calculation is 50 s, whereas about 190 s was taken in the experiment. This discrepancy directly affect on the downcomer and core water level behaviors (see Figure 9 and 10). As shown in Figure 10, the downcomer water level doesn't increase continuously due to the intermittent accumulator injection.

The intermittent injection behavior might be caused by the code characteristics rather than by inadequate modeling.

4.1.6 Core Uncovery and Heatup

Core uncovery cannot be directly measured. Instead, local void fraction can be retrieved from the eight differential pressure measurements installed in the active core region. Transient void distributions along the core are compared in Figure 8. The dark indicates liquid phase and the white indicates vapor phase. In the experiment, core uncovery was observed three times and also was predicted by the code. In RELAP5 calculations, the duration of the first core uncovery at 140 s is very short, the second uncovery at 300 s is long-lived and deep, and the third uncovery begins too early. The higher void fractions in the upper core predicted by the RELAP5 are considered, in general, due to the overestimation of interphase drag force.

The core heatup is affected by two-phase water level, not dependent on collapsed core water level. The core heatup is strongly affected by core uncovery. RELAP5 doesn't predict the first core heatup at 2.1 m and the second heatup by the code appears higher than that of measured data. The third core heatup is predicted earlier as shown in Figure 16 because of earlier depletion of accumulator.

4.1.7 Steam Generator Behavior

As soon as safety injection signal occurs, the condenser and the feedwater are isolated. Accordingly, the steam generator pressure increases up to the setpoint of safety valves, 7.2 MPa, by heat transfer between the primary and the secondary. After 172 seconds from this event, the pressure of the secondary side becomes higher than that of the primary side and thus reverse heat transfer initiates. Figure 17 shows that RELAP5 overpredicts the secondary pressure from 200 s, i.e., RELAP5 predicts slower depressurization of steam generator pressure. This difference could likely result from uncertainties in environmental heat loss as well as in U-tube heat transfer. RELAP5 seems to underpredict heat transfer through U-tube from secondary side to primary side in the steam generator.

Figure 18 shows liquid temperature of lower part of steam generator riser. The time which the liquid temperature begins to fall rapidly, coincides with the time of accumulator injection. The injected liquid from accumulators is transported to the U-tube through the core and the hot leg. When injected liquid reaches U-tubes, the primary side of U-tubes is superheated state or saturation state. Therefore, the riser temperature after the liquid arrives at U-tubes is decreased due to the heat transfer between the secondary side and the primary side. In RELAP5 results, the deviation between calculated temperature and measured temperature slowly increases because of mis-prediction of void distribution in primary side. As shown in Figure 14, the inlet plenum of the steam generator contains some liquid after 1000 seconds in experiment but it was not predicted in the calculation.

In summary, an overprediction of void in the U-tubes result in underprediction of heat transfer from the secondary side to the primary side.

4.1.8 Mass Distribution in the Core

Mass distribution of the upper part in the core can be represented by the differential pressure of the upper plenum which is shown in Figure 11. Sudden increases of the differential pressures appear both in the experiment and in the calculation. During the first period, the pressure difference in the upper plenum is rapidly decreased by low quality break flow. The first minimum differential pressure occurs before loop seal clearing. After loop seal clearing, the differential pressure increases by manometric head balance between the core and the hot leg. Fast depressurization continues again until the accumulators actuate. During this period, the code underpredicts the differential pressure. It is due to the overestimation of the two-phase break flow. During the next period, the injection of the accumulator water increases the differential pressure. We can recognize that the final period is characterized by a redistribution and monatomic decrease of coolant until the upper plenum is empty. Figure 19 shows an identical result as discussed.

Table 3. Measurement Qualifications

Parameter/Unit	Meas. Min~Max	Meas. Uncer-tainty	RELAP5 Parameter
Pressurizer Pressure, MPa	0~18	1.5	p-05105
Break Flow Rate, cm^3/s	0~105000	360	p-13701
DP at Downcomer, HPa	-16~484	5.0	p-02209 - p-13902
DP at Upper Plenum, HPa	-13~107	1.2	p-09901 - p-01610
DP at Crossover Leg Downflow Side, HPa	-219~381	6.0	p-13521 - p-13502
DP at Crossover Leg Upflow Side, HPa	-32~168	2.0	p-13521 - p-13701
DP at SG Inlet Plenum, HPa	-19~101	1.2	p-13303 - p-13401
DP at SG U-tube Upflow Side, HPa	-445~1022	15	p-13401 - p-13405
Accumulator Flow Rate, cm^3/s	0~830	5	mflowj-24001
Cladding Temperature, C	0~500	4	httemp-013100908
SG Dome Pressure, MPa	0~8	0.7	p-16801
SG Liquid Temperature, C	0~500	4	tempf-16704
Hot Leg Void Fraction	0~1	---	voidg-13101

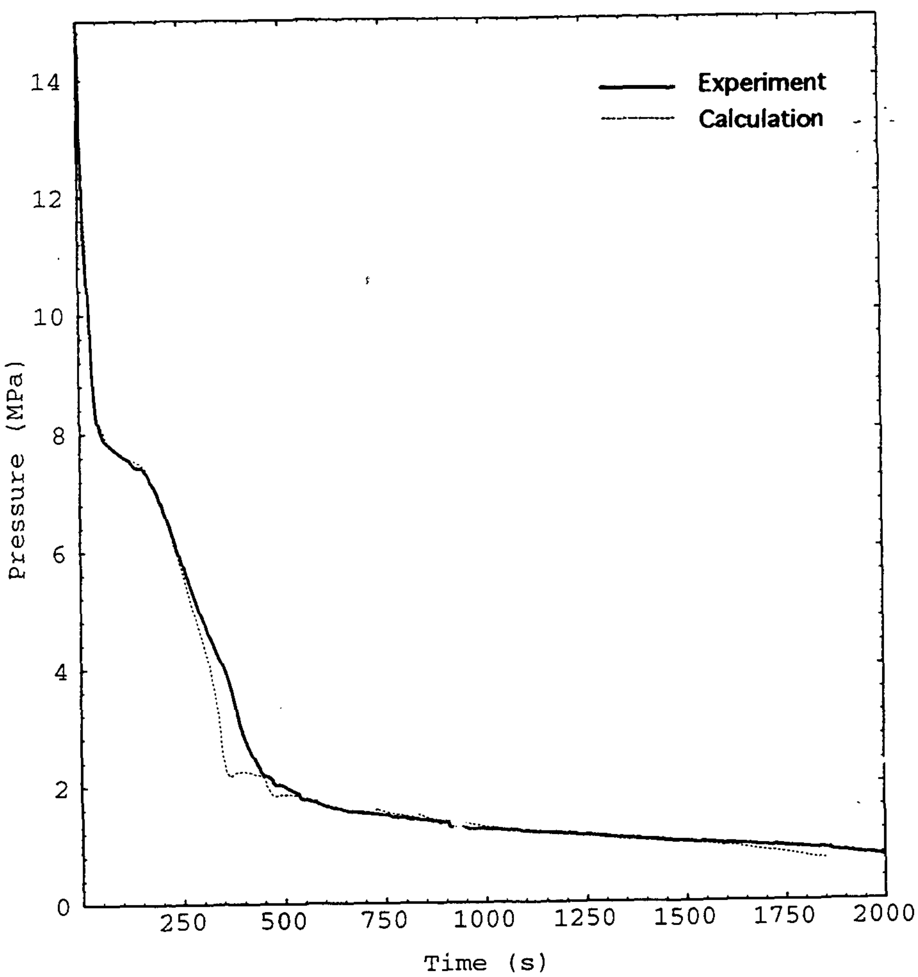

Figure 5 Comparison of the pressurizer pressures

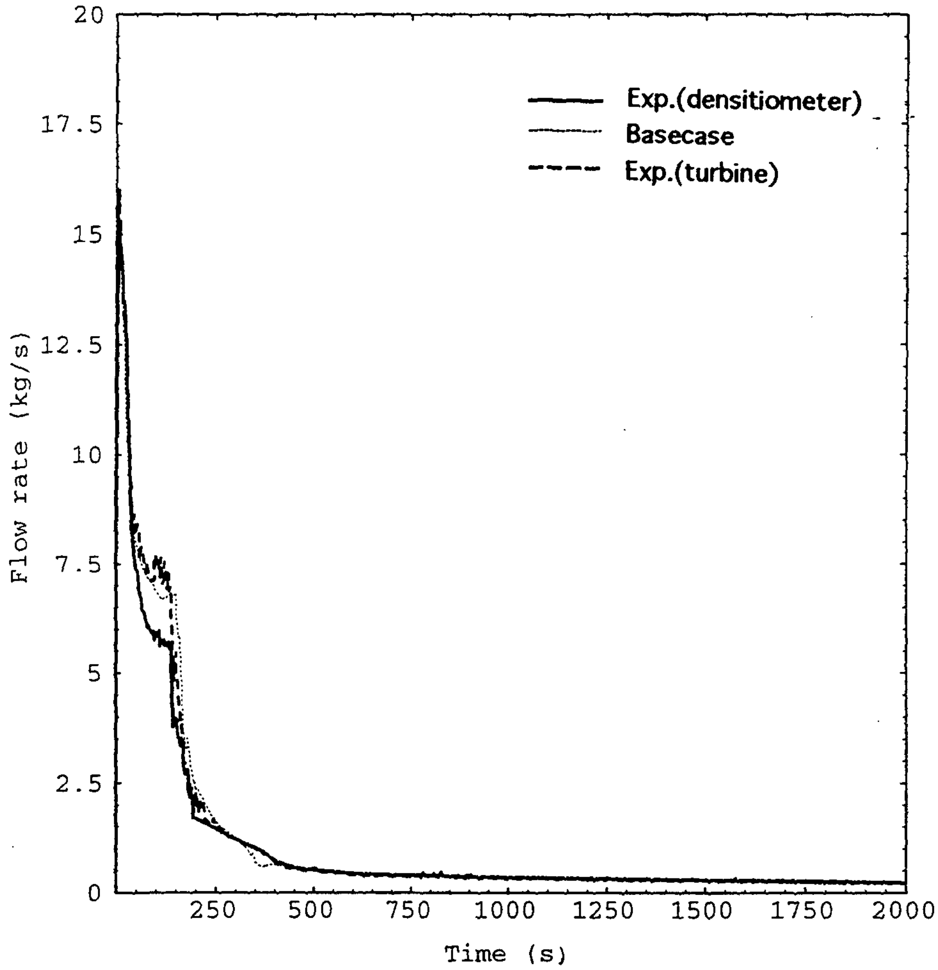

Figure 6 Comparison of the break flow rates

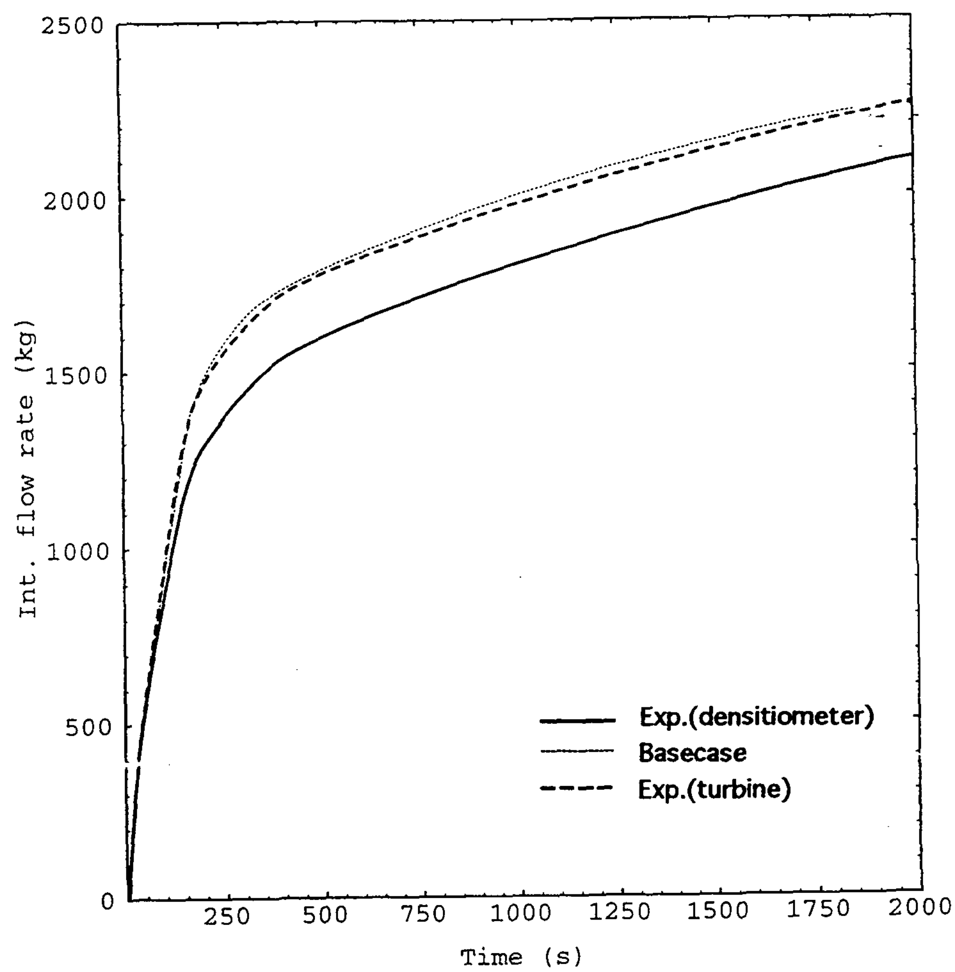

Figure 7 Comparison of the integrated break flow rates.

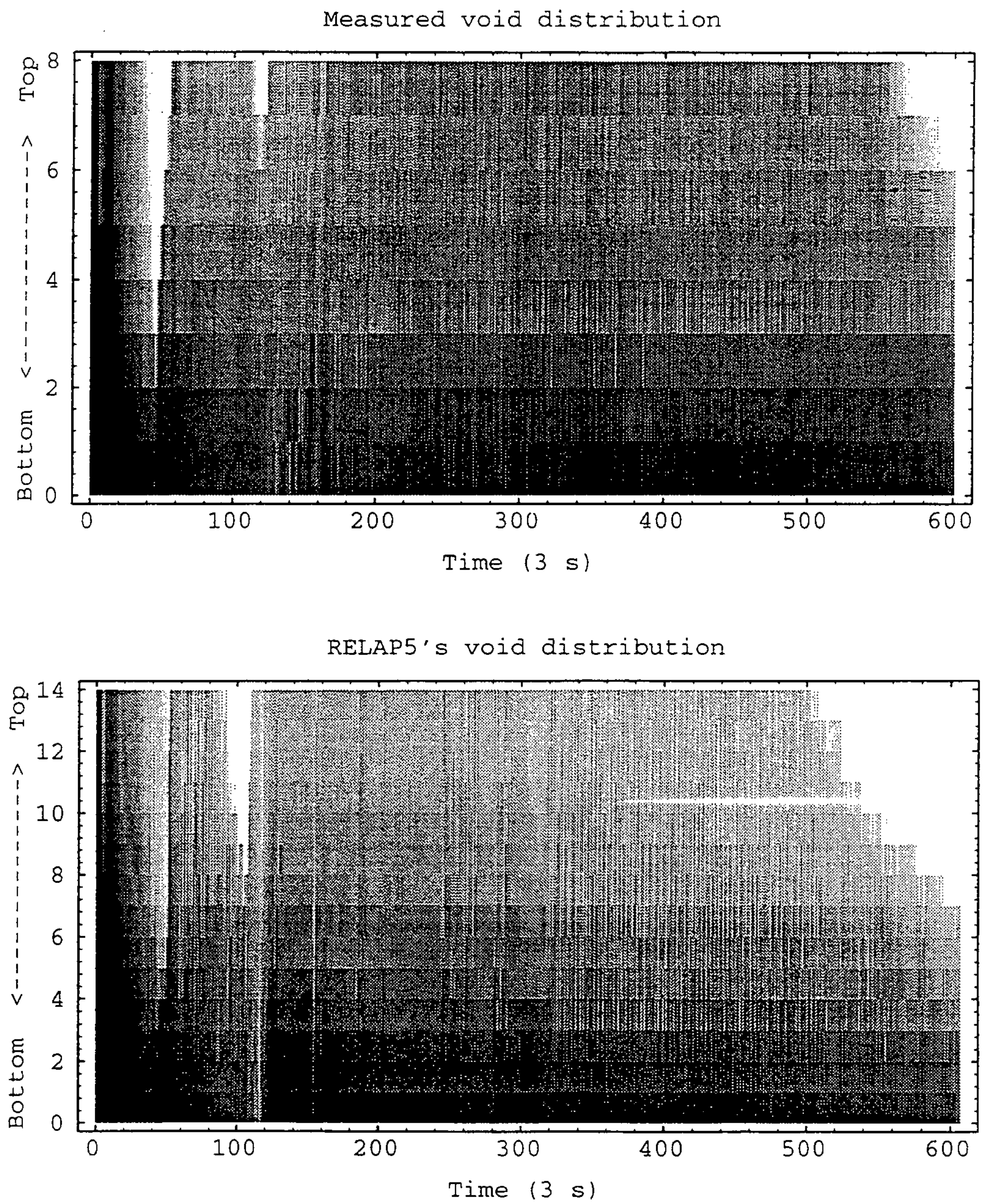

Figure 8 Comparison of transient void distributions at the core (white : vapor, Dark : liquid)

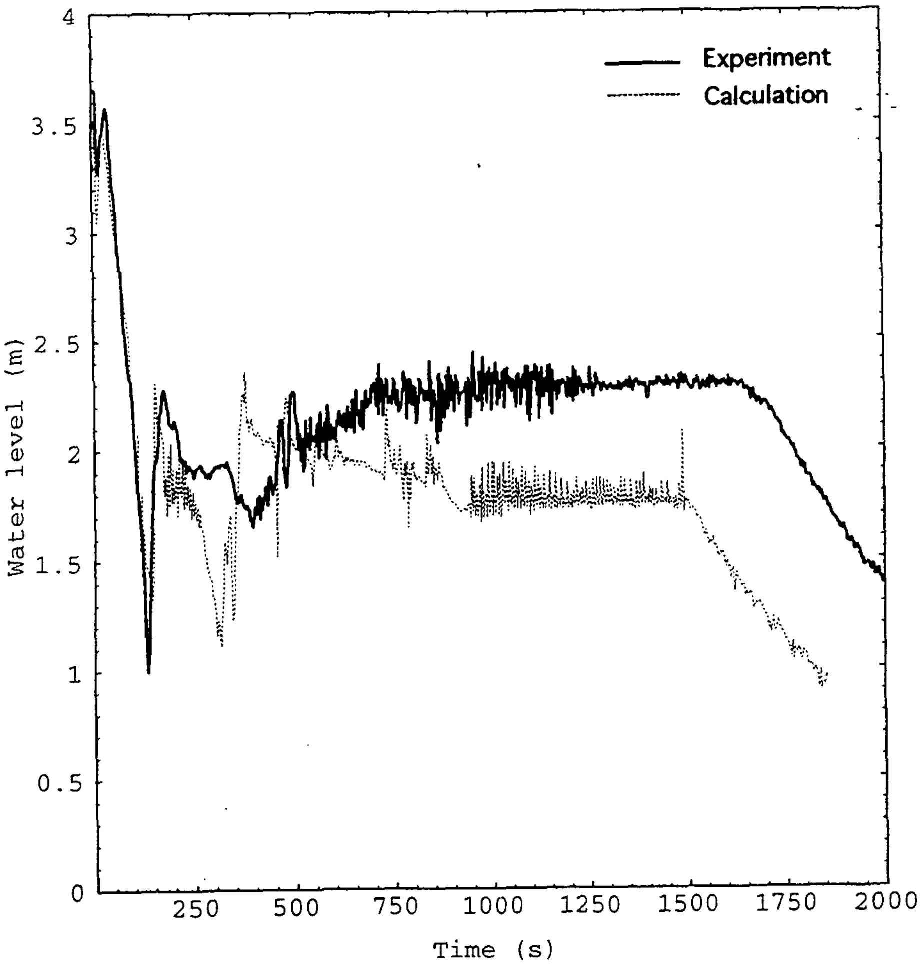

Figure 9 Comparison of the collapsed core water levels

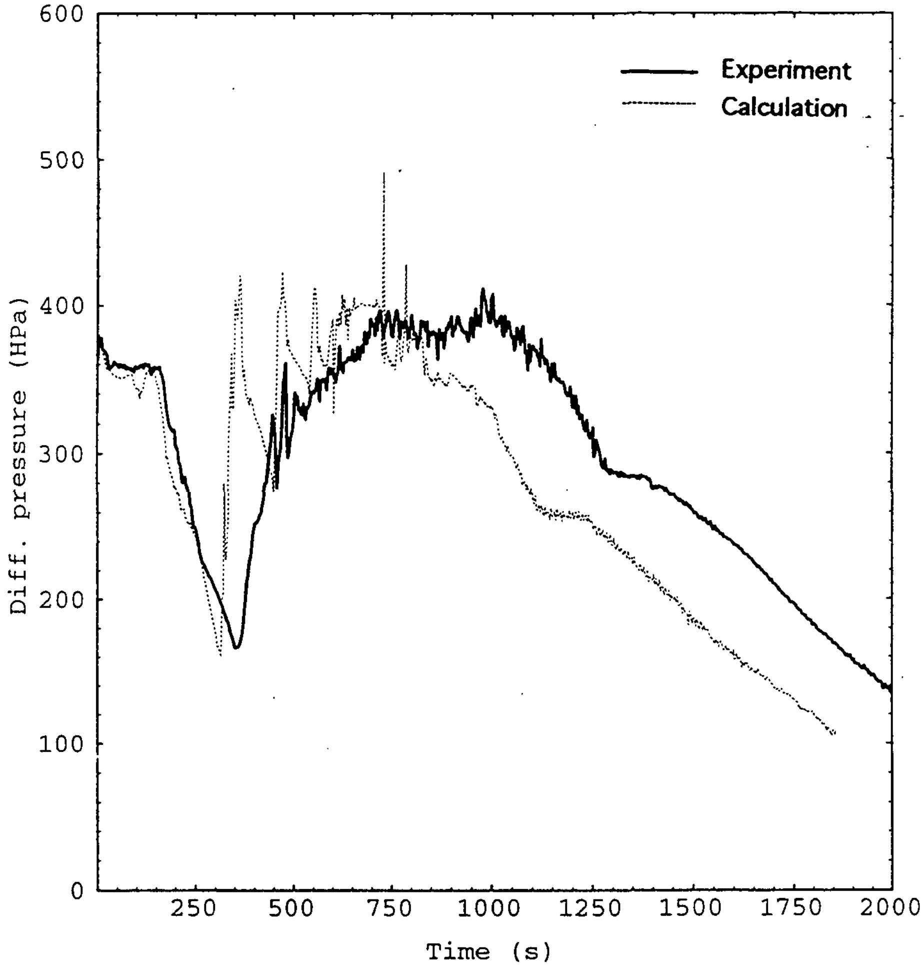

Figure 10 Comparison of the DPs at the downcomer

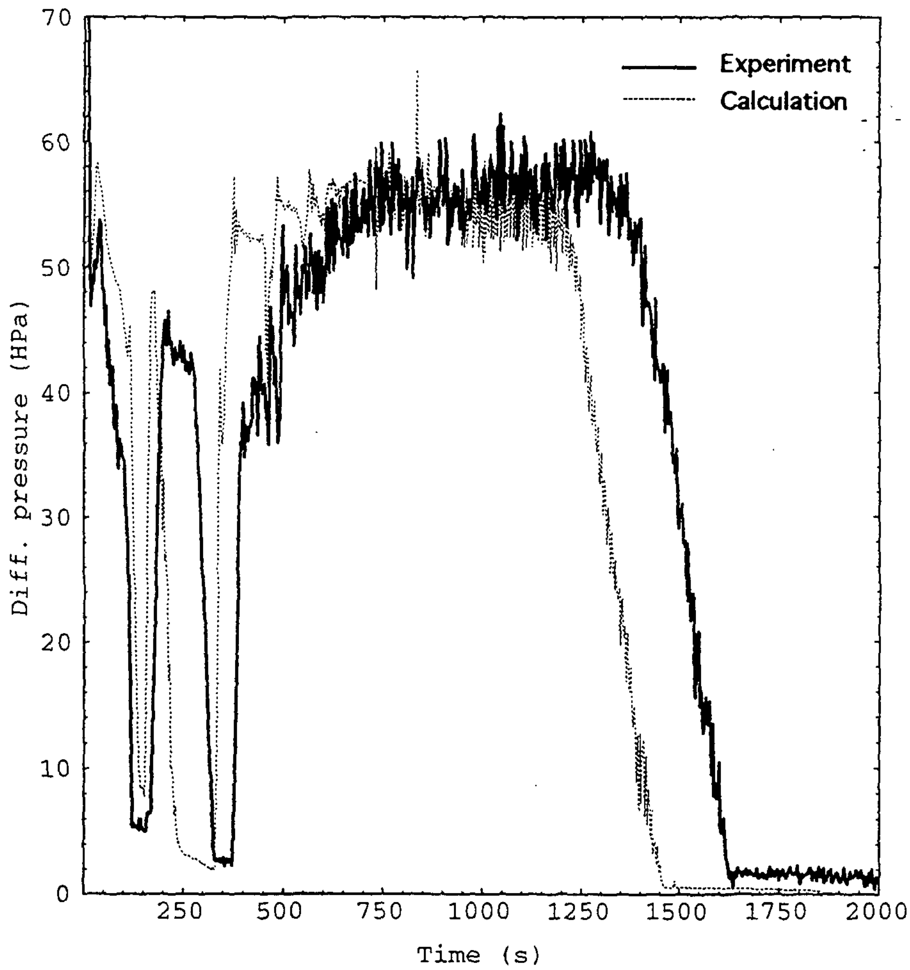

Figure 11 Comparison of the DPs at the upper plenum

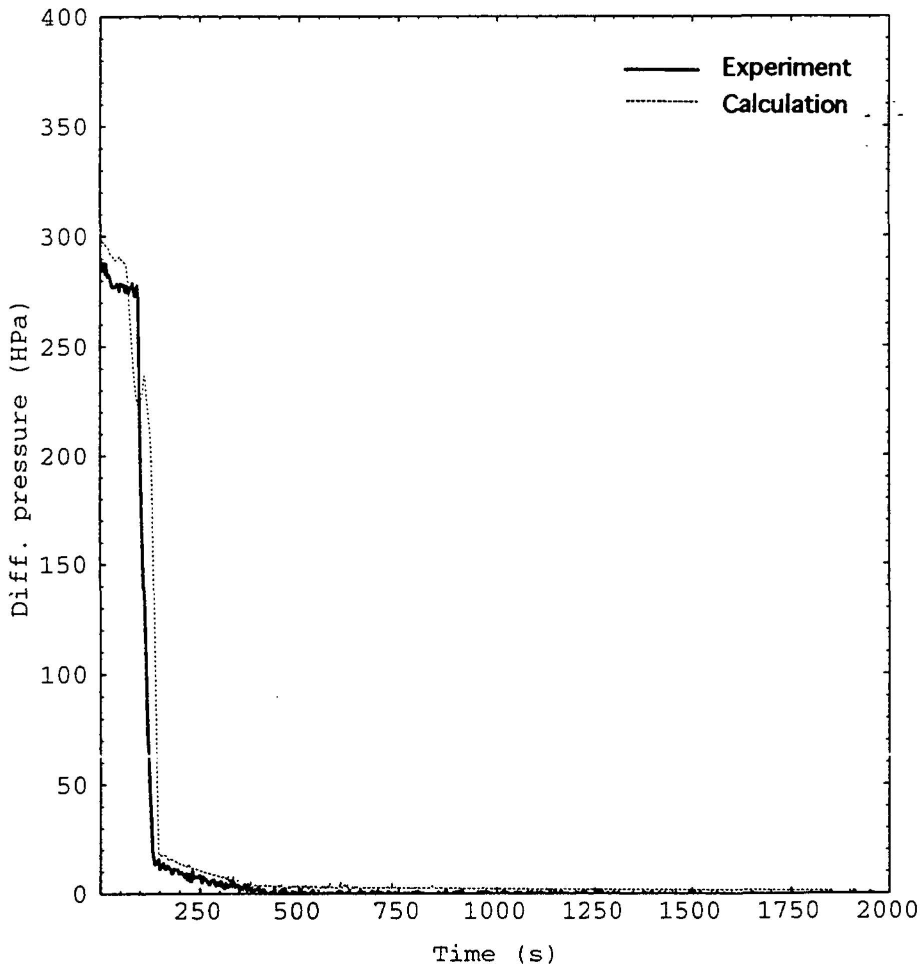

Figure 12 Comparison of the DPs at the downflow side of the crossover leg 1

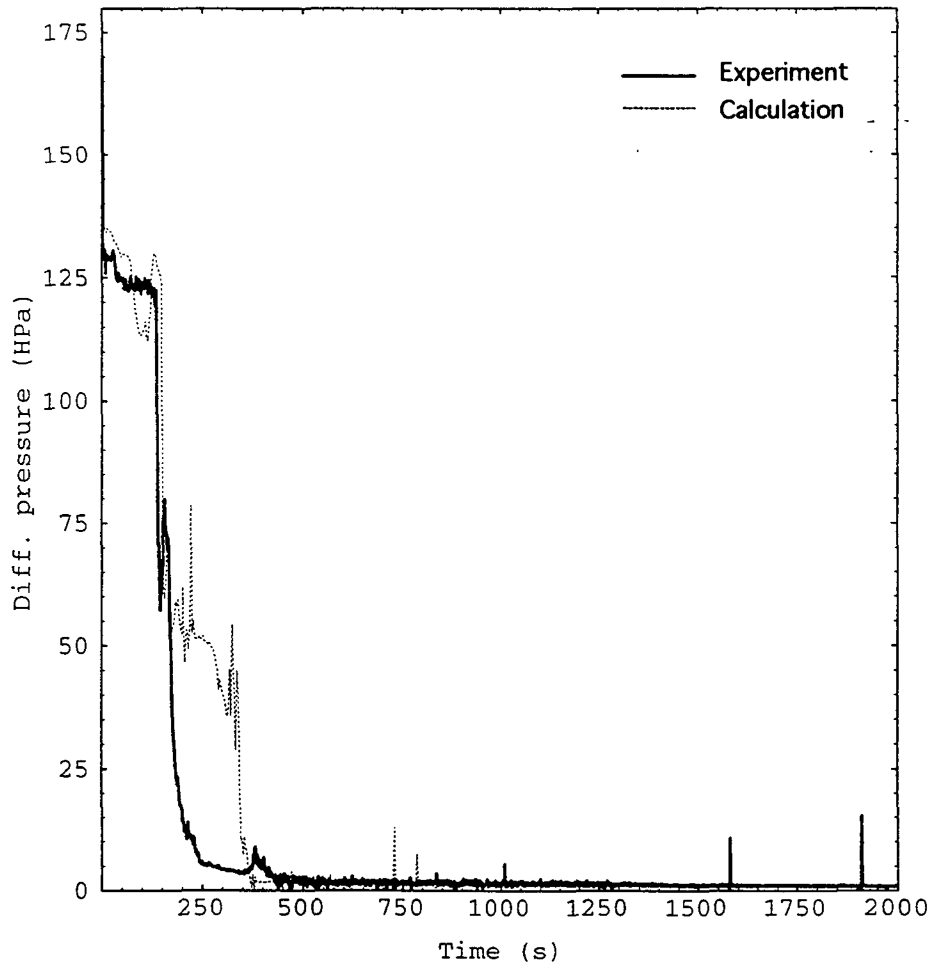

Figure 13 Comparison of the DPs at the upflow side of the crossover leg 1

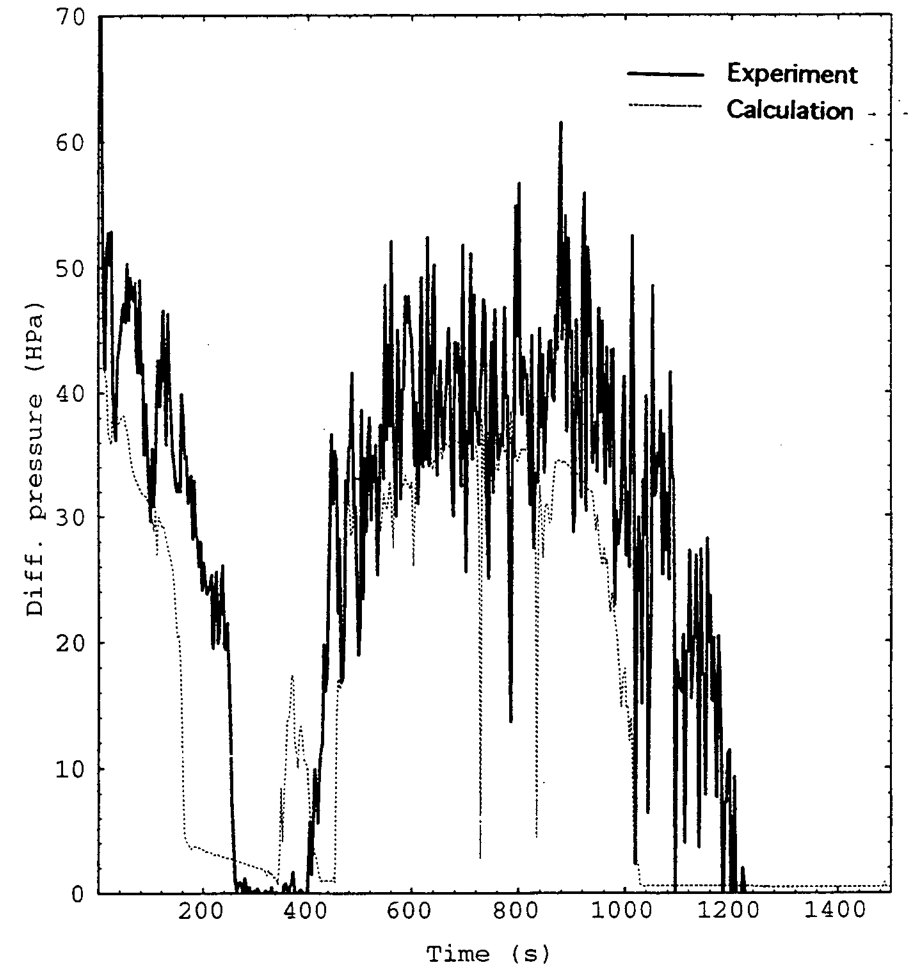

Figure 14 Comparison of the DPs at the SG 1 inlet plenum

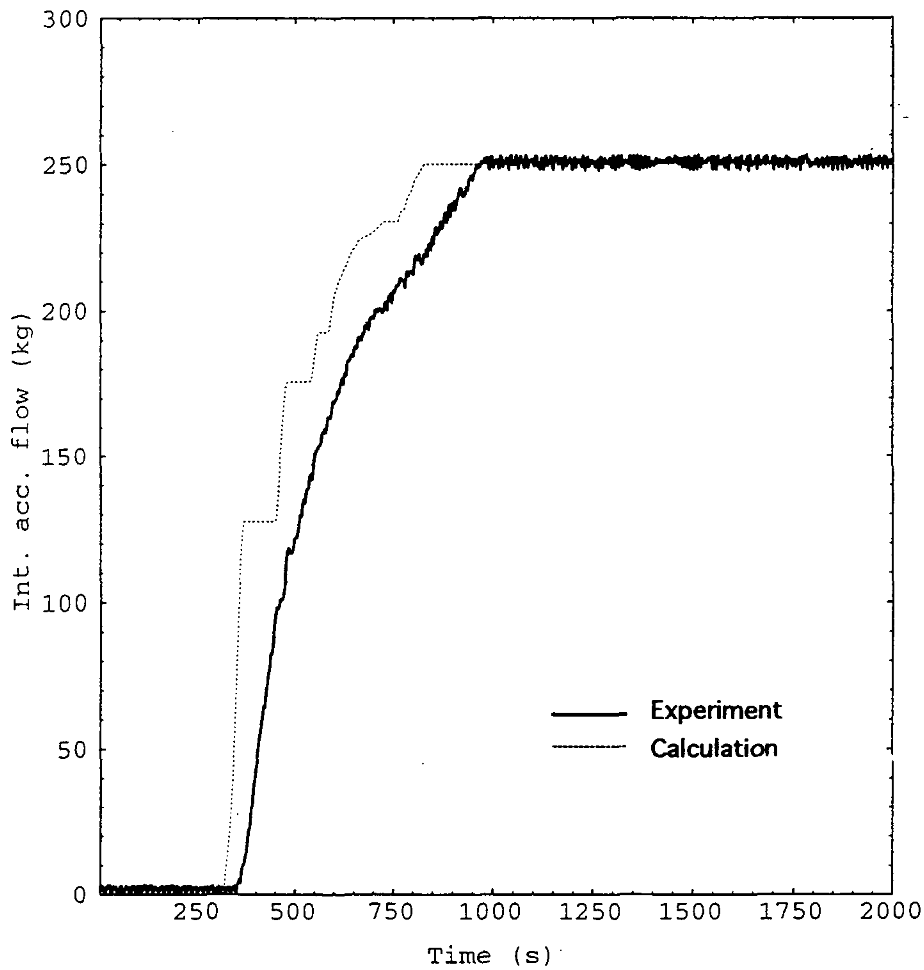

Figure 15 Comparison of the integrated accumulator flows

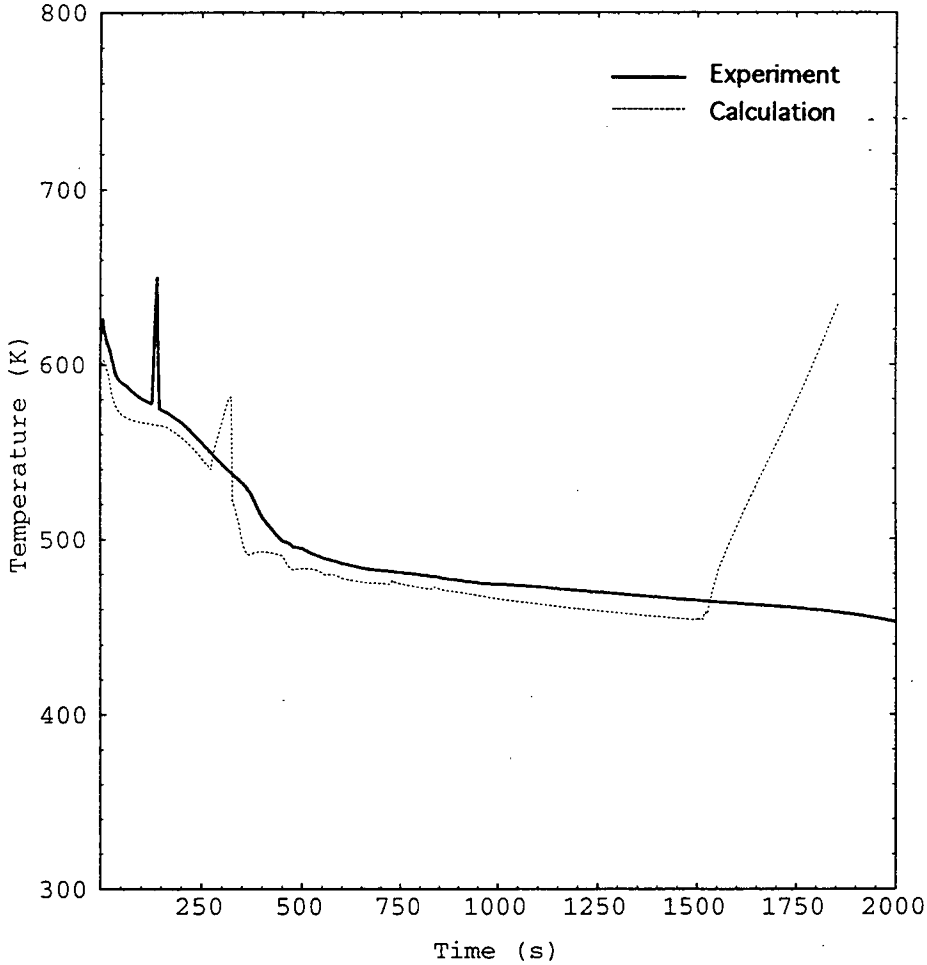

Figure 16 Comparison of the rod surface temperatures at 2.1 m

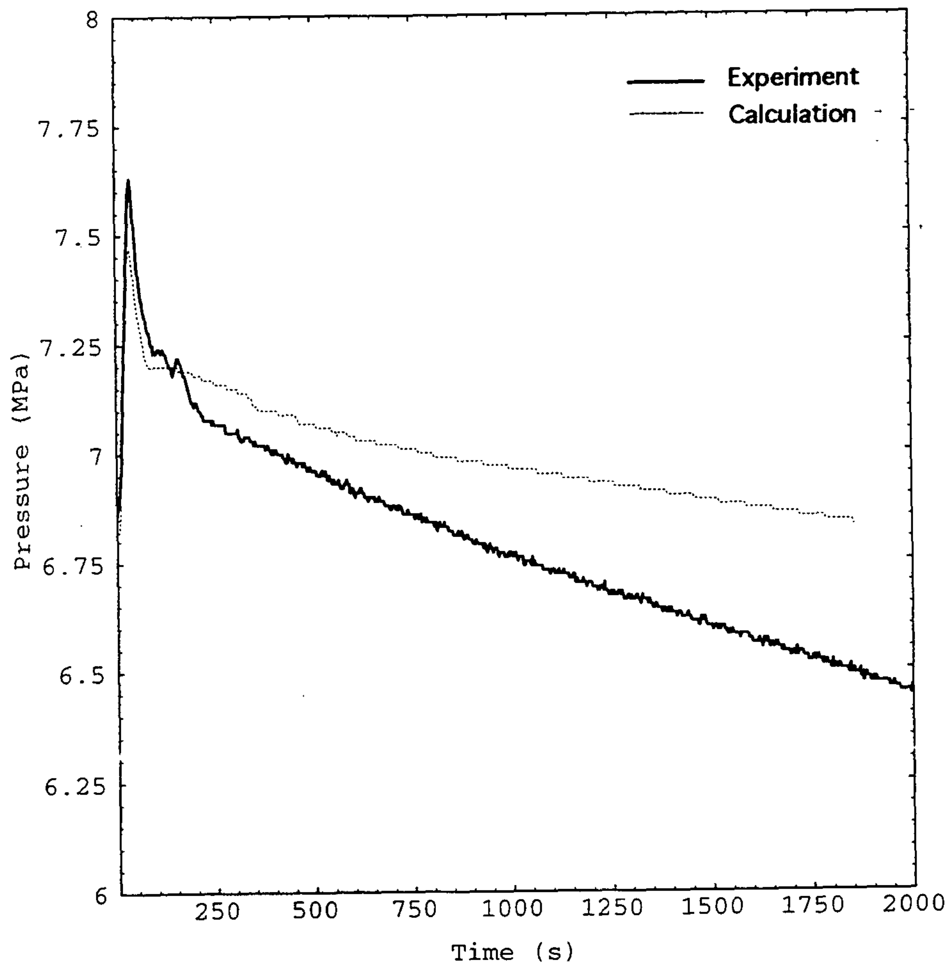

Figure 17 Comparison of the steam generator dome pressures

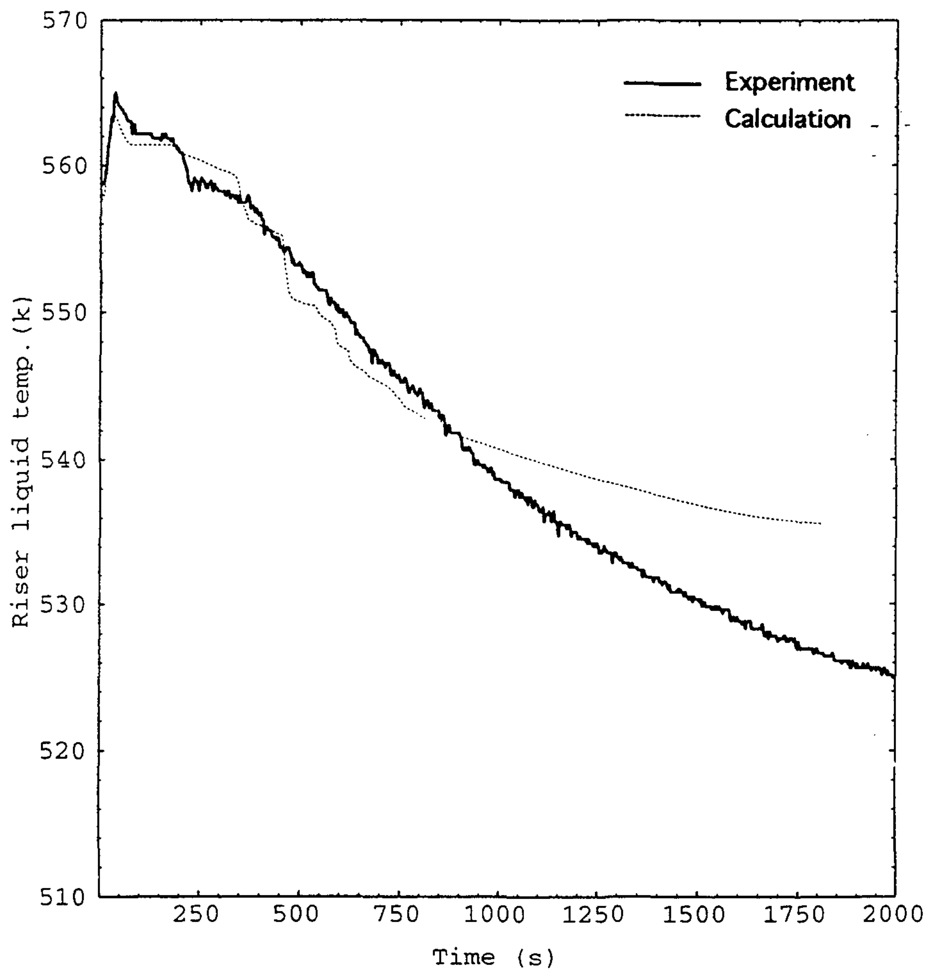

Figure 18 Comparison of the liquid temperature at the SG 1 bottom

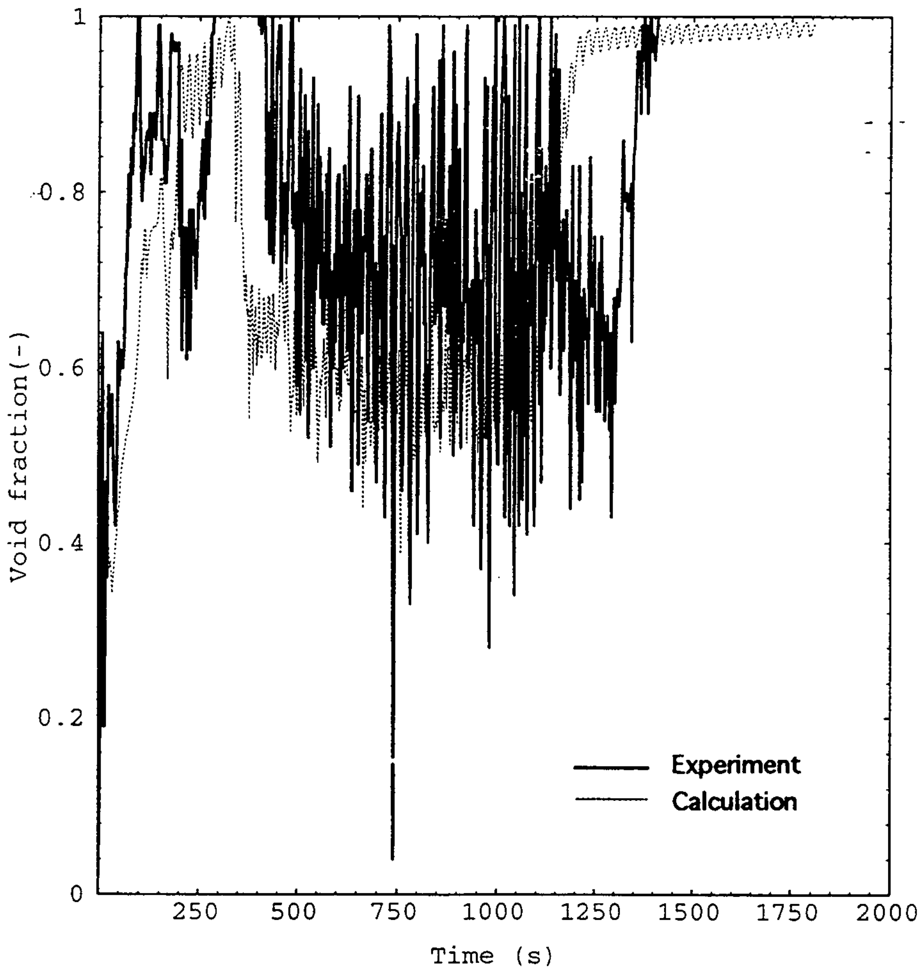

Figure 19 Comparison of the void fraction at the hot leg 1

4.2 Sensitivity Calculations

In addition to the base case calculation, sensitivity calculations are performed to examine the effects of input model and code options. The deviations in the RELAP5/MOD3 predictions are presumed to result primarily from the overprediction of the break flow, the incomplete loop seal clearing, and the overprediction of interphase drag force in core (underprediction of interphase drag forces is also found in the SG inlet plenum DP prediction). To improve the results, the input parameters, first, have been examined.

4.2.1 Two-phase discharge coefficient for the break junction

A sensitivity calculation was performed to examine the effect of the discharge coefficient at the break. The two-phase discharge coefficient of 0.8 was adopted in Case 1, while 1.20 was used in the base case.

Figures 20 to 24 show the results of the calculation. Figure 21 shows the two-phase break flow is reduced in earlier phase, but is rather increased in later period with decreasing the two-phase discharge coefficient to 0.85. Such a behavior was not fully understood in the current analysis. Overall behaviors for other parameters are almost the same as those of the base case calculations.

4.2.2 Interphase drag model

A sensitivity calculation was performed to examine the effect of interphase drag model. On the basis that the interphase drag are generally overestimated, they are reduced by half. Although such a correction is not based on a physical principle, it shows the overall effect of interphase drag model on the system behaviors. Figures 25 to 26 show a primary system pressure and break flow rate, which do not show a significant change due to the interphase drag. Figure 27 shows the integrated break flow. The integrated break flow until 1800 s is reduced by 29 kg in comparison with that of the base case. As shown in Figure 28, primary mass inventory is also improved. Figure 29 shows the collapsed core water level behavior. It remains almost unchanged until 350 s and thereafter increased by 0.3 m comparing with the base case result. Figure 32 shows the steam generator inlet plenum DP behaviors, which is further underestimated after completion of accumulator injection, as expected. The results, generally, show that the interphase drag model has still large uncertainties.

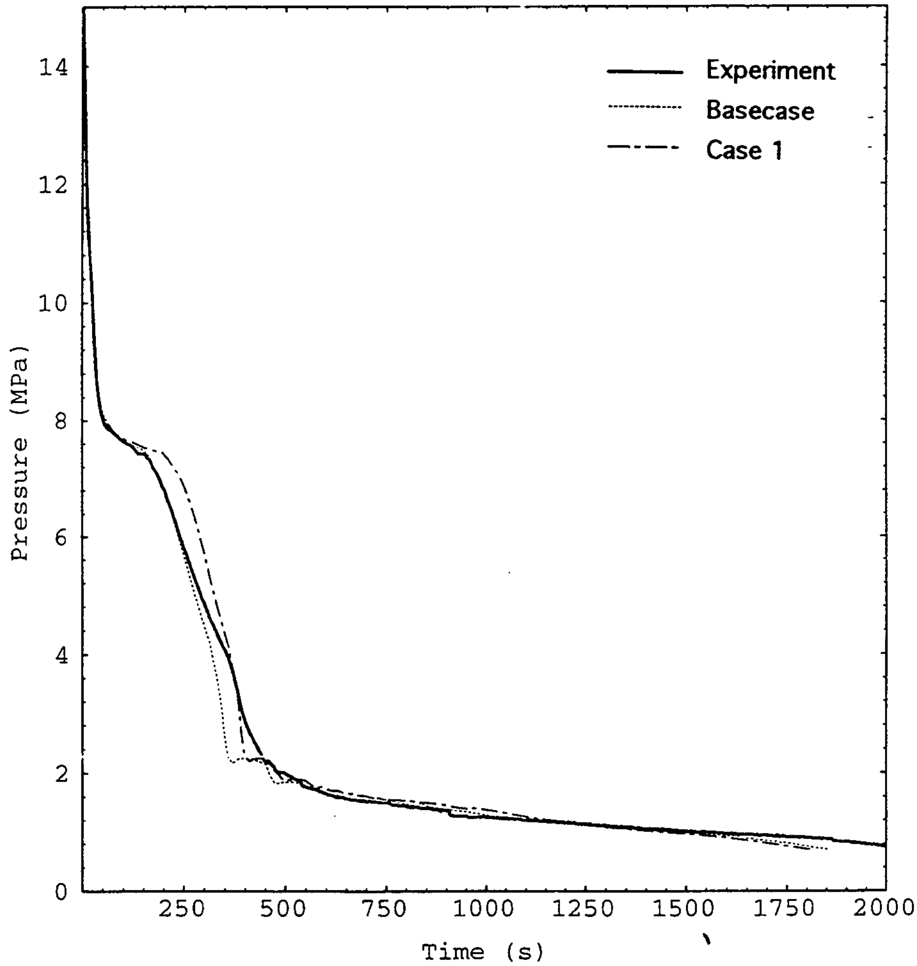

Figure 20 Comparison of the pressurizer pressures ; two-phase discharge coefficient sensitivity calculations

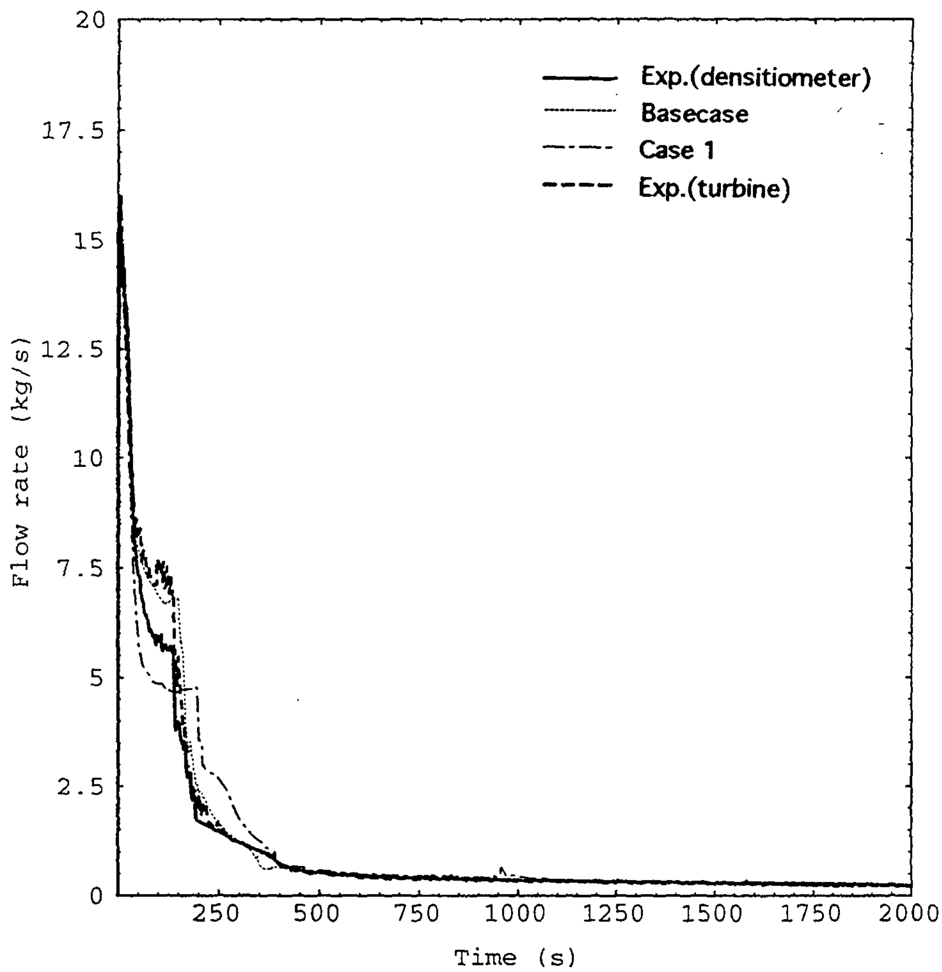

Figure 21 Comparison of the break flows ; two-phase discharge coefficient sensitivity calculations

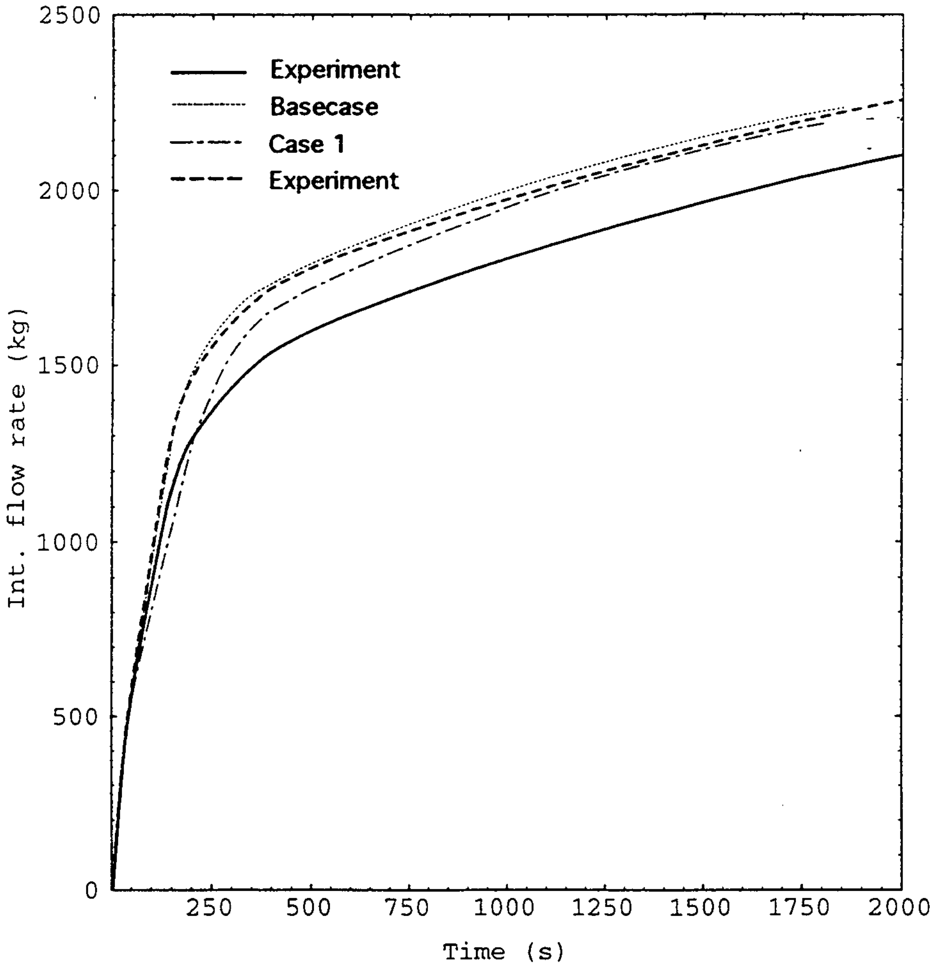

Figure 22 Comparison of the integrated break flows ; two phase discharge coefficient sensitivity calculations

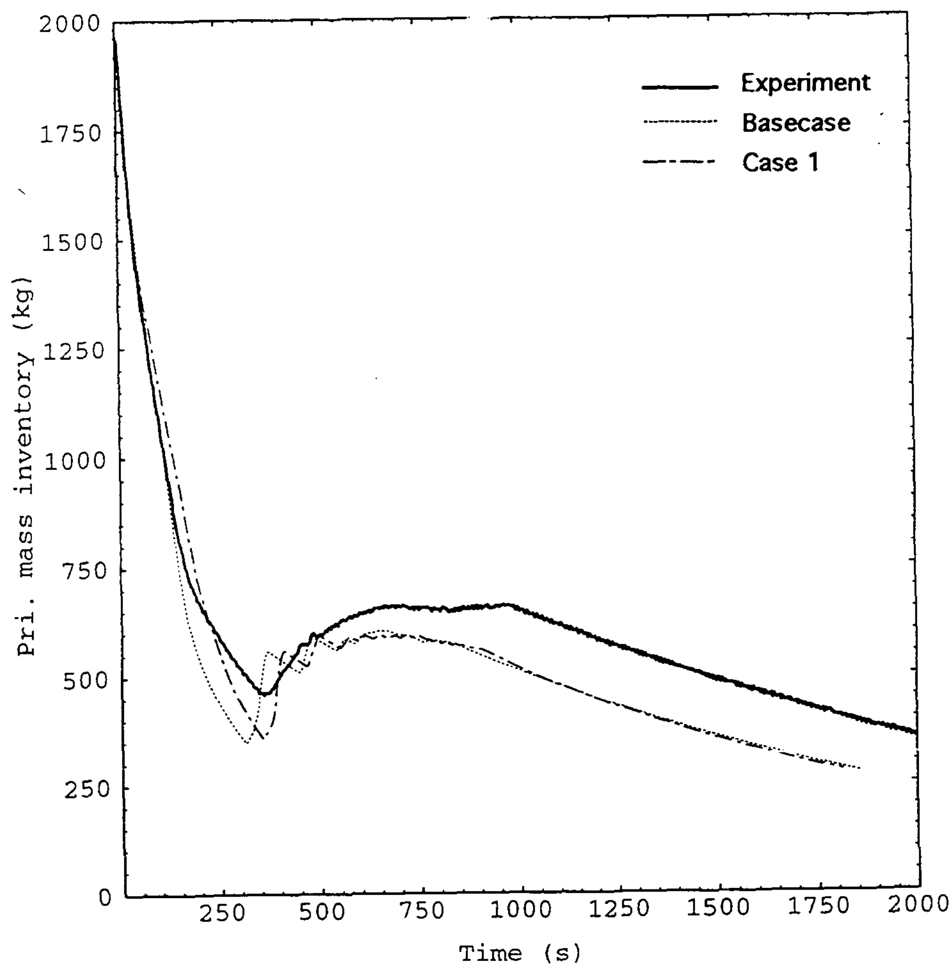

Figure 23 Comparison of the primary mass inventory ; two phase discharge coefficient sensitivity calculations

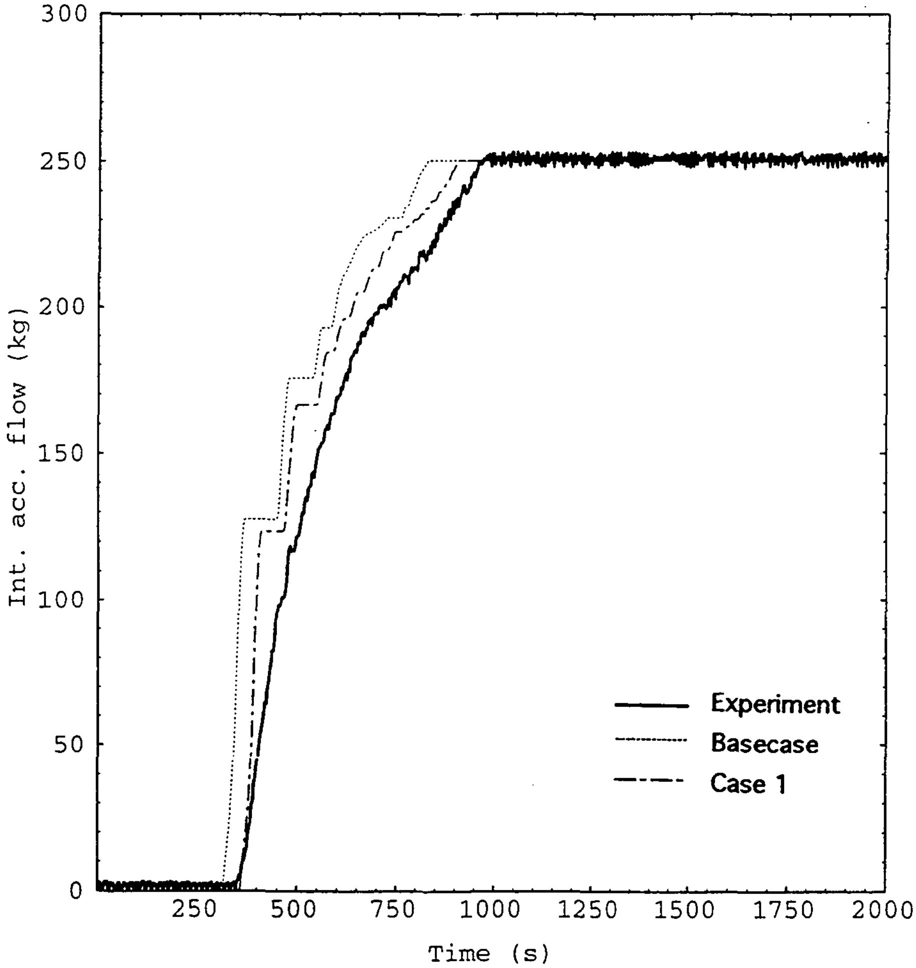

Figure 24 Comparison of the integrated accumulator injections; two phase discharge coefficient sensitivity calculations

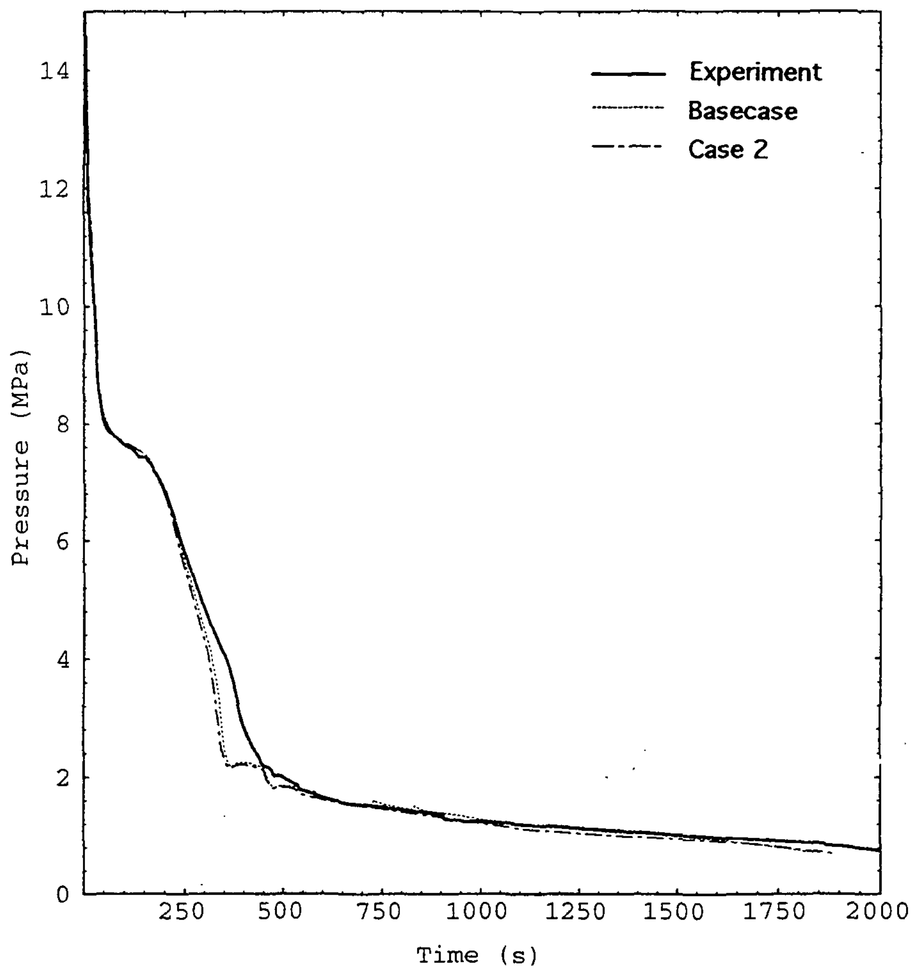

Figure 25 Comparison of the pressurizer pressure ; interphase drag sensitivity calculation

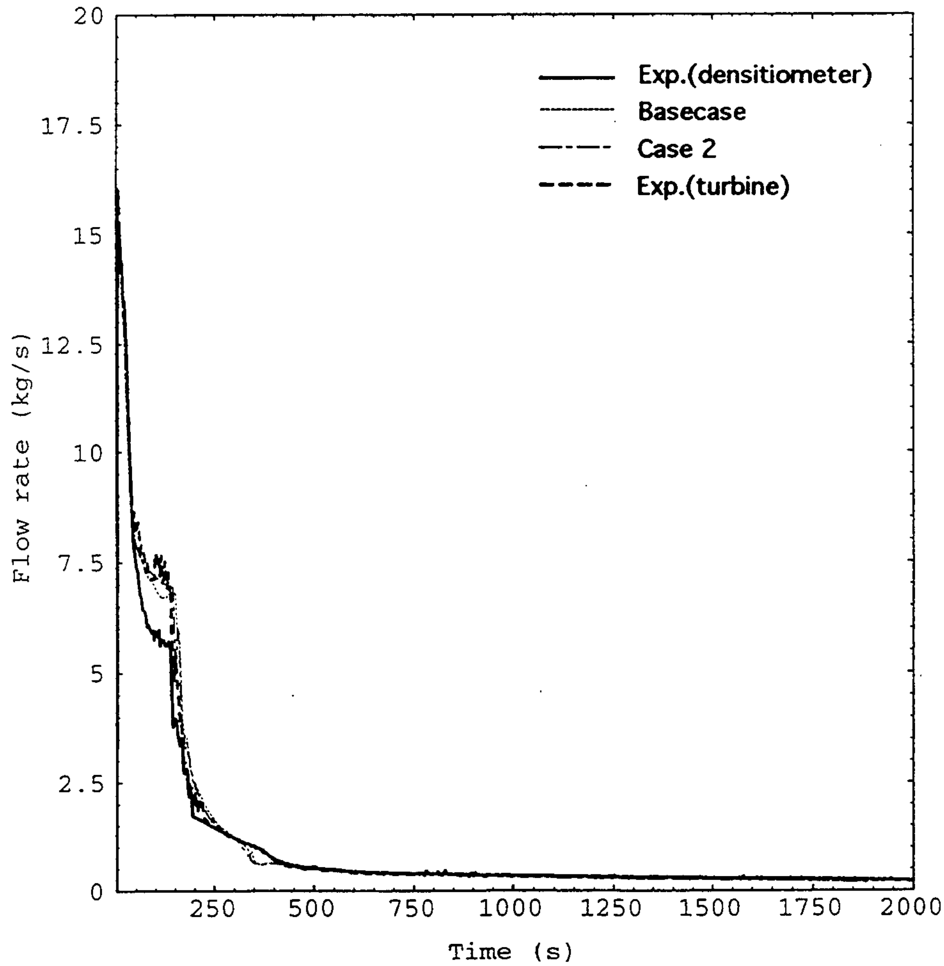

Figure 26 Comparison of the break flow rates ; interphase drag sensitivity calculation

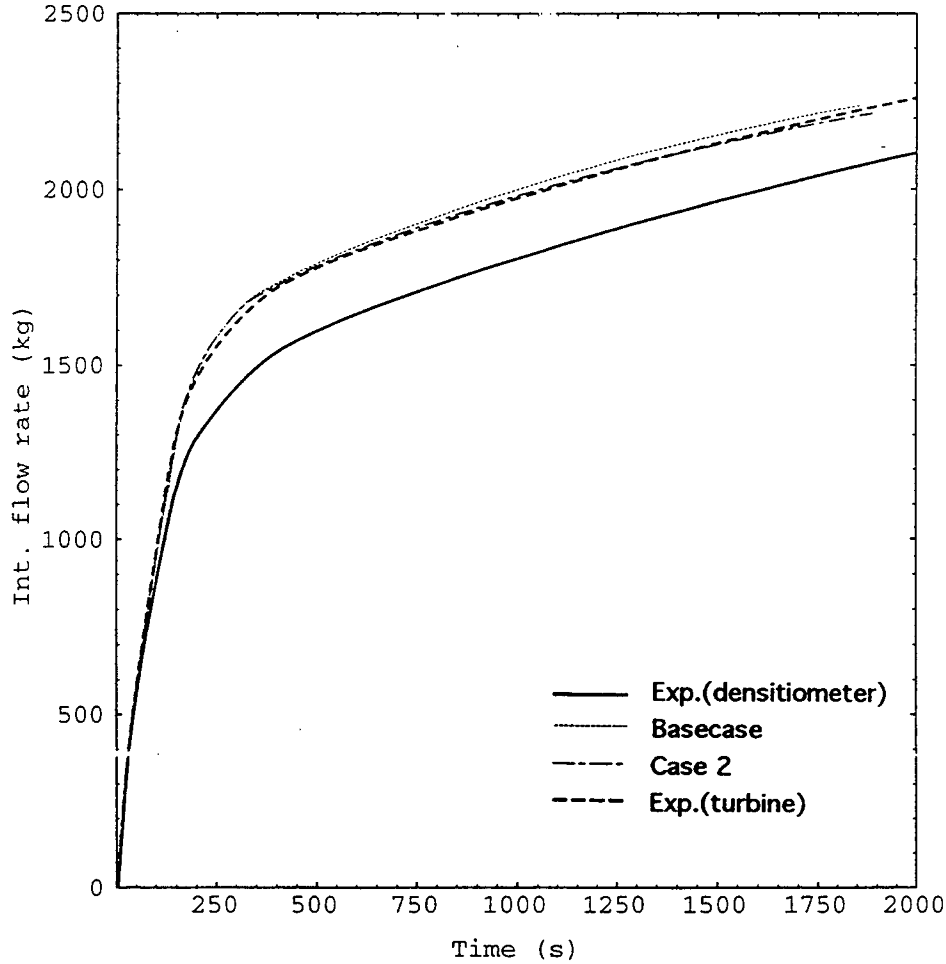

Figure 27 Comparison of the integrated break flow rates ; interphase drag sensitivity calculation

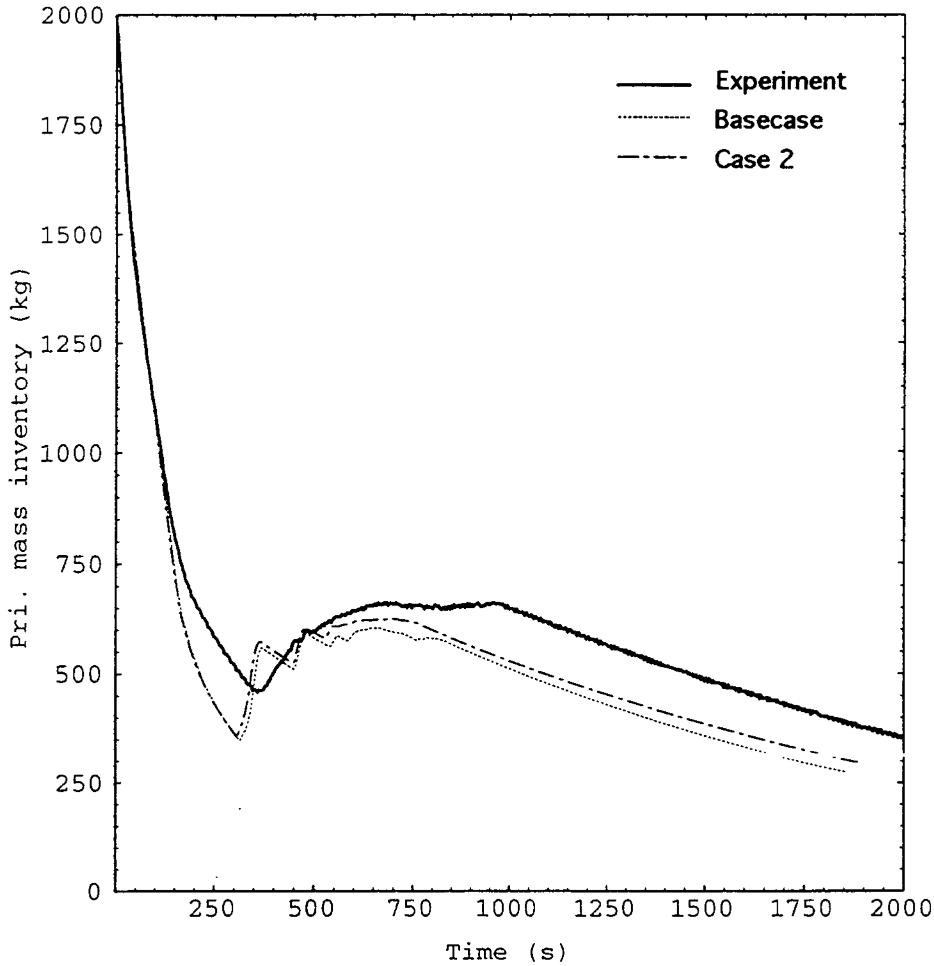

Figure 28 Comparison of the primary mass inventory ; interphase drag sensitivity calculation

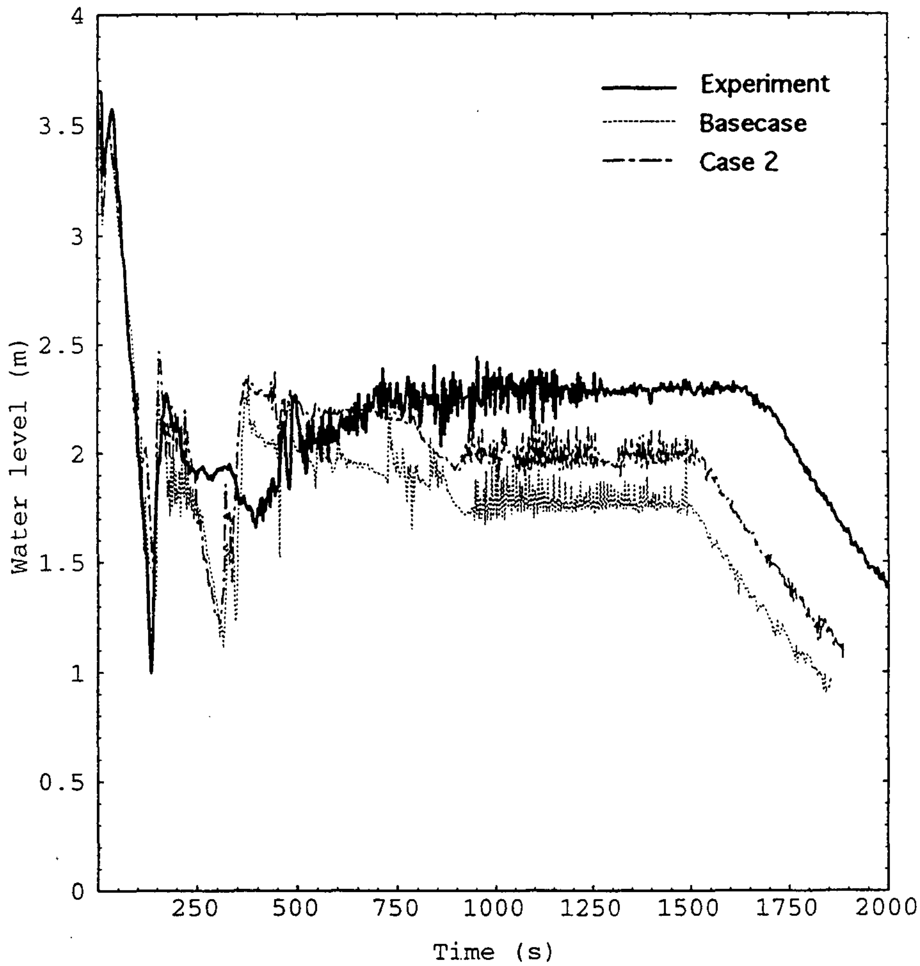

Figure 29 Comparison of the collapsed core water levels ; interphase drag sensitivity calculation

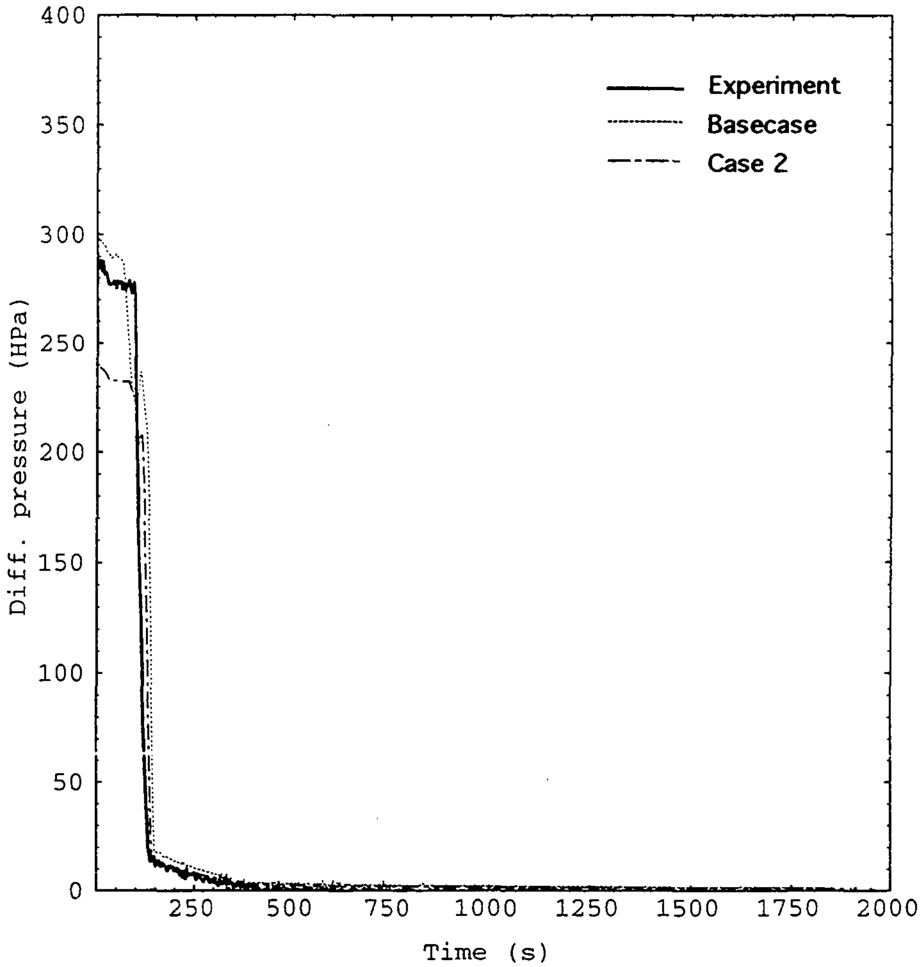

Figure 30 Comparison of the DPs at the downflow side of the crossover leg 1; interphase drag sensitivity calculation

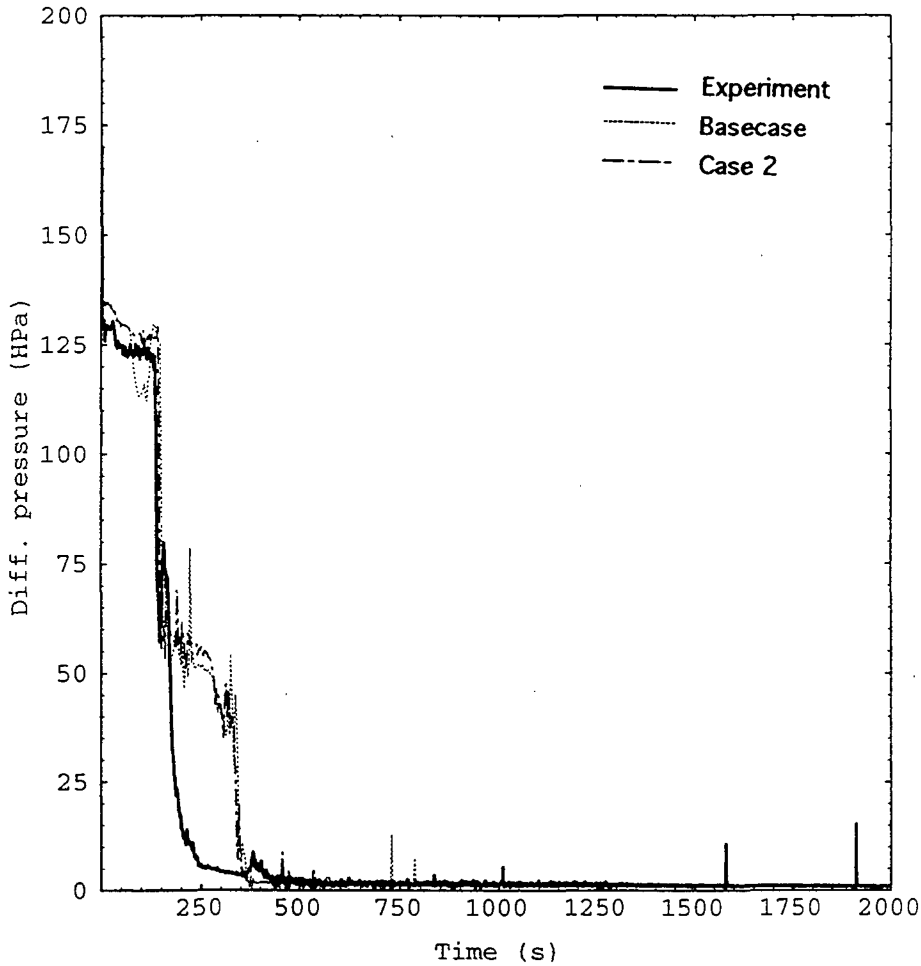

Figure 31 Comparison of the DPs at the upflow side of the crossover leg 1; interphase drag sensitivity calculation

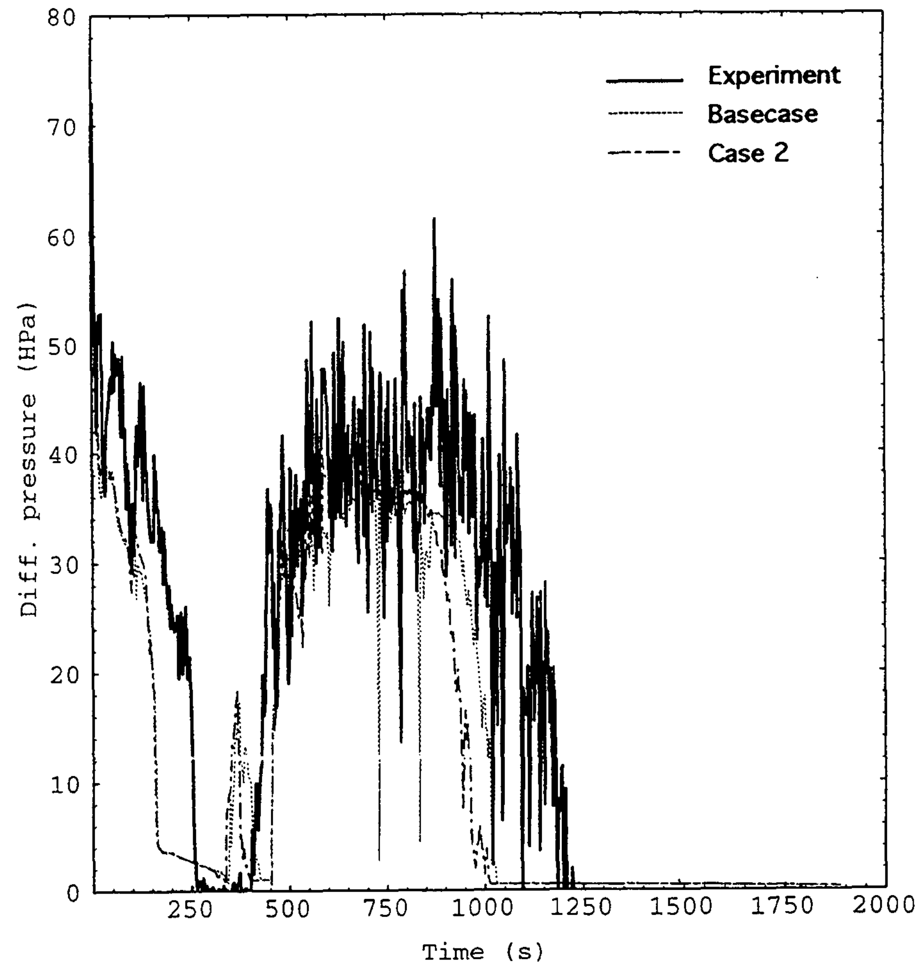

Figure 32 Comparison of the DPs at the inlet plenum of the SG 1 ; interphase drag sensitivity calculation

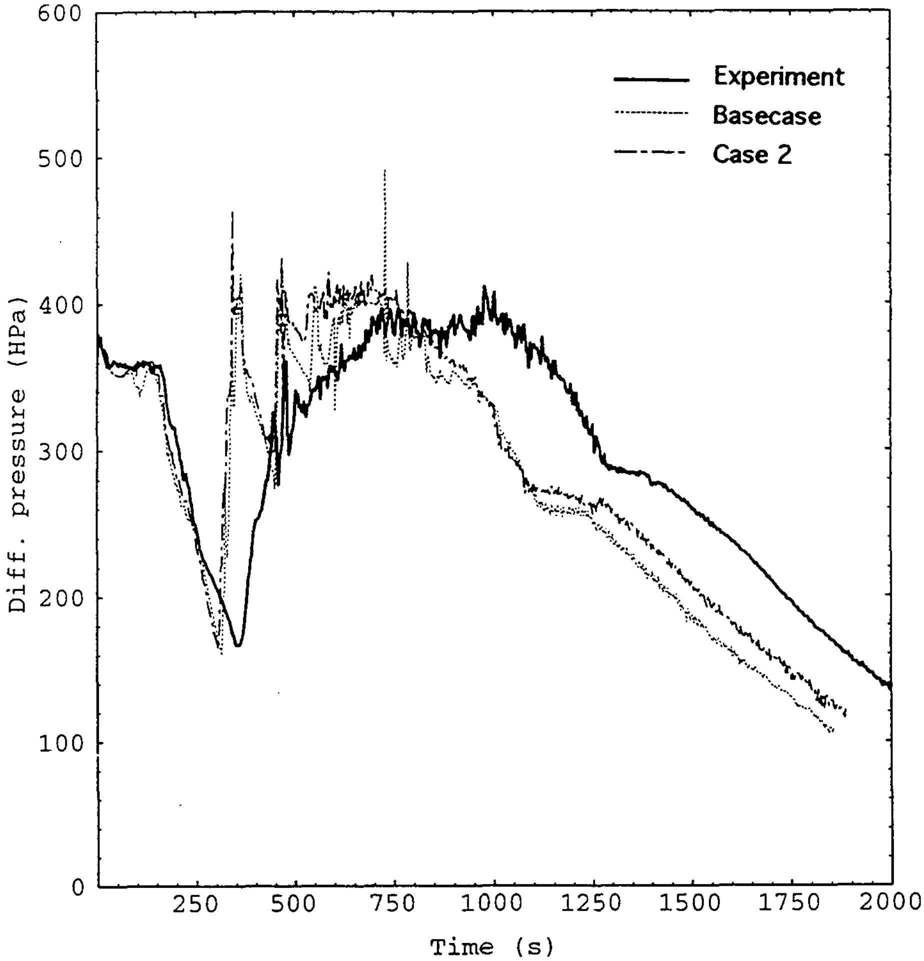

Figure 33 Comparison of the DPs at the downcomer ; interphase drag sensitivity calculation

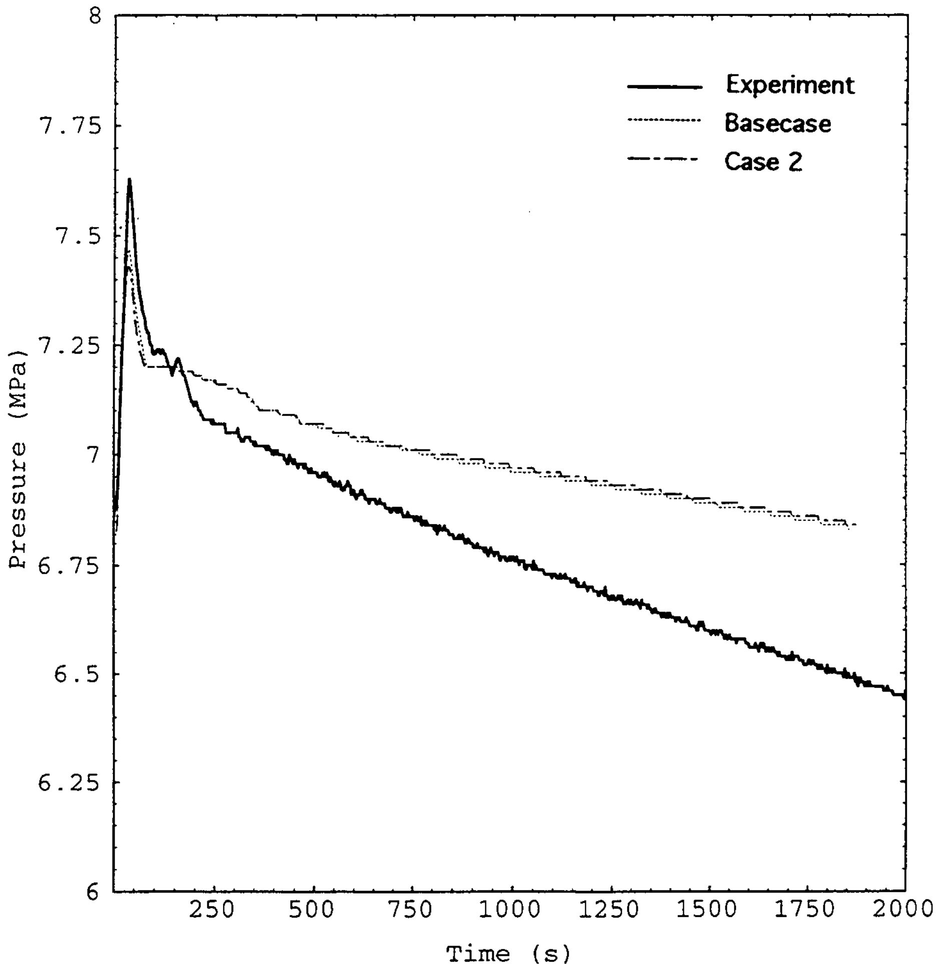

Figure 34 Comparison of the SG 1 pressures ; interphase drag sensitivity calculation

5. RUN STATISTICS

For comparison of computation times, the source programs of RELAP5/MOD3 Version 7j were compiled and executed on both the Solbourne 5/600 workstation which is compatible to a SUN workstation and CONVEX C3410ES machine. Figure 35 shows time step size, DT vs. transient time. Figure 36 represents CPU time vs. transient time. The computational efficiency of RELAP5/MOD3 simulations are summarized in Table 4.

When executed on the vector machine Convex, the computational time has decreased to 40% of those on the Solbourne. This indicates that some modifications of the current RELAP5/MOD3 version are desirable for taking advantage of the vector machines (Performances of Solbourne and CONVEX are 3.4 Mflops and 100.0 Mflops, respectively)

Table 4. Comparison of Computation Times

Parameter	Solbourne	CONVEX
No. of Volume	251	251
Problem Time, s	1856	1867
CPU Time, s	1.394e05	5.637e04
No. of Time Step	93954	95441
Average Time Step, s	0.0198	0.0196
CPU Time/Problem Time	75.1	30.2
Grind Time, s [a)]	0.00593	0.00235
Maximum Time Step, s [b)]	0.02	0.02

Solbourne : Solbourne 5/600 (scalar machine)
Main Memory 32 MB
Performance 3.4 Mflops

CONVEX CONVEX C3410ES
Main Memory 128 MB
Performance 100 Mflops

Note a) (CPU time)/(No. of volumes)/(No. of time steps)
b) User Input

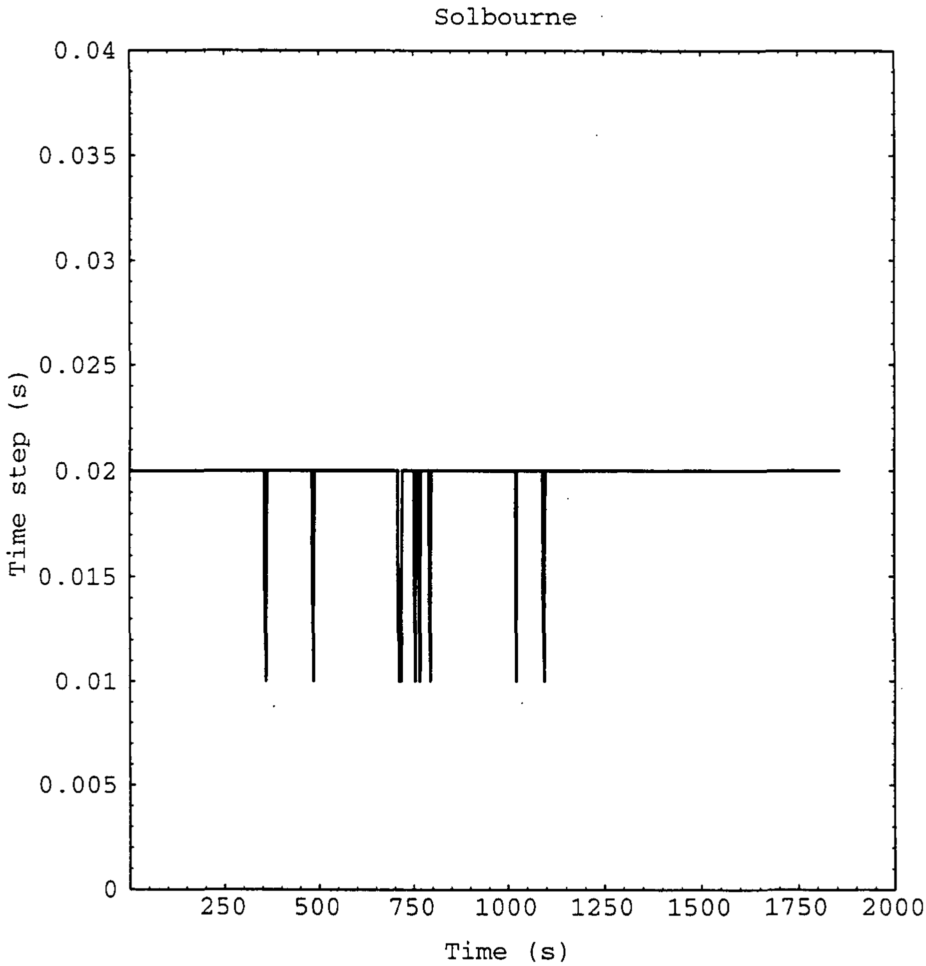

Figure 35 Time step size vs. Transient time

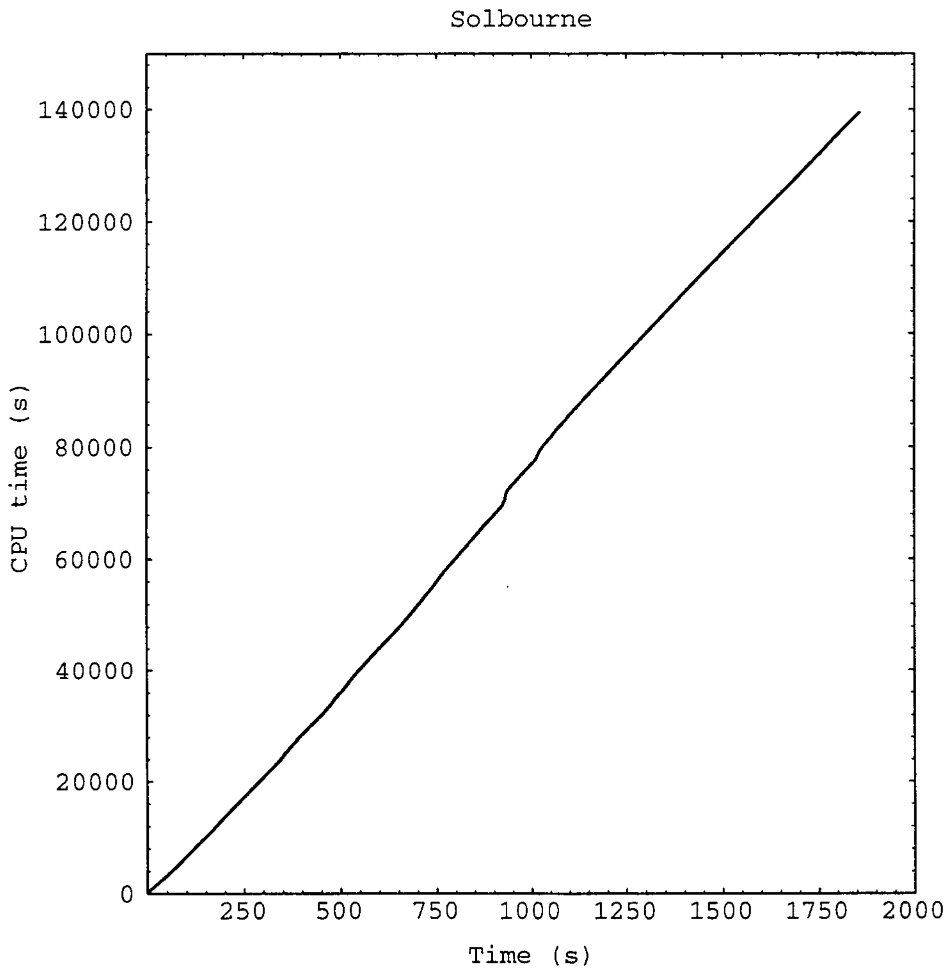

Figure 36 CPU time vs. Transient time

6. CONCLUSIONS

In this study, BETHSY 6.2TC, 6 inch cold leg side break test, is analyzed by the RELAP5/MOD3 Version 7j code. Generally, the predictions of RELAP5/MOD3 version 7j concerned with the important thermalhydraulic parameters and phenomena, such as primary pressure, break flow rate, core heatup, loop seal clearing, and primary mass distribution, are in reasonable agreement comparing with the measured data. However, the code shows some deviations in the prediction of loop seal clearing, collapsed core water level after the loop seal clearing, and accumulator injection behaviors. Through extensive comparison with measurement and sensitivity studies, major findings are described as follows;

(1) Primary coolant system pressure is well predicted except two-phase break flow period. The calculation begin to overpredict the depressurization rate about 280 s. This difference is likely to be due to overprediction of the break flow.

(2) The break flow during two phase blowdown from low quality to high quality is delayed in the calculation, and as a result, the integrated break flow is overpredicted in comparison with that of measured data. Until 300 s, RELAP5 overpredicts the integrated break flow by 135 kg comparing with that of experimental data.

(3) The loop seals would block the flow of steam passing through the hot leg to the break. Once the loop seal is cleared, less coolant will be available to mitigate core heatup which could occur during the boil-off phase. In the experiment the loop seal clearings of all loops occurred almost at 134 s and RELAP5 predicts 138 s. In the RELAP5 results, the downflow side is completely drained but the upflow side is partially drained. Complete drain is established after about 200 s.

(4) The RELAP5 predicts the early initiation of drain in steam generator inlet plenum after the loop seal clearing. It comes from the underestimation of the interphase drag. Significant liquid holdup is found during the accumulator injection period both in the experimental data and in the calculation results.

(5) The effect of the excessive accumulator injection in the early period of injection seems to be significant in determining the behavior of core void distribution or core collapsed water level. Time elapsed during 50 % injection of the accumulator inventory in the RELAP5 is about 50 s. In contrast about 190 s was taken in the experiment. The intermittent injection behavior is caused by code characteristics.

(6) According to the cladding temperature measurement in the electrical heated rods, the core uncovery occurred three times. The RELAP5 calculation shows that the duration of the first core uncovery is very short, but the second is long and deep. The third begins too early. The predictions of core heatup depend on those of core uncoveries, the first core heatup has been skipped in the calculation while the second has been overpredicted. The third heatup has been advanced than that of the experiment

(7) Finally, in sensitivity studies, the reduced interphase drag forces have improved the overall simulation of BETHSY 6.2TC experiment. Significant effect has been found in the calculation results, particularly, after 350 s. The integrated break flow until 1800 s could be reduced by 29 kg. Considering this effect, it is concluded that the interphase drag model has still large uncertainties.

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10. P. CLEMENT, T. CHATAING, R. DERUAZ, "ISP-27 BETHSY Experiment 9.1b 2 Inch Cold Leg Break without HPSI and with Delayed Ultimate Procedure." Comparison Report, NEA/CSNI/R(R92)20, 1992, OECD Nuclear Energy Agency

Appendix A

RELAP5 Input Listing for BETHSY 6.2TC Test

```
= BETHSY test 6.2 TC
*
*
100   new   transnt
101   run
102   si  si
*104   none
105      2.     4.
110   nitrogen
*
*
*=*=*=*=*=*=*=*=*=*
*
* time step control
*
201   2000.   1.e-7  0.02  3    150  10000  10000
*
*$##############################################################
*
*  minor edits
*
*   Param  Number
*
301  dt     0
302  dtcrnt 0
303  emass  0
*
310  cntrlvar    50     *Primary total mass w/o PZR
312  cntrlvar    138    *DP4R2
313  cntrlvar    115    *S/G level based on DP4R2
314  cntrlvar    238    *DP5R2
315  cntrlvar    215    *S/G level based on DP5R2
*
318   voidg    131010000
319   voidg    135130000
320   voidg    139010000
321   voidg    013150000
*
324  cntrlvar      70     *INTQMB
326  cntrlvar     170     *MGV1
327  cntrlvar     272     *MSM2
328  cntrlvar     173     *P+47
329  cntrlvar      74     *P+P
330  cntrlvar     274     *P+SM2
*
331   mflowj   022060000
332   mflowj   473000000
334   mflowj   138010000
335   mflowj   238010000
*
337   cntrlvar      79     *TE012A
339   cntrlvar      81     *TE0304
341   cntrlvar      83     *TE041
343   cntrlvar      85     *TE042
349   cntrlvar     175     *TE454C
351   cntrlvar      87     *TS0209L
352   cntrlvar      88     *TS0215L
353   cntrlvar      89     *TS0219L
354   cntrlvar      90     *TS0220L
355   cntrlvar      91     *TS0224L
356   cntrlvar      92     *TS0228L
*
357   cntrlvar     177     *VP1
358   cntrlvar      20     *W+02
*359   cntrlvar     67      *Core level based on Dp
360   cntrlvar      93     *ZSCORE
361   cntrlvar      94     *Heated core collapsed level
*
372   cntrlvar     137     *DP426 SG1 upflow side
373   cntrlvar     143     *DP436 SG1 downflow side
375   cntrlvar     133     *DP12VG IL SG side
376   cntrlvar     134     *DP12VP IL Pump side
*
380   voidg    137010000
381   quale    137010000
383   voidgj   151000000
385   voidg    152010000
386   quale    152010000
387   voidgj   153000000
388   mflowj   153000000
389   cntrlvar      78     *SEBREAK
*
*##############################################################
*
*  TRIPS
```

```
*
*  Accumulator Opening Signal
*
401  p    051050000 le  null    0    4.20e6    n
*                                 .
406  time  0      ge  timeof  401  2.0      n
*
*   Accumulator Closing Signal
*
443  cntrlvar  260  gt  null  0  0.61384  n
444  cntrlvar  360  gt  null  0  0.59524  n
601  406  and  443  n
602  406  and  444  n
*
*  Accumulator Level Control Variables
*
*        Name      Type     Scaling F  Initial  Flag
20525900  accmi2   integral  1.0      0.     1
20525901  mflowj    240010000
*
20526000  acclvl2  integral -0.022412  5.53648  1
20526001  velfj     240010000
*
*        Name      Type     Scaling F  Initial  Flag
20535900  accmi3   integral  1.0      0.     1
20535901  mflowj    340010000
*
*        Name      Type     Scaling F  Initial  Flag
20536000  acclvl3  integral -0.022412  5.44634  1
20536001  velfj     340010000
*
*  Always true/false trips
*
403  time 0   gt   null   0 -999.   1  * this trip is always true
404  time 0   lt   null   0 -999.   1  * this trip is always false
*  ---------------------------
*
*  Break trip
*
405  time 0   ge   null   0        0.0  1  * break trip
*
*  ---------------------------
*
*  Scram signal
*
440  p   051050000   le   null   0  13.0e6    1
*
*  SG Relief Valve Set Point
*
441  p   470010000   gt   null   0  7.2e6    n
442  p   470010000   le   null   0  7.2e6    n
*
*  SI signal
*
450  p   051050000   le   null   0  11.76e6   1
*
*   End of transient trip logic
*
430  p   051050000   le   null   0  0.7e6    1
606  430  or   430   n
607  440  and  441   n
608  440  and  442   n
600  606
*
*$##############################################################
*
*   Break nozzle and associated components
*
*$##############################################################
*
*   component 151 - junction to nozzle
*
*        name     type
1510000   nozin    sngljun
*
*      vol from   vol to     area    fls rloss fvcahs  scdc  2pdc  shdc
*
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*510101 137010003 152000000 1.88205-4 0.0  0.0  031020  1.0   1.0   1.0
1510101 137010003 152000000 1.88205-4 0.0  0.0  031020  1.0   1.0   1.0
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
*  junction initial flows
1510201   0  6.26866-5   6.26866-5   0.  *  8.91312-6
*
```

```
*     Hyd.D.  F.C.  G.I.  S.
1510110  .01548  0.   1.   1.
*
*=*=*=*=*=*=*=*=*=*
*
*   component 152 - nozzle
*
*      name    type
1520000  brnoz   snglvol
*
*      area     lnth   vol horiz vert delz rough  diam   pvbfe
1520101 1.88205e-4   1.56   0.0  0.0   0.0 0.0  1.5e-6 0.1548  00000
1520101 1.88205e-4   4.68   0.0  0.0   0.0 0.0  1.5e-6 0.4644  00000
*
*        pressure  quality
1520200  0    15455914. 1252620. 2448917. 0.
*
*=*=*=*=*=*=*=*=*=*
*
*   component 153 - junction from nozzle - trip valve - choking occurs here
*
*      name     type
1530000  nozout    valve
*
*     vol from   vol to     area    fls   rloss  vcahs  scdc  2pdc  shdc
*
1530101 152010000 154000000 1.88205e-4 0.786 0.786  00020  0.85  1.20  0.96
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
<<<<<<<<<<<<<
*
* junction initial flows
1530201  0 0.      0.       0.  * 0.
*
1530300  trpvlv
1530301  405
*
*     Hyd.D.  F.C.  G.I.  S.
1530110  .01875  0.   1.  1.
*
*=*=*=*=*=*=*=*=*=*
*
*    component 154 - atmospheric sink volume
*
1540000    atmosph   tmdpvol
1540101   1.0e6  1.0  0.0  0.0   0.0  0.0  0.0  0.0  11
1540200   102  0
1540201   0.0  1.0e5  1.0
*
*
*
*$##########################################################
*
*   Vessel components
*
*$##############################################################
*
*
*   component 11 - lower portion of lower plenum
*
*      name     type
0110000  lowerpl  branch
*     njun  flag
0110001  2  0
*    area  length  volume  horiz  vert  delz   rough  diam  pvbfe
*
0110101 0.0 1.00    0.15323   0.0 -90. -1.00  4.57e-5  0.039  00100
*          pressure   temperature
0110200  0     15502632. 1237671.   2447804. 0.
*     jun from   jun to     area   floss  rloss  vcahs
0111101 022010000 011000000   0.0    0.0    0.0   01100
0112101 011000000 012000000   0.0    0.0    0.0   01100
*      hyd.d    flood.c   gas.intcp    slope
0111110 .045      0.       1.         1.
0112110 .01587     0.       1.         1.
*      flow-f  flow-g  velj
0111201    .831166 .831166 0.  *  16.67382
0112201    .374453 .374453 0.  *  16.67337
*
*=*=*=*=*=*=*=*=*=*
*
*   component 12 - upper portion of lower plenum
*
*      name    type
0120000  upperlp  branch
*     njun  flag
0120001   2   0
*    area  length  volume  horiz vert  delz  rough  diam   pvbfe
0120101  0.0  1.054  0.0620907  0.0  90.  1.054  4.57e-5  0.01543  00100
*          pressure  temperature
0120200  0     15494890. 1236187.    2447988. 0.
*      jun from   jun to      area    f loss   r loss   vcahs
0121101  012010000 013000000  .0428   1.5      1.5  01100
0122101  012010000 014000000  .002143  13.5     13.5  01000
*        hyd.d    flood.c     gas.intcp   slope
0121110     .01130     0.         1.       1.
0122110     .004       0.         1.       1.
*      flow-f  flow-g  velj
0121201   .50718   .50718   0.  *  16.41908
0122201   .1623888  .1623888  0.  *  .2632216
*
*=*=*=*=*=*=*=*=*=*
*
*   component 13 - core
*
*      name   type
0130000   core   pipe
*      nvol
0130001   16
0130101   0.0    1        *volume areas
0130102   0.0428  15
0130103   0.0    16
*
0130201   .0428   15       *junction areas
*
0130301   0.11  1        *volume length
0130302   0.3265   3
0130303   0.261   13
0130304   0.1965  15
0130305   0.35    16
*
0130401   0.004708  1     *volume volume
0130402   0.0       15
0130403   0.01807   16
*
0130601   90.0      16   *vert angle
*
0130701   .11       1    *delta z
0130702   .3265     3
0130703   .261     13
0130704   .1965    15
0130705   .35      16
*
0130801   4.57e-5  .01130  16  *roughness diam
*
* increased form loss.
*>>>> jjj, 0.0325 -> 0.0425
0130901  .0425  .0425   1  *junction loss coef
0130902   0.0    0.0   2  *junction loss coef
0130903  .0425  .0425   3  *junction loss coef
0130904   0.0    0.0   4  *junction loss coef
0130905  .0425  .0425   5  *junction loss coef
0130906   0.0    0.0   6  *junction loss coef
0130907  .0425  .0425   7  *junction loss coef
0130908   0.0    0.0   8  *junction loss coef
0130909  .0425  .0425   9  *junction loss coef
0130910   0.0    0.0  10  *junction loss coef
0130911  .0425  .0425  11  *junction loss coef
0130912   0.0    0.0  12  *junction loss coef
0130913  .0425  .0425  13  *junction loss coef
0130914   0.0    0.0  14  *junction loss coef
0130915  .0425  .0425  15  *junction loss coef
*                         * adjusted to give known core dp
0131001   00100   16        *volume flags pvbfe
*
0131101    01000  15        *junction flags vcahs
*
0131201   0     15490295. 1236034. 2448098. 0.       0. 1
0131202   0     15488611. 1244113. 2448138. 0.       0. 2
0131203   0     15486106. 1253154. 2448197. 0.       0. 3
0131204   0     15483856. 1263176. 2448251. 0.       0. 4
0131205   0     15481873. 1276498. 2448298. 0.       0. 5
0131206   0     15479897. 1292988. 2448345. 0.       0. 6
0131207   0     15477943. 1311733. 2448392. 0.       0. 7
0131208   0     1.5476+7  1331184. 2448438. 0.      0. 8
0131209   0     15474083. 1349857. 2448484. 0.       0. 9
0131210   0     15472177. 1366230. 2448529. 0.       0. 10
0131211   0     15470291. 1379394. 2448574. 0.       0. 11
0131212   0     15468410. 1389239. 2448619. 0.       0. 12
0131213   0     15466545. 1396474. 2448663. 0.       0. 13
0131214   0     15464909. 1401218. 2448702. 0.       0. 14
```

```
0131215  0    15463514. 1405970. 2448736. 0.     0. 15
0131216  0    15461619. 1405780. 2448781. 0.     0. 16
*
0131300  1
0131301  16.419 0.0  0.0  15
*
0131401  .0113   0.     1.     1.  15
*
*=*=*=*=*=*=*=*=*
*
*  core bypass
*
*     name   type
0140000  cbypass pipe
*    nvol
0140001  16
0140101  1.421e-2  16     *volume areas
0140201 .002143  1     *junction areas
0140202 .01421  2     *junction areas
0140203 .002143  3     *junction areas
0140204 .01421  4     *junction areas
0140205 .002143  5     *junction areas
0140206 .01421  6     *junction areas
0140207 .002143  7     *junction areas
0140208 .01421  8     *junction areas
0140209 .002143  9     *junction areas
0140210 .01421  10     *junction areas
0140211 .002143  11     *junction areas
0140212 .01421  12     *junction areas
0140213 .002143  13     *junction areas
0140214 .01421  14     *junction areas
0140215 .002143  15     *junction areas
0140301  0.11  1     *volume length
0140302  0.3265  3
0140303  0.261  13
0140304  0.1965  15
0140305  0.35  16
0140401  0.0    16   *volume volume
0140601  90.0    16   *vert angle
0140701  .11    1   *delta z
0140702  .3265    3
0140703  .261    13
0140704  .1965    15
0140705  .35    16
0140801  4.57e-5  .0247  16  *roughness diam
0140901    9.9    9.9   1  *junction loss coef
0140902    0.0    0.0   2  *junction loss coef
0140903    9.9    9.9   3  *junction loss coef
0140904    0.0    0.0   4  *junction loss coef
0140905    9.9    9.9   5  *junction loss coef
0140906    0.0    0.0   6  *junction loss coef
0140907    9.9    9.9   7  *junction loss coef
0140908    0.0    0.0   8  *junction loss coef
0140909    9.9    9.9   9  *junction loss coef
0140910    0.0    0.0  10  *junction loss coef
0140911    9.9    9.9  11  *junction loss coef
0140912    0.0    0.0  12  *junction loss coef
0140913    9.9    9.9  13  *junction loss coef
0140914    0.0    0.0  14  *junction loss coef
0140915    9.9    9.9  15  *junction loss coef
0141001   00000  16      *volume flags pvbfe
0141101   01000  15      *junction flags vcahs
0141201  0     15490481. 1235418. 2448093. 0.     0. 1
0141202  0     15488757. 1235373. 2448134. 0.     0. 2
0141203  0     15486335. 1237846. 2448192. 0.     0. 3
0141204  0     15484055. 1241228. 2448246. 0.     0. 4
0141205  0     15482126. 1246788. 2448292. 0.     0. 5
0141206  0     15480097. 1254885. 2448341. 0.     0. 6
0141207  0     15478183. 1265417. 2448386. 0.     0. 7
0141208  0     15476173. 1277951. 2448434. 0.     0. 8
0141209  0     15474282. 1291839. 2448479. 0.     0. 9
0141210  0     15472296. 1306128. 2448526. 0.     0. 10
0141211  0     15470432. 1320009. 2448571. 0.     0. 11
0141212  0     15468471. 1332816. 2448618. 0.     0. 12
0141213  0     15466633. 1344212. 2448661. 0.     0. 13
0141214  0     15464918. 1352021. 2448702. 0.     0. 14
0141215  0     15463547. 1359267. 2448735. 0.     0. 15
0141216  0     15461537. 1368246. 2448783. 0.     0. 16
0141300  0
0141301   .1623707 .1623707 0. 1 * .263286
0141302   .0245039 .0273133 0. 2 * .2634723
0141303   .1627623 .1627623 0. 3 * .263616
0141304   .02460005 .0274259 0. 4 * .26377
0141305   .1636544 .1636544 0. 5 * .2639266
0141306   .0247902 .0276487 0. 6 * .2640856
0141307   .1653176 .1653176 0. 7 * .264248
0141308   .0251018 .028014  0. 8 * .264414
0141309   .1677343 .1677343 0. 9 * .2645853
0141310   .0254996 .0284808 0. 10 * .2647614
0141311   .1704255 .1704255 0. 11 * .264942
0141312   .0258971 .02894764 0. 12 * .265127
0141313   .1729312 .1729312 0. 13 * .2653177
0141314   .02620984 .02931515 0. 14 * .265464
0141315   .1745947 .1745947 0. 15 * .2656115
*
*        Hyd.D.  F.C.  G.I.  S.  J#
0141401     .004    0.    1.   1.  1
0141402     .0247   0.    1.   1.  2
0141403     .004    0.    1.   1.  3
0141404     .0247   0.    1.   1.  4
0141405     .004    0.    1.   1.  5
0141406     .0247   0.    1.   1.  6
0141407     .004    0.    1.   1.  7
0141408     .0247   0.    1.   1.  8
0141409     .004    0.    1.   1.  9
0141410     .0247   0.    1.   1.  10
0141411     .004    0.    1.   1.  11
0141412     .0247   0.    1.   1.  12
0141413     .004    0.    1.   1.  13
0141414     .0247   0.    1.   1.  14
0141415     .004    0.    1.   1.  15
*
*=*=*=*=*=*=*=*=*
*
*   component 99 upper plenum 1
*
*      name   type
0990000  upplen1  branch
*     njun  flag
0990001  4   0
*     area  length  volume  horiz vert  delz  rough  diam  flags
0990101  0.0  1.0195  9.2776e-2  0.0  90.  1.0195 4.57e-5 .2443 00000
*           pressure  temperature
0990200  0      15456691. 1404736.    2448898. 0.
*      jun from  jun to      area    f loss  r loss  vcahs
0991101  014010000  099000000   .002143 13.5   13.5  01000
0992101  013010000  099000000   .0332   1.5    1.5  01100
*
0993101  099010000  015000000    0.0    0.3    0.3  01000
0994101  099010000  017000000    0.0    0.92   .998 01000
*       flow-f  flow-g  velj
0991201   .175652   .175652  0.  *  .2658806
0992201   .460415  .460415 0.  *  16.4184
0993201   .2751455 .333819  0.  *  16.73307
0994201   -.02337057 -.02598164 0.  *  -.0489953
*        Hyd.D.  F.C.  G.I.  S
0991110   .004     0.    1.   1.
0992110   .0124    0.    1.   1.
0993110   .2081    0.    1.   1.
0994110   .0603    0.    1.   1.
*
*=*=*=*=*=*=*=*=*
*
*   component 15 upper plenum 2
*
*      name   type
0150000  upplen2  branch
*     njun  flag
0150001  4   0
*     area  length  volume  horiz vert  delz  rough  diam  flags
0150101  0.0  0.117   .010295   0.0  90.  0.117  4.57e-5 .2081 00000
*           pressure  temperature
0150200  0      15452849. 1404722.    2448990. 0.
*      jun from  jun to      area    f loss  r loss  vcahs
0151101  015010000  016000000  0.087988  0.0   0.0   01000
0152101  015010000  131000000  0.010936  .46   .834  01002
0153101  015010000  231000000  0.010936  .46   .834  01002
0154101  015010000  331000000  0.010936  .46   .834  01002
*       flow-f  flow-g  velj
0151201   1.67755-4   1.68066-4   0.  *  .0102017
0152201   .736549  .825657  0.  *  5.56716
0153201   .733967  .822822  0.  *  5.54765
0154201   .741957  .831373  0.  *  5.60804
*        Hyd.D.  F.C.  G.I.  S
0151110   .2081    0.    1.   1.
0152110   .118     0.    1.   1.
0153110   .118     0.    1.   1.
0154110   .118     0.    1.   1.
*
*=*=*=*=*=*=*=*=*
```

```
*
*  component 16 - flow area from upper plenum to upper head
*
*     name   type
0160000  upplen2   snglvol
*   area  length  volume  horiz vert  delz  rough   diam  flags
0160101 0.0 2.713   .15418  0.0  90.  2.713  4.57e-5 .129   00000
*           pressure  temperature
0160200  0    15443147. 1382495.    2449221. 0.
*
*=*=*=*=*=*=*=*=*
*
*  component 17 - guide tubes
*
*     name   type
0170000  gtubes   snglvol
*    area   length  volume  horiz vert  delz  rough  diam  flags
0170101  .002856 0.0    8.083e-3  0.0  90.   2.83 4.57e-5 .0603 00000
*           pressure  temperature
0170200  0     15443081. 1297053.    2449223. 0.
*
*=*=*=*=*=*=*=*=*
*
*  component 18 - upper head
*
*     name   type
0180000  uphead  branch
*    njun  flag
0180001  3     0
*    area length volume   horiz  vert  delz   rough diam flags
0180101  0.0 0.4015 4.8919e-2 0.0  90.0  0.4015 4.57e-5 0.0 00000
*           pressure  temperature
0180200  0     15431459. 1291054.    2449500. 0.
*      jun from  jun to     area    f loss  r loss  vcahs
0181101  016010000 018000000 7.0686e-6 0.0  0.0    01100
0182101  017010000 018000000 7.063e-4  0.92 .998   01000
0182101  017010000 018000000 2.743e-3  24.67 24.67  01000
0183101  018000000 019000000 0.0       0.0  0.0    01100
*      flow-f  flow-g  velj
0181201    1.245642-4  1.245642-4  0.  *  .00495906
0182201    -.0243771  -.027159  0.  *  -.0492356
0183201    -9.44463-4  -9.53585-4  0.  *  -.04409565
*      Hyd.D  F.C.  G.I.  S
0181110  .003    0.    1.   1.
0182110  .0203   0.    1.   1.
0183110  .170    0.    1.   1.
*
*=*=*=*=*=*=*=*=*
*
*  component 19 - upper head to downcomer bypass
*
*     name   type
0190000  dcbypas  snglvol
*    area  length  volume  horiz  vert  delz    rough    diam  flags
0190101   0.0   1.4565   9.3593e-2   0.0  -90.  -1.41786  4.57e-5 .135  00000
*           pressure  temperature
0190200  0     15437960. 1316919.    2449345. 0.
*
*=*=*=*=*=*=*=*=*
*
*  component 200 - junction to downcomer bypass
*
*     Represent the 8 orifices "at elevation 9063" in this junction
*     even though they are .461 m higher
*       -- see page 21 of BETHSY design document
*
2000000   dcbyjun   sngljun
*        from        to       area      f-loss r-loss   flags
2000101    019010000   021000000 6.262e-5    1.75  1.75    01000
2000201  0  -.944216    -.944216    0.  *  -.044873
*      Hyd.D  F.C.  G.I.  S
2000110   6.00e-3  0.    1.   1.
*
*=*=*=*=*=*=*=*=*
*
*  component 21 - downcomer bypass
*
*     name   type
0210000  dcbypas  pipe
0210001  3           *nvol
0210101  0.0  3        *volume area
0210201  0.0  2        *jun area
0210301    1.7614   1   *volume length
0210302    1.142635  2
0210303    0.2095    3
```

```
0210401   3.7831e-3  1    *volume volume
0210402   2.4414e-3  2
0210403   0.9697e-3  3
0210601   -18.2     1    *vert angle
0210602   -21.6     2
0210603   -90.0     3
0210701  -.55049     1    *delta z
0210702  -.42005     2
0210703  -.2095      3
0210801   4.57e-5  0.0   3 *roughness  diam
0210901   0.1     0.1   1 *junction  f-loss   r-loss
0210902   0.0     0.0   2
0211001   00000  3          *volume flags
0211101   01000  2         *junction vcahs
0211201   0      15445658. 1228907. 2449162. 0.       0. 1
0211202   0      15449269. 1231340. 2449075. 0.       0. 2
0211203   0      15451607. 1236349. 2449020. 0.       0. 3
0211300   0
0211301   -.0277381   -.0277381   0. 1 *  -.04492795
0211302   -.0277818  -.0291224   0. 2 *  -.044893
*      Hyd.D.   F.C.  G.I.  S.
0211401   .0492    0.    1.   1.  1
0211402   .0737    0.    1.   1.  2
*
*=*=*=*=*=*=*=*=*
*
*  component 20 - downcomer inlet
*
*     name   type
0200000   dcinlet   branch
*    njun  flag
0200001    5    0
*    area   length   volume   horiz vert   delz  rough   diam  flags
0200101   0.0  0.927   .0433240  0.0  -90.  -0.927  4.57e-5  0.0   00000
*           pressure  temperature
0200200   0     15455819. 1238261.     2448919. 0.
*      jun from   jun to       area      f loss   r loss  vcahs
0201101   021010000  020000000  0.0         0.0   0.0  01100
*
0202101   139010000  020000000  1.0936e-2   .834  2.52   01001
0203101   239010000  020000000  1.0936e-2   .834  2.52   01001
0204101   339010000  020000000  1.0936e-2   .834  2.52   01001
*
0205101   020010000  022000000  0.0         0.10  0.10  01100
*      flow-f  flow-g  velj
0201201   -.01282946  -.01305428  0.  *  -.04487
0202201   .673065   .673065  0.  *  5.56155
0203201   .671398   .671398  0.  *  5.54783
0204201   .67872    .67872   0.  *  5.60814
0205201   .860922   .97241   0.  *  16.67272
*       Hyd.D.  F.C.  G.I.  S
0201110   0.0     0.    1.   1.
0202110   .118    0.    1.   1.
0203110   .118    0.    1.   1.
0204110   .118    0.    1.   1.
0205110   .1731   0.    1.   1.
*
*=*=*=*=*=*=*=*=*
*
*  component 22 - downcomer
*
*       name   type
0220000    dcomer   pipe
0220001    10           *=nvol
0220101     0.0     1    *volume area
0220102   .02353     9    *volume area
0220103     0.0     10    *volume area
0220201     0.0      9    *junction area
*
0220301   .3246      1    *volume length
0220302   .5465      2    *volume length
0220303   .4575      3    *volume length
0220304   .522       7    *volume length
0220305   .5875      8    *volume length
0220306   0.0        9    *volume length
0220307   1.054      10   *volume length
*
0220401   .0083195   1    *volume volumes
0220402     0.0     8
0220403   .01933981  9
0220404   .027976   10
*
0220601   -90.0   8     *vertical angles
0220602   -32.08  9
0220603   -90.0   10
```

```
*
0220701 -.3246   1    *delta z
0220702 -.5465   2
0220703 -.4575   3
0220704 -.522    7
0220705 -.5875   8
0220706 -.4365   9
0220707 -1.054   10
*
0220801  4.57e-5  .1731  9 *roughness  diam
0220802  4.57e-5  4.5e-2 10
*
0220901  0.0  0.0  7 *junction f-loss r-loss
0220902  .054  .054  8 *junction f-loss r-loss
0220903  1.517 1.517  9 *junction f-loss r-loss
*
0221001   00000 10      *volume  flags
0221101   01000 9       *junction vcahs
*
0221201  0     15460079.  1238243. 2448818. 0.      0. 1
0221202  0     15463240.  1238212. 2448742. 0.      0. 2
0221203  0     15466943.  1238185. 2448654. 0.      0. 3
0221204  0     15470556.  1238155. 2448568. 0.      0. 4
0221205  0     15474407.  1238125. 2448476. 0.      0. 5
0221206  0     15478257.  1238095. 2448384. 0.      0. 6
0221207  0     15482108.  1238065. 2448293. 0.      0. 7
0221208  0     15486200.  1238031. 2448195. 0.      0. 8
0221209  0     15489953.  1238003. 2448106. 0.      0. 9
0221210  0     15494953.  1237836. 2447987. 0.      0. 10
*
0221300  0
0221301  .937746  1.055746 0.  1 *  16.67275
0221302  .937733  1.05572  0.  2 *  16.67283
0221303  .93772   1.055692 0.  3 *  16.6729
0221304  .937707  1.055664 0.  4 *  16.67297
0221305  .937693  1.055634 0.  5 *  16.67304
0221306  .93768   1.055605 0.  6 *  16.6731
0221307  .937666  1.055575 0.  7 *  16.6732
0221308  .93765   1.055543 0.  8 *  16.67327
0221309  .937634  .942164  0.  9 *  16.67326
*      Hyd.D.  F.C.  G.I.  S  J#
0221401  .1731   0.   1.   1.  9
*
*=*=*=*=*=*=*=*=*
*
*input for the pressurizer and pressurizer surge line
*
*=*=*=*=*=*=*=*=*
*
*    component 50 pressurizer surge line
*
*        name       type
0500000   prsurg    pipe
*        nvol
0500001   3
0500101   0.0       1 *volume areas
0500102  1.445e-3    2
0500103   0.0        3
0500201  1.445e-3    2 *junction areas
0500301  0.850       1 *volume lengths
0500302  0.0         2
0500303  2.69        3
0500401  1.11865e-3  1 *volume volumes
0500402  9.0406e-3   2
0500403  3.86375e-3  3
0500601  90.         1 *vertical angles
0500602  0.92        2
0500603  90.         3
0500701  0.850       1 *elevation changes
0500702  0.1         2
0500703  2.69        3
0500801  4.57e-5  0.0429 3      *roughness  diam
0500901  2.05     2.05   2      *junction loss coef
0501001  00         3  *volume fe
0501101  01000      2  *junction vcahs
0501201  0      15449544. 1397160. 2449069. 0.     0. 1
0501202  0      15445835. 1408776. 2449157. 0.     0. 2
0501203  0      15436258. 1483856. 2449386. 0.     0. 3
0501300  0
0501301  .00580774  .00580775  0.     1 * .00582751
0501302  .00554202  .00554213  0.     2 * .00552067
*      Hyd.D.  F.C.  G.I.  S.
0501401  .0429   0.   1.   1.  2
*
*=*=*=*=*=*=*=*=*

*
*    component 51 - pressurizer
*
*        name     type
0510000    preszr   pipe
*        nvol
0510001    5
*
0510101    0.0     5 *volume areas
*
0510201    3.1276e-2  1  *junction areas
0510202    3.4636e-2  4
*
0510301    0.105    1  *volume lengths
0510302    0.892    2
0510303    5.4145   4
0510304    0.105    5
*
0510401    2.1616e-3  1  *volume volumes
0510402    2.7890e-2  2
0510403    0.187535   4
0510404    2.4245e-3  5
*
0510601    90.      5  *vertical angles
0510801    4.57e-5  0.210  5  *roughness  diam
0510901    0.0     .0.0   4  *junction loss coef
0511001    00     5  *volume flags fe
0511101    01000  4  *junction flags vcahs
*
0511201    0     15427112. 1540847. 2449604. 0.     0. 1
0511202    0     15424059. 1550165. 2449677. 0.     0. 2
0511203    0     15405463. 1599025. 2450122. 0.     0. 3
*
0511204    0     15384827. 1600265. 2450639. .400648 0. 4
0511205    0     15381707. 1600470. 2450743. 1.     0. 5
*
0511300    0
0511301    2.47638-4   2.47828-4   0. 1 *  .00486484
0511302    2.16846-4   2.16978-4   0. 2 *  .00468266
0511303    2.405517-4  .634924     0. 3 *  .00497514
0511304    -.670095    8.16247-6   0. 4 *  2.846056-5
*      Hyd.D.  F.C.  G.I.  S.
0511401   .210    0.    1.   1.  4
*
*=*=*=*=*=*=*=*=*
*
*    component  53 - pressurizer to surge line
*
*        name     type
0530000   prtosur   sngljun
*      vol from    vol to     area f-loss r-loss f-loss vcahs
0530101 050010000  051000000 0.0 0.0 0.0  01100
* junction initial flows
0530201  0  .0054341    .00550881  0.   *  .00511983
*      Hyd.D.  F.C.  G.I.  S.
0530110  .0429   0.   1.   1.
*
*=*=*=*=*=*=*=
*
*  steam line manifold volume and steam dumps
*
*=*=*=*=*=*=*=
*
*=*=*=*=*=*=*=*=
*
*   component 470 - steam line manifold
*
*       name    type
4700000  tsmdom  snglvol
*    area     length   volume  horz vert  delz  rough  diam  fe
4700101 6.495e-3  1.0     0.0     0.0  0.0    0.0 4.57e-5 9.094-2 00
*       flag   pressure quality
4700200  0     6800035.  1248029.  2583446.  .999303
*
*=*=*=*=*=*=*=*=
*
*   component 471 - trip valve for control of secondary pressure
*                   boundary condition
*
*
*       name    type
4710000   sg-pr-v   valve
*      vol from   vol to    area    f-loss r-loss  vcahs
4710101  470010000  472000000 6.495-3  0.0   0.0    00100
*          l-flow   g-flow  velj
4710201  0  2.302603    6.68682    0.  *  1.542008
```

```
4710300  mtrvlv
*    open  close  rate  ic
4710301  404   440   0.5   1.
*    Hyd.D.  F.C.  G.I.  S.
4710110  .0429   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 472 - steamline sink volume
*
*    name    type
4720000  stmsink  tmdpvol
4720101  1.0e6  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
*    ebt   trip
4720200  102   450
4720201  -1.  6.80e6  1.0
*
*=*=*=*=*=*=*=*=*
*
*  component 473 - S/G Relief Valve
*
*    name    type
4730000  orifice  valve
*
*    vol from   vol to    area     fls rloss vcahs  scdc  2pdc  shdc
*
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>>>>>>>>>>>>>
*730101 470010000 474000000  1.85057e-4  0.0  0.0  00120  1.0   1.0   1.2
4730101 470010000 474000000  1.85057e-4  0.0  0.0  00120  1.0   0.8   0.8
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
* junction initial flows
4730201  0 0.     0.       0. * 0.
*
4730300  mtrvlv
*    open  close  rate  ic
4730301  607   608   0.2   0.
*
*    Hyd.D.  F.C.  G.I.  S.
4730110  .01535  0.   1.   1.
*
*=*=*=*=*=*=*=*=*
*
*   component 474 - atmospheric sink volume
*
4740000   atmosph  tmdpvol
4740101  1.0e6  1.0  0.0  0.0  0.0  0.0  0.0  0.0  11
4740200  102  0
4740201  0.0  1.0e5  1.0
*
*=*=*=*=*=*=*=*=
*
*core heater rod heat structures
*
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10131000  14   8   2   1     0.0
*      mesh flags
10131100   0   1
*      nint  right coord
10131101   4   0.00415
10131102   3   0.00475
*    composition*interval number
10131201   2   4
10131202   1   7
*     source*interval
10131301   0.0   1
10131302   1.0   3
10131303   0.0   7
*    temperature*mesh
10131401   623.  5
10131402   573.  8
*left boundary data
*      vol  incr  bc area code fact  struc no
10131501   0   0   0   0   0.0   1
10131502   0   0   0   0   0.0   2
10131503   0   0   0   0   0.0   3
10131504   0   0   0   0   0.0   4
10131505   0   0   0   0   0.0   5
10131506   0   0   0   0   0.0   6
10131507   0   0   0   0   0.0   7
10131508   0   0   0   0   0.0   8
10131509   0   0   0   0   0.0   9
```

```
10131510   0   0   0   0   0.0   10
10131511   0   0   0   0   0.0   11
10131512   0   0   0   0   0.0   12
10131513   0   0   0   0   0.0   13
10131514   0   0   0   0   0.0   14
*right boundary data
*        bound vol  incr  bc  area code factor structure no
10131601   013020000   0   1   0   4.1706   1
10131602   013030000   0   1   0   4.1706   2
10131603   013040000   0   1   0   3.3339   3
10131604   013050000   0   1   0   3.3339   4
10131605   013060000   0   1   0   3.3339   5
10131606   013070000   0   1   0   3.3339   6
10131607   013080000   0   1   0   3.3339   7
10131608   013090000   0   1   0   3.3339   8
10131609   013100000   0   1   0   3.3339   9
10131610   013110000   0   1   0   3.3339   10
10131611   013120000   0   1   0   3.3339   11
10131612   013130000   0   1   0   3.3339   12
10131613   013140000   0   1   0   2.5100   13
10131614   013150000   0   1   0   2.5100   14
*  source type  mult   l*dir r*dir  structure no
10131701   1   0.047295  0   0   1
10131702   1   0.052760  0   0   2
10131703   1   0.058518  0   0   3
10131704   1   0.077852  0   0   4
10131705   1   0.096486  0   0   5
10131706   1   0.109805  0   0   6
10131707   1   0.114133  0   0   7
10131708   1   0.109836  0   0   8
10131709   1   0.096554  0   0   9
10131710   1   0.077926  0   0   10
10131711   1   0.058592  0   0   11
10131712   1   0.043317  0   0   12
10131713   1   0.028464  0   0   13
10131714   1   0.028462  0   0   14
*
10131901 .0134  .16325 3.49275 .13125 .48975 .2325 .2325 1. 1
10131902 .0134  .48975 3.16625 .45775 .16325 .2325 .2325 1. 2
10131903 .0134  .7835  2.8725  .1305  .3915  .2325 .2325 1. 3
10131904 .0134 1.0445  2.6115  .3915  .1305  .2325 .2325 1. 4
10131905 .0134 1.3055  2.3505  .1305  .3915  .2325 .2325 1. 5
10131906 .0134 1.5665  2.0895  .3915  .1305  .2325 .2325 1. 6
10131907 .0134 1.8275  1.8285  .1305  .3915  .2325 .2325 1. 7
10131908 .0134 2.0885  1.5675  .3915  .1305  .2325 .2325 1. 8
10131909 .0134 2.3495  1.3065  .1305  .3915  .2325 .2325 1. 9
10131910 .0134 2.6105  1.0455  .3915  .1305  .2325 .2325 1. 10
10131911 .0134 2.8715  .7845   .1305  .3915  .2325 .2325 1. 11
10131912 .0134 3.1325  .5235   .3915  .1305  .2325 .2325 1. 12
10131913 .0134 3.36125 .29475  .09825 .42475 .2325 .2325 1. 13
10131914 .0134 3.55775 .09825  .29475 .22825 .2325 .2325 1. 14
*
*=*=*=*=*=*=*=*=*=*=*=
*
*  core baffle heat structure
*
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound  reflood flag
10141000   16   4   2   1   0.214572    0
*       mesh flags
10141100   0 1
*      number intervals  right bound
10141101     3          .215772
*        composition
10141201     1  3
*      source interval
10141301   0.0  3
*      temperature mesh no
10141401   558.8   4
*left boundary data
*        bound vol  incr    bc  area code factor structure no
10141501   013010000   00000   1   1   0.11    1
10141502   013020000   00000   1   1   0.3265  2
10141503   013030000   00000   1   1   0.3265  3
10141504   013040000   00000   1   1   0.261   4
10141505   013050000   00000   1   1   0.261   5
10141506   013060000   00000   1   1   0.261   6
10141507   013070000   00000   1   1   0.261   7
10141508   013080000   00000   1   1   0.261   8
10141509   013090000   00000   1   1   0.261   9
10141510   013100000   00000   1   1   0.261   10
10141511   013110000   00000   1   1   0.261   11
10141512   013120000   00000   1   1   0.261   12
10141513   013130000   00000   1   1   0.261   13
```

```
10141514  013140000  00000  1  1  0.1965 14
10141515  013150000  00000  1  1  0.1965 15
10141516  013160000  00000  1  1  0.35   16
*right boundary data
10141601  014010000  00000  1  1  0.11   1
10141602  014020000  00000  1  1  0.3265  2
10141603  014030000  00000  1  1  0.3265  3
10141604  014040000  00000  1  1  0.261  4
10141605  014050000  00000  1  1  0.261  5
10141606  014060000  00000  1  1  0.261  6
10141607  014070000  00000  1  1  0.261  7
10141608  014080000  00000  1  1  0.261  8
10141609  014090000  00000  1  1  0.261  9
10141610  014100000  00000  1  1  0.261  10
10141611  014110000  00000  1  1  0.261  11
10141612  014120000  00000  1  1  0.261  12
10141613  014130000  00000  1  1  0.261  13
10141614  014140000  00000  1  1  0.1965 14
10141615  014150000  00000  1  1  0.1965 15
10141616  014160000  00000  1  1  0.35   16
*source data
10141701  0  0.0  0.0  0.0  16
*additional boundary data
*           hyd diam
10141801  0.0 10. 10. 0. 0. 0. 0. 1.0 16
10141901  0.0 10. 10. 0. 0. 0. 0. 1.0 16
*
*=*=*=*=*=*=*=
*
*  Material property tables
*
*=*=*=*=*=*=*=
*
*thermal properties for stainless steel
*
*  thermal conductivity
20100100  tbl/fctn  1  1
20100101  293.   13.9
20100102  373.   15.1
20100103  473.   16.7
20100104  573.   18.3
20100105  673.   19.8
20100106  873.   23.0
20100107  1073.   26.1
*  volumetric specific heat
20100151  293.   3.58e6
20100152  373.   3.89e6
20100153  473.   4.10e6
20100154  573.   4.21e6
20100155  673.   4.26e6
20100156  873.   4.41e6
20100157  1073.   4.66e6
*
*------------------------------------------------------------*
*
*thermal properties for boron nitride
*
*  function for thermal conductivity
20100200  tbl/fctn  2  2
20100201  293.  2000.  2.0  0.0  0.0  0.0  0.0  0.0  0.0
*  function for volumetric specific heat
20100251  293.  423.    1.22e6  1.4e3    0.0  0.0  0.0  0.0  0.0
20100252  423.  1173.   1.46e6  1.62e3   0.0  0.0  0.0  0.0  0.0
*
*------------------------------------------------------------*
*
*thermal properties for inconel 600
*
*  thermal conductivity
20100300  tbl/fctn  1  1
*
20100301  323.   14.9
20100302  373.   15.6
20100303  473.   17.2
20100304  673.   20.4
20100305  873.   23.7
20100306  1073.   27.4
*
*  volumetric specific heat
*
20100351  323.   3.76320e6
20100352  373.   3.85526e6
20100353  473.   4.02919e6
20100354  673.   4.26422e6
20100355  873.   4.68003e6
20100356  1073.   4.98467e6
*
*------------------------------------------------------------*
*
*  thermal properties for insulator: rockwool
*
*  thermal conductivity
20100400  tbl/fctn  1  1
20100401  311.15  0.1192
20100402  422.15  0.1681
20100403  533.15  0.2166
20100404  811.15  0.3448
*  volumetric specific heat
20100451  1.36e5
*
*=*=*=*=*=*=*=
*=*=*=*=*=*=*=
*
*  Tables of core power
*
*=*=*=*=*=*=*=
*=*=*=*=*=*=*=
*
*  core power table
*
20200100  power  440
*       time  power
20200101   -1.0  2.863e6
20200102    0.0  2.863e6
20200103   53.0  2.863e6
20200104   60.0  2.647e6
20200105   70.0  2.398e6
20200106   80.0  2.188e6
20200107   90.0  1.997e6
20200108  100.0  1.859e6
20200109  120.   1.589e6
20200110  150.   1.298e6
20200111  200.   1.016e6
20200112  300.   0.688e6
20200113  400.   0.631e6
20200114  600.   0.557e6
20200115  800.   0.530e6
20200116  1000.   0.506e6
20200117  1200.   0.484e6
20200118  1400.   0.464e6
20200119  1700.   0.440e6
20200120  2000.   0.425e6
20200121  2179.   0.417e6
*
*=*=*=*=*=*=*=*=*=
*
*   control variables for non-loop-specific items
*
*=*=*=*=*=*=*=*
*
*   Pressurizer level from height times void
*
20500100  prlev  sum   1.0   7.27431  1
20500101  0.0    0.105    voidf  051010000
20500102         0.892    voidf  051020000
20500103         5.4145   voidf  051030000
20500104         5.4145   voidf  051040000
20500105         0.105    voidf  051050000
*
*=*=*=*=*=*=*=*=
*
*   Pressurizer level from dpp1
*
20500200  plvdp1a  sum   1.0   3385.26  1
20500201  0.0   10.1937  cntrlvar 36
* NOTE:  cntrlvar 36 is presently in hPa thus the factor in front
*     has been multiplied by 100.  When cntrlvar is later
*     expressed in kPa, the factor will have to be multiplied
*     by 1000.
20500202       -11.738    rhog  051050000
*
20500300  plvdp1b  sum   1.0   502.625  1
20500301  0.0      0.25   rhof  051020000
20500302          +0.25   rhof  051030000
20500303          +0.25   rhof  051040000
20500304          +0.25   rhof  051050000
20500305          -1.0    rhog  051050000
*
20500400  plvdp1c  div   1.0   6.73516  1
20500401  cntrlvar 003   cntrlvar 002
```

```
*
20500500 prlvdp1 sum 1.0 6.89016 1
20500501 .155 1.0 cntrlvar 004
*
*=*=*=*=*=*=*=*=
*
* Pressurizer level from dpp2
*
20500600 plvdp2a sum 1.0 2902.71 1
20500601 0.0 10.1937 cntrlvar 37
* NOTE: cntrlvar 37 is presently in hPa thus the factor in front
*     has been multiplied by 100. When cntrlvar is later
*     expressed in kPa, the factor will have to be multiplied
*     by 1000.
20500602      -9.765  rhog 051050000
*
20500700 plvdp2b sum 1.0 502.625 1
20500701 0.0    0.25  rhof 051020000
20500702       +0.25  rhof 051030000
20500703       +0.25  rhof 051040000
20500704       +0.25  rhof 051050000
20500705       -1.0   rhog 051050000
*
20500800 plvdp2c div 1.0 5.77511 1
20500801 cntrlvar 007 cntrlvar 006
*
20500900 prlvdp2 sum 1.0 6.85311 1
20500901 1.078 1.0 cntrlvar 008
*
*=*=*=*=*=*=*=*=
*
* Pressure at top of core -- labeled: P02
*
20501000 p02 sum 1.0 15461314. 1
20501001 0.0 1.0 p 013160000
20501002 -0.44145 rho 013160000
*
*=*=*=*=*=*=*=*=
*
*   must modify for new nodalization !!!!!
*
* System masses outside of the loops
*
20501100 cormas sum 1.0 128.9974 1
20501101 0.0  4.70800e-3 rho 013010000
20501102      1.39742e-2 rho 013020000
20501103      1.39742e-2 rho 013030000
20501104      1.11708e-2 rho 013040000
20501105      1.11708e-2 rho 013050000
20501106      1.11708e-2 rho 013060000
20501107      1.11708e-2 rho 013070000
20501108      1.11708e-2 rho 013080000
20501109      1.11708e-2 rho 013090000
20501110      1.11708e-2 rho 013100000
20501111      1.11708e-2 rho 013110000
20501112      1.11708e-2 rho 013120000
20501113      1.11708e-2 rho 013130000
20501114      8.41020e-3 rho 013140000
20501115      8.41020e-3 rho 013150000
20501116      1.80700e-2 rho 013160000
*
20501200 cbymas sum 1.0 43.02845 1
20501201 0.0  1.56310e-3 rho 014010000
20501202      4.639565e-3 rho 014020000
20501203      4.639565e-3 rho 014030000
20501204      3.70881e-3 rho 014040000
20501205      3.70881e-3 rho 014050000
20501206      3.70881e-3 rho 014060000
20501207      3.70881e-3 rho 014070000
20501208      3.70881e-3 rho 014080000
20501209      3.70881e-3 rho 014090000
20501210      3.70881e-3 rho 014100000
20501211      3.70881e-3 rho 014110000
20501212      3.70881e-3 rho 014120000
20501213      3.70881e-3 rho 014130000
20501214      2.79226e-3 rho 014140000
20501215      2.79226e-3 rho 014150000
20501216      4.97350e-3 rho 014160000
*
20501300 dcmas sum 1.0 302.991 1
20501301 0.0  4.33240e-2 rho 020010000
20501302      8.31950e-3 rho 022010000
20501303      1.285914e-2 rho 022020000
20501304      1.076497e-2 rho 022030000
20501305      1.228266e-2 rho 022040000
20501306      1.228266e-2 rho 022050000
20501307      1.228266e-2 rho 022060000
20501308      1.228266e-2 rho 022070000
20501309      1.382387e-2 rho 022080000
20501310      1.933981e-2 rho 022090000
20501311      2.79760e-2 rho 022100000
20501312      .15323     rho 011010000
20501313      6.20907e-2 rho 012010000
*
20501400 vesmas sum 1.0 294.6566 1
20501401 0.0  9.27760e-2 rho 099010000
20501402      1.02950e-2 rho 015010000
20501403      .15418     rho 016010000
20501404      8.08300e-3 rho 017010000
20501405      4.89190e-2 rho 018010000
20501406      9.35930e-2 rho 019010000
20501407      3.78310e-3 rho 021010000
20501408      2.44140e-3 rho 021020000
20501409      9.69700e-4 rho 021030000
*
20501500 prsrmas sum 1.0 174.215 1
20501501 0.0  1.11865e-3 rho 050010000
20501502      9.04060e-3 rho 050020000
20501503      3.86375e-3 rho 050030000
20501504      2.16160e-3 rho 051010000
20501505      2.78900e-2 rho 051020000
20501506      0.187535   rho 051030000
20501507      0.187535   rho 051040000
20501508      2.42450e-3 rho 051050000
*
*=*=*=*=*=*=*=*=
*
* heat transfered from core heater rods to the fluid
*
20502000 htrl sum 1.0 2819841. 1
20502001 0.0  1.0 q 013010000
20502002      1.0 q 013020000
20502003      1.0 q 013030000
20502004      1.0 q 013040000
20502005      1.0 q 013050000
20502006      1.0 q 013060000
20502007      1.0 q 013070000
20502008      1.0 q 013080000
20502009      1.0 q 013090000
20502010      1.0 q 013100000
20502011      1.0 q 013110000
20502012      1.0 q 013120000
20502013      1.0 q 013130000
20502014      1.0 q 013140000
20502015      1.0 q 013150000
20502016      1.0 q 013160000
*
20502100 htrt sum 1.0 2861687. 1
20502101 0.0  1.0 q 014010000
20502102      1.0 q 014020000
20502103      1.0 q 014030000
20502104      1.0 q 014040000
20502105      1.0 q 014050000
20502106      1.0 q 014060000
20502107      1.0 q 014070000
20502108      1.0 q 014080000
20502109      1.0 q 014090000
20502110      1.0 q 014100000
20502111      1.0 q 014110000
20502112      1.0 q 014120000
20502113      1.0 q 014130000
20502114      1.0 q 014140000
20502115      1.0 q 014150000
20502116      1.0 q 014160000
20502117      1.0 cntrlvar 020
*
*=*=*=*=*=*=*=*=
*
* volumetric flow rates in l/s
*
20502200 vflowdc div 1000. 22.06456 1 * DC
20502201 rho 022030000 mflowj 022030000
*
20502300 vflowby div 1000. -.0591992 1 * DC bypass
20502301 rho 021010000 mflowj 021010000
*
*=*=*=*=*=*=*=*=
*
* Differential pressures outside of the loops
*
```

```
*=*=*=*=*=*=*=*=
*
20502500 dp0200   sum   1.e-2  434.981  1
20502501  0.0     1.0    p 011010000
20502502          -1.0   p 099010000
20502503          +0.981   rho 011010000
20502504          -4.6082  rho 099010000
*
20502600 dp031    sum   1.e-2  74.2688  1
20502601  0.0     1.0    p 099010000
20502602          -1.0   p 015010000
20502603          +4.6082  rho 099010000
20502604          +0.5787  rho 015010000
*
20502700 dp03123  sum   1.e-2  254.429  1
20502701  0.0     1.0    p 099010000
20502702          -1.0   p 016010000
20502703          +4.6082  rho 099010000
20502704          +12.4390  rho 016010000
*
20502800 dp034    sum   1.e-2  224.285  1
20502801  0.0     1.0    p 015010000
20502802          -1.0   p 018010000
20502803          -0.5787  rho 015010000
20502804          +1.9545  rho 018010000
*
20502900 dp04142  sum   1.e-2  89.3505  1
20502901  0.0     1.0    p 019010000
20502902          -1.0   p 018010000
20502903          +1.3693  rho 019010000
20502904          +1.9545  rho 018010000
*
20503000 dp050    sum   1.e-2  103.962  1
20503001  0.0     1.0    p 021020000
20503002          -1.0   p 019010000
20503003          +0.1092  rho 021020000
20503004          -1.3693  rho 019010000
*
20503100 dp0r1    sum   1.e-2  733.535  1
20503101  0.0     1.0    p 011010000
20503102          -1.0   p 018010000
20503103          +0.981   rho 011010000
20503104          +1.9545  rho 018010000
*
20503200 dp051    sum   1.e-2  168.4494 1
20503201  0.0     1.0    p 139020000
20503202          -1.0   p 019010000
20503203          -1.3693  rho 019010000
*
20503300 dp052    sum   1.e-2  360.969  1
20503301  0.0     1.0    p 022090000
20503302          -1.0   p 139020000
20503303          +2.5727  rho 022090000
*
20503400 dp053    sum   1.e-2  114.7663  1
20503401  0.0     1.0    p 011010000
20503402          -1.0   p 022090000
20503403          +0.981   rho 011010000
20503404          -2.5727  rho 022090000
*
20503500 dp0r3    sum   1.e-2  508.274  1
20503501  0.0     1.0    p 011010000
20503502          -1.0   p 131010000
20503503          +0.981   rho 011010000
*
20503600 dpp1     sum   1.e-2  447.8805 1
20503601  0.0     1.0    p 051020000
20503602          -1.0   p 051050000
20503603          +3.8848  rho 051020000
20503604          +0.1422  rho 051050000
*
20503700 dpp2     sum   1.e-2  381.058  1
20503701  0.0     1.0    p 051020000
20503702          -1.0   p 051050000
20503703          -5.1699  rho 051020000
20503704          -10.1582  rho 051050000
*
20503800 dpp2alt  sum   1.e-2  390.483  1
20503801  0.0     1.0    p 051020000
20503802          -1.0   p 051040000
20503803          -5.1699  rho 051020000
20503804          +16.9149  rho 051040000
*
*=*=*=*=*=*=*=*=
*
*  Averaged system parameters
*
*=*=*=*=*=*=*=*=
*
*  Averages of loop temperatures and sg parameters
*
*=*=*=*=*=*=*=*=
*
20504000  avhlt  sum  1.0  314.979  1
20504001  -273.15  .333  tempf 133010000
20504002           .333  tempf 233010000
20504003           .333  tempf 333010000
*
20504100  avclt  sum  1.0  284.5446 1
20504101  -273.15  .333  tempf 137020000
20504102           .333  tempf 237020000
20504103           .333  tempf 337020000
*
20504200  avgsgp   sum  1.0  6802104. 1
20504201   0.0   .333  p    168010000
20504202         .333  p    268010000
20504203         .333  p    368010000
*
20504300  avsgfw   sum  1.0  .54945   1
20504301   0.0   .333  mflowj 461000000
20504302         .333  mflowj 561000000
20504303         .333  mflowj 661000000
*
20504400  avsgstm  sum  1.0  .521268  1
20504401   0.0   .333  mflowj 466000000
20504402         .333  mflowj 566000000
20504403         .333  mflowj 666000000
*
*=*=*=*=*=*=*=*=
*
*  Core bypass flow ratio
*
20504500  cbfr   div   1.0   .01603145 1
20504501  mflowj 12010000 mflowj 12020000
*
*=*=*=*=*=*=*=*=
*
*  total primary system mass with and without pressurizer
*
20505000  totmas   sum   1.0   1798.082 1 * without przr
20505001  0.0    1.0 cntrlvar 011
20505002         1.0 cntrlvar 012
20505003         1.0 cntrlvar 013
20505004         1.0 cntrlvar 014
20505005         1.0 cntrlvar 101
20505006         1.0 cntrlvar 102
20505007         1.0 cntrlvar 103
20505008         1.0 cntrlvar 104
20505009         1.0 cntrlvar 201
20505010         1.0 cntrlvar 202
20505011         1.0 cntrlvar 203
20505012         1.0 cntrlvar 204
20505013         1.0 cntrlvar 301
20505014         1.0 cntrlvar 302
20505015         1.0 cntrlvar 303
20505016         1.0 cntrlvar 304
20505017         1.0 cntrlvar 193
20505018         1.0 cntrlvar 293
20505019         1.0 cntrlvar 393
*
20505100  tmaswp   sum   1.0   1972.297 1 * with przr
20505101  0.0    1.0 cntrlvar 050
20505103         1.0 cntrlvar 015
*
*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=
*
*=*=*=*=*=*=*=*=
*
*
*primary loop piping components loop 1
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 131 - loop 1 hot leg
*
*      name     type
1310000  hotlga1  snglvol
*      area     length  volume horiz vert delz rough diam flags
```

```
1310101 1.0936e-2  1.1941 0.0 0.0 0.0 0.0 4.57e-5 .118 00000
*        pressure  temperature
1310200  0    15452546. 1404560.    2448997. 0.
*
*=*=*=*=*=*=*=*=*=
*
*  component 132 - pressure surge line nozzle in loop 1
*
*     name    type
1320000  hotlga2  branch
*    njun  flag
1320001  0   0
*     area    length  vol horiz vert delz rough diam  flags
1320101 1.0936e-2  0.5   0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*        pressure  temperature
1320200  0    15452509. 1404484.   2.449+6  0.
*
*=*=*=*=*=*=*=*=*=
*
*  component 133 - loop 1  hot leg to sg
*
*     name    type
1330000  hotlga3  pipe
*     nvol
1330001  3
1330101  1.0936e-2  3  *volume area
1330201  1.0936e-2  2  *junction area
1330301  0.79775    1  *volume length
1330302  1.44800    2
1330303  0.5506     3
1330401  0.0        3  *volume volumes
1330601  0.0        1  *vert angle
1330602  90.        2
1330603  50.        3
1330701  0.0        1  *delta z
1330702  1.44800    2
1330703  0.4637     3
1330801  4.57e-5 .118  3  *rough  diam
1330901  0.117  0.117  1  *junction  f-loss  r-loss
1330902  0.065  0.065  2  *junction  f-loss  r-loss
1331001  00000  3       * vol flags
*
1331101  101000 1       * vcahs
1331102   01000 2       * vcahs
*
1331201  0    15452492. 1404373. 2.449+6  0.      0. 1
1331202  0    15447531. 1404171. 2449117. 0.      0. 2
1331203  0    1.5441+7  1404094. 2449272. 0.      0. 3
1331300  0
1331301  .735694  .735694  0. 1  *  5.56192
1331302  .735653  .824658  0. 2  *  5.56226
*     Hyd.D.  F.C.  G.I.  S.
1331401  .118   0.   0.55  0.785  2
*
*=*=*=*=*=*=*=*=*=
*
*  component 401 - Lp 1. h.l. junction to pressurizer surge nozzle
*
*     name    type
4010000  hotlg4a  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
4010101  131010000  132000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
4010201  0  .73651   .73651   0.  *  5.56743
*     Hyd.D.  F.C.  G.I.  S.
4010110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=*=
*
*  component 402 - Lp 1. h.l. junction from pressurizer surge nozzle
*
*     name    type
4020000  hotlg5a  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
4020101  132010000  133000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
4020201  0  .73572   .73572   0.  *  5.56173
*     Hyd.D.  F.C.  G.I.  S.
4020110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=*=
*
*  component 403 - Lp 1. h.l. junction from pressurizer surge nozzle
*
*     name    type
```

```
4030000   prsurgj  sngljun
*     vol from   vol to  area f-loss  r-loss  vcahs
4030101  132010000  050000000 0.0  0.0  0.0   01002
*        l-flow  g-flow  velj
4030201  0  .00642165  .00642169  0.  *  .00584199
*     Hyd.D.  F.C.  G.I.  S.
4030110  .0429   0.   1.   1.
*
*=*=*=*=*=*=*=*=*=
*
*  component 135 - loop 1  cold leg pump suction piping
*
*    name     type
1350000 pumpsa  pipe
*        nvol
1350001      21
1350101  1.0936e-2  21   *volume areas
1350201  1.0936e-2  20   *junction areas
1350301  0.4189     1   *volume lengths
1350302  0.8149     2
1350303  0.8149     3
1350304  0.2315     4
1350305  0.4635     5
1350306  0.3245     6
1350307  0.3500     7
1350308  0.1965     8
1350309  0.1965     9
1350310  0.2610    10
1350311  0.2652    11
1350312  0.2485    12
1350313  0.8200    13
1350314  0.2485    14
1350315  0.2652    15
1350316  0.2610    16
1350317  0.1965    17
1350318  0.1965    18
1350319  0.3500    19
1350320  0.3245    20
1350321  0.4635    21
1350401  0.0       21
1350601  -54.35     1   *vertical angle
1350602  -90.      10
1350603  -79.8     11
1350604  -36.0     12
1350605   0.0      13
1350606   36.0     14
1350607   79.8     15
1350608   90.0     21
1350701 -0.3403     1   *delta z
1350702 -0.8149     2
1350703 -0.8149     3
1350704 -0.2315     4
1350705 -0.4635     5
1350706 -0.3245     6
1350707 -0.3500     7
1350708 -0.1965     8
1350709 -0.1965     9
1350710 -0.2610    10
1350711 -0.2610    11
1350712 -0.1460    12
1350713  0.00      13
1350714  0.1460    14
1350715  0.2610    15
1350716  0.2610    16
1350717  0.1965    17
1350718  0.1965    18
1350719  0.3500    19
1350720  0.3245    20
1350721  0.4635    21
1350801  4.57e-5  0.0  21  *volume roughnes diam
1350901  .065    .065    1 *f-loss  r-loss
1350902  0.0     0.0    11 *f-loss  r-loss
1350903  .117    .117   12
1350904  .117    .117   13
1350905  0.0     0.0    20
1351001  00000  21      * volume flags
1351101  01000  20      *junction vcahs
1351201  0     15438505. 1239755. 2449332. 0.      0. 1
1351202  0     15442754. 1239654. 2449231. 0.      0. 2
1351203  0     15448767. 1239553. 2449087. 0.      0. 3
1351204  0     15452627. 1239524. 2448995. 0.      0. 4
1351205  0     15455191. 1239466. 2448934. 0.      0. 5
1351206  0     15458098. 1239426. 2448865. 0.      0. 6
1351207  0     15460587. 1239383. 2448805. 0.      0. 7
1351208  0     15462603. 1239358. 2448757. 0.      0. 8
```

```
1351209 0   15464053. 1239334. 2448723. 0.     0. 9
1351210 0   15465741. 1239301. 2448683. 0.     0. 10
1351211 0   15467667. 1239268. 2448637. 0.     0. 11
1351212 0   15469167. 1239238. 2448601. 0.     0. 12
1351213 0   15469673. 1239136. 2448589. 0.     0. 13
1351214 0   15469098. 1239105. 2448603. 0.     0. 14
1351215 0   15467583. 1239072. 2448639. 0.     0. 15
1351216 0   15465643. 1239039. 2448685. 0.     0. 16
1351217 0   15463942. 1239014. 2448725. 0.     0. 17
1351218 0   15462481. 1238990. 2448760. 0.     0. 18
1351219 0   15460450. 1238946. 2448809. 0.     0. 19
1351220 0   15457942. 1238906. 2448869. 0.     0. 20
1351221 0   1.5455+7 1238848. 2448938. 0.      0. 21
1351300 0
1351301 .673333 .744737 0. 1 * 5.55987
1351302 .673312 .760486 0. 2 * 5.56
1351303 .673291 .760446 0. 3 * 5.56013
1351304 .673283 .760426 0. 4 * 5.56016
1351305 .673271 .760407 0. 5 * 5.56024
1351306 .673262 .760389 0. 6 * 5.56029
1351307 .673253 .760372 0. 7 * 5.56034
1351308 .673247 .76036 0. 8 * 5.56038
1351309 .673242 .760351 0. 9 * 5.56041
1351310 .673235 .76034 0. 10 * 5.56045
1351311 .673228 .760327 0. 11 * 5.56049
1351312 .673222 .686695 0. 12 * 5.56053
1351313 .673204 .673204 0. 13 * 5.56066
1351314 .6732  .686673 0. 14 * 5.5607
1351315 .673195 .760296 0. 15 * 5.56074
1351316 .673192 .760298 0. 16 * 5.56078
1351317 .673189 .760301 0. 17 * 5.56082
1351318 .673186 .760303 0. 18 * 5.56085
1351319 .67318 .760304 0. 19 * 5.5609
1351320 .673176 .760308 0. 20 * 5.56095
*   Hyd.D.  F.C.  G.I.  S.
1351401 .118   0.   1.  1. 20
*
*=*=*=*=*=*=*=*=
*
*  component 442 - outlet portion of loop 1 pump
*
*     name    type
4420000 pmpouta branch
*   njun flag
4420001 1 0
*     area length  volume  horiz  vert  delz  rough  diam  pvbfe
4420101 0.0  .0715  5.144e-3  0.0  -90. -.0715 4.57e-5  .118 00000
*       pressure  temperature
4420200 0   15455837. 1238754.  2448919. 0.
*    jun from  jun to    area  f loss  r loss vcahs
4421101 442010000 137000000 .087185 0.0  0.0  01000
*    flow-f flow-g  velj
4421201  .0844358 .0879169 0.  * 5.5611
*    Hyd.D.  F.C.  G.I.  S.
4421110 .118   0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  component 137 - loop 1 pump discharge piping
*
*      name  type
1370000 cldlga1 pipe
*    nvol
1370001 2
1370101 1.0936e-2  2  *volume areas
1370201 1.0936e-2  1  *juntion areas
1370301 1.5261    1  *volume lengths
1370302 1.005     2  *volume lengths
1370401 0.0      2  *volume volumes
1370501 0.0      2  *horiz angle
1370601 0.0      2  *vertical angle
1370701 0.0      2  *delta z
1370801 4.57e-5 0.0 2  *roughness  diam
1370901 0.0  0.0 1  *junction f-loss  r-loss
1371001 00  2      *volume fe
1371101 01000  1     *junction vcahs
1371201 0   15455913. 1238602. 2448917. 0.     0. 1
1371202 0   15455878. 1238499. 2448918. 0.     0. 2
1371300 0
1371301 .673116 .673116 0. 1 * 5.56125
*    Hyd.D.  F.C.  G.I.  S.
1371401 .118   0.   1.  1.  1
*
*=*=*=*=*=*=*=*=
*
*  component 138 - loop 1  accumulator nozzle
*
*     name    type
1380000 accnoza  branch
*    njun  flag
1380001  2  0
*      area     length  volume horiz vert delz rough diam  flags
1380101  1.0936e-2 0.354   0.0 0.0 0.0 0.0 4.57e-5 .118 00000
*           pressure  temperature
1380200  0    15455859. 1238462.    2448918. 0.
*      vol from   vol to  area f-loss r-loss  vcahs
1381101  137010000 138000000 1.0936e-2 0.0 0.0 01000
1382101  138010000 139000000 1.0936e-2 0.0 0.0 01000
*         l-flow  g-flow  velj
1381201   .673097 .673097 0.  * 5.56136
1382201   .67309  .67309  0.  * 5.5614
*     Hyd.D.  F.C.  G.I.  S.
1381110  .118    0.   1.  1.
1382110  .118    0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  component 139 - loop 1  cold leg piping
*
*     name    type
1390000  cldlga2  pipe
*     nvol
1390001  2
1390101  1.0936e-2   2 *volume areas
1390201  1.0936e-2   1 *junction areas
1390301  .78406      1 *volume lengths
1390302  .53586      2
1390401  0.0         2 *=volume volumes
1390601  0.0         2 *vertical angle
1390701  0.0         2 *delta z
1390801  4.57e-5  0.0  2 *roughness  diam
1390901  .144   .144  1 *junction f-loss  r-loss
1391001  00000 2       *volume flags
1391101  01000 1       *junction vcahs
1391201  0    15455844. 1238381. 2448919. 0.     0. 1
1391202  0    15455800. 1238326. 2448920. 0.     0. 2
1391300  0
1391301  .673075 .673075  0. 1 * 5.56149
*     Hyd.D.  F.C.  G.I.  S.
1391401  .118    0.   1.  1.  1
*
*=*=*=*=*=*=*=*=*=*=
*  .
*  loop 1 - pump
*
*=*=*=*=*=*=*=*=*=*=
*
*  component 136 - primary pump - loop 1
*
*      name   type
1360000  pumpa   pump
*     area    length volume  horiz vert  delz   flags
1360101 0.0      0.0715 7.813e-3 0.0 90.0 0.0715  00000
*      inlet vol    area    kf   kr   flags
1360108  135010000  1.0936e-2  0.0  0.0  01000
1360109  442000000  .017717    0.0  0.0  01000
*      flag  pressure  temperature
1360200 0     15454517.    1238767.    2448950. 0.
*      flag  liq    vap   interface
1360201   0  .673168  .76031   0.   * 5.56103
1360202   0  .4155115 .4155115 0.   * 5.56112
*     Hyd.D.  F.C.  G.I.  S.
1360110  .118    0.   1.  1.
1360111  .118    0.   1.  1.
*
*     table   2phase  2phase diff  torque  time   pump   reverse
*   indicator  index   table   table  index  trip   indicator
1360301   0     0       0      -1      0     0       1
*
*  pump rated conditions
*
*     velocity initial  flow   head  torque inert dens   mot tf2 tf0 tf1 tf
*     rad/sec  ratio  m3/sec   m    n-m   kg-m2 kg/m3 torq
1360302  311.   .0801  6.3056e-2  78.0 144.75  37.3  750.0  0.  0. 4.65e-2 0. 0
*
*  pump coastdown velocity table
*        trip
1366100   440
*        t since SI    v (rad/s)
1366101      -1.        24.911
```

```
1366102    0.    0.0
*
*------------------------------------------------------------------------
*
*..... bethsy pump single phase homologous curves
*
*    han
1361100 1  1  0.0  1.3257 0.1  1.3317 0.2  1.3273 0.3  1.3135 0.4  1.2909
1361101      0.5  1.2603 0.6  1.2223 0.7  1.1780 0.75  1.1536 0.775 1.1409
1361102      0.8  1.1279 0.825 1.1146 0.85  1.1009 0.875 1.0870 0.9  1.0728
1361103      0.925 1.0583 0.95  1.0437 0.975 1.0287 0.987 1.0215 1.0  1.0135
*    ban
1361200 2  1  0.0  0.5139 0.1  0.5633 0.2  0.6128 0.3  0.6622 0.4  0.7116
1361201      0.5  0.7610 0.6  0.8105 0.7  0.8599 0.75  0.8846 0.775 0.8969
1361202      0.8  0.9093 0.825 0.9216 0.85  0.9340 0.875 0.9463 0.9  0.9587
1361203      0.925 0.9710 0.95  0.9834 0.975 0.9957 0.987 1.0017 1.0  1.0081
*    hvn
1361300 1  2  0.0  -0.5772 0.1  -0.4471 0.2  -0.3169 0.3  -0.1868 0.4  -0.0567
1361301      0.5  0.0733 0.6  0.2035 0.7  0.3572 0.75  0.4471 0.775 0.4951
1361302      0.8  0.5450 0.825 0.5969 0.85  0.6508 0.875 0.7066 0.9  0.7643
1361303      0.925 0.8238 0.95  0.8852 0.975 0.9485 0.987 0.9795 1.0  1.0135
*    bvn
1361400 2  2  0.0  -0.5772 0.1  -0.4145 0.2  -0.2518 0.3  -0.0891 0.4  0.0735
1361401      0.5  0.2362 0.6  0.3989 0.7  0.5616 0.75  0.6429 0.775 0.6836
1361402      0.8  0.7243 0.825 0.7579 0.85  0.7915 0.875 0.8263 0.9  0.8611
1361403      0.925 0.8972 0.95  0.9333 0.975 0.9707 0.987 0.9886 1.0  1.0081
*    had
1361500 1  3  -1.  1.3257  0.0  1.3257
*    bad
1361600 2  3  -1.  0.5139  0.0  0.5139
*    hvd
1361700 1  4  -1.0  1.3257 -.900 1.2801 -.800 1.2346 -.700 1.1889 -.600 1.1434
1361701      -.500 1.0978 -.400 1.0522 -.300 1.0067 -.275 0.9953 -.250 0.9839
1361702      -.225 0.9725 -.200 0.9611 -.175 0.9497 -.150 0.9383 -.125 0.9269
1361703      -.100 0.9156 -.075 0.9042 -.050 0.8928 -.025 0.8814  0.00 0.8700
*    bvd
1361800 2  4  -1.0  0.5139  0.00 0.5139
*    hat
1361900 1  5  0.0  1.3257  1.00 1.3257
*    bat
1362000 2  5  0.0  0.5139  1.00 0.5139
*    hvt
1362100 1  6  .0  0.8700  .025 0.8814 .050 0.8928 .075 0.9042 .100 0.9156
1362101      .125 0.9269 .150 0.9383 .175 0.9497 .200 0.9611 .225 0.9725
1362102      .250 0.9839 .275 0.9953 .300 1.0067 .400 1.0522 .500 1.0978
1362103      .600 1.1434 .700 1.1889 .800 1.2346 .900 1.2801 1.00 1.3257
*    bvt
1362200 2  6  0.0  0.5139  1.000 0.5139
*
*------------------------------------------------------------------------
*
*  the following four curves were not provided in the bethsy data base
*  the values used were estimated from the relap5/mod2 manual examples
*
*------------------------------------------------------------------------
*
*    har
1362300  1  7  -1.0  0.1   0.0  1.3257
*    bar
1362400  2  7  -1.0  -1.5  0.0  .5139
*    hvr
1362500  1  8  -1.0  0.1   0.0  -.5772
*    bvr
1362600  2  8  -1.0  -1.5  0.0  -.5772
*
*------------------------------------------------------------------------
*
*    two-phase multiplier curves from semiscale
*
*
1363000   0   0.0  0.0   0.1  0.0   0.15 0.05  0.24 0.80
1363001        0.3  0.96  0.4  0.98  0.6  0.97  0.8  0.90
1363002        0.9  0.80  0.96 0.50  1.0  0.0
1363100   0   0.0  0.0   1.0  0.0
*
*    two-phase difference tables from semiscale
*
1364100 1  1  0.0  0.00   0.1  0.83   0.2  1.09
1364101       0.5  1.02   0.6  1.015  0.7  1.01
1364102       0.9  0.94   1.0  1.00
1364200 1  2  0.0  0.00   0.1  -0.04  0.2  0.00   0.3  0.11
1364201       0.4  0.21   0.8  0.67   0.9  0.80   1.0  1.0
1364300 1  3  -1.0  -1.06  -0.9  -1.24  -0.8  -1.77
1364301       -0.7  -2.36  -0.6  -2.79  -0.5  -2.91  -0.4  -2.67
1364302       -0.25 -1.69  -0.1  -0.50  0.0  0.00
1364400 1  4  -1.0  -1.16  -0.9  -0.78  -0.8  -0.05
1364401       -0.7  -0.31  -0.6  -0.17  -0.5  -0.17
1364402       -0.35  0.00  -0.2  0.05   0.0  0.11
1364500 1  5  0.0  0.00   0.2  -0.34
1364501       0.4  -0.65  0.6  -0.95
1364502       0.8  -1.19  1.0  -1.47
1364600 1  6  0.0  0.11   0.1  0.13   0.25  0.15
1364601       0.4  0.13   0.5  0.07   0.6  -0.04   0.7  -0.23
1364602       0.8  -0.51  0.9  -0.91  1.0  -1.47
1364700 1  7  0.0  0.0    1.0  0.0
1364800 1  8  0.0  0.0    1.0  0.0
1364900 2  1  0.0  0.0    1.0  0.0
1365000 2  2  0.0  0.0    1.0  0.0
1365100 2  3  0.0  0.0    1.0  0.0
1365200 2  4  0.0  0.0    1.0  0.0
1365300 2  5  0.0  0.0    1.0  0.0
1365400 2  6  0.0  0.0    1.0  0.0
1365500 2  7  0.0  0.0    1.0  0.0
1365600 2  8  0.0  0.0    1.0  0.0
*
*$#######################################################
*
*   loop 1 - steam generator primary components
*
*$#######################################################
*
*  SG plena and U-tubes
*
*       name    type
1340000  stmgena  pipe
*       number volumes
1340001   10
*       flow areas
1340101 0.0       1
1340102 1.0342e-2  9
1340103 0.0       10
*       junction flow areas
1340201 1.0342e-2  9
*       lengths
1340301 0.798     1
1340302 2.43125   9
1340303 0.798     10
*       volumes
1340401 35.0607e-3 1
1340402 0.0        9
1340403 35.0607e-3 10
*       vertical angles
1340601 90.       5
1340602 -90.      10
*       elevation changes
1340701 0.798     1
1340702 2.43125   4
1340703 2.39125   5
1340704 -2.39125  6
1340705 -2.43125  9
1340706 -0.798    10
*       rough  diam
1340801 4.57e-5  .229  1
1340802 1.5e-6   1.968e-2 9
1340803 4.57e-5  .229  10
*     forward  reverse  losses
1340901 .041    .120  1
1340901 0.0     0.0   1
1340902 0.0     0.0   4
1340903 .0176   .0176 5
1340903 0.0     0.0   5
1340904 0.0     0.0   8
1340905 .120    .041  9
1340905 0.0     0.0   9
*       volume control flags
1341001 00     10
*       junction control flags
*1341101 101000  1  *ccfl on
1341101 01000   1  *ccfl on
1341102 01000   8  *ccfl off for j's 2-8
*1341103 101000  9  *ccfl on
1341103 01000   9  *ccfl on
*
*
*       initial pressure  temperature
1341201 0       15436793. 1403223. 2449373. 0.      0. 1
1341202 0       15425028. 1334894. 2449654. 0.      0. 2
1341203 0       15407168. 1294973. 2450081. 0.      0. 3
1341204 0       15389026. 1271472. 2450515. 0.      0. 4
1341205 0       15370869. 1257227. 2450950. 0.      0. 5
```

```
1341206 0     15370393. 1248631. 2450961. 0.      0. 6
1341207 0     15387680. 1243697. 2450547. 0.      0. 7
1341208 0     15405148. 1240870. 2450129. 0.      0. 8
1341209 0     15422637. 1239138. 2449711. 0.      0. 9
1341210 0     15434519. 1239802. 2449427. 0.      0. 10
*    junction initial condition flag
1341300 0
*    initial junction veloc
1341301 .777455 .777455 0. 1 * 5.56222
1341302 .747364 .747364 0. 2 * 5.56189
1341303 .731844 .731844 0. 3 * 5.56159
1341304 .72317  .72317  0. 4 * 5.5613
1341305 .718167 .718167 0. 5 * 5.56101
1341306 .715213 .715213 0. 6 * 5.56074
1341307 .713473 .713473 0. 7 * 5.56047
1341308 .712458 .712458 0. 8 * 5.56021
1341309 .711822 .711822 0. 9 * 5.55995
*
*
*    Hyd.D.  F.C.  G.I.  S   J#
1341401 1.968e-2  0.   1.0   1.  1 *ccfl on
1341402 1.968e-2  0.   1.    1.  8 *ccfl off for j's 2-8
1341403 1.968e-2  0.   1.0   1.  9 *ccfl on
*
*=*=*=*=*=*=*=
*
*  steam generator inlet junction
*
4040000 sgina sngljun
4040101 133010000 134000000 1.0936e-2 0.0 0.0 001100
4040201 0  .735644 .790273 0. * 5.56239
*    Hyd.D.  F.C.  G.I.  S.
4040110 .118   0.   1.  1.
*
*=*=*=*=*=*=*=
*
*  steam generator outlet junction

4050000 sgouta sngljun
4050101 134010000 135000000 1.093578e-2 0.0 0.0 01100
4050201 0  .673344 .749263 0. * 5.55981
*    Hyd.D.  F.C.  G.I.  S.
4050110 .118   0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*steam generator secondary system components - loop 1
*
*=*=*=*=*=*=*=*=
*
*  component 160 - sg riser
*
*     name   type
1600000 tubebun  pipe
*     nvol
1600001  4
1600101  0.0   4      *volume areas
1600201  0.0   3      *junction areas
1600301  2.43125 3     *volume lengths
1600302  3.50875 4
1600401  0.13995 3     *volume volumes
1600402  0.20198 4
1600601  90.    4     *vertiical angles
1600801  4.57e-5  0.03503 4  *roughness diam
1600901  2.127  2.127 3  *junction resistance
1601001  00100    4   *flags pvbfe
1601101  01000    3   *flags vcahs
*
1601201  0   6880094. 1251151. 2582833. .1493304 0.  1
1601202  0   6865542. 1251266. 2582952. .253388  0.  2
1601203  0   6852337. 1250624. 2583057. .3140066 0.  3
1601204  0   6837103. 1249857. 2583183. .337368  0.  4
1601300  0
1601301  .3891006   .508203  0. 1 * 14.30343
1601302  .43904     .595841  0. 2 * 14.31952
1601303  .474469    .648711  0. 3 * 14.33273
*      hyd.d  flood.c  gas.intcp  slope  j#
1601401  .03503   0.     1.     1.   3  * d from J50 p46
*
*=*=*=*=*=*=*=
*
*  component 161 - lower steam dome
*
*      name   type
1610000  lstmdom  pipe
*     nvol
1610001  3
1610101  0.0      3  *volume area
1610201  0.0      2  *junction area
1610301  0.9875    1  *volume length
1610302  0.80275   2
1610303  0.80275   3
1610401  5.0807e-2  1  *volume volumes
1610402  3.9111e-2  2  *volume volumes
1610403  3.9111e-2  3  *volume volumes
1610601  90.      3
1610801  4.57e-5 .249  3  *rough  diam
1610901  0.0    0.0    2 *junction  f-loss  r-loss
1611001  00000  3       * vol flags
1611101  01000  2      * vcahs
1611201  0     6825485. 1249295. 2583288.  .23317  0. 1
1611202  0     6820431. 1249017. 2583331.  .237487 0. 2
1611203  0     6815835. 1248783. 2583370.  .211535 0. 3
1611300  0
1611301   .498383   1.260604 0. 1  * 14.34604
1611302   .500664    1.243184 0. 2 * 14.33462
*     Hyd.D.  F.C.  G.I.  S.
1611401  .249    0.   1.  1.  2
*
*=*=*=*=*=*=*=
*
*  component 162 - middle steam dome and separator
*
*     name    type
1620000  mstmdom  branch
*     njun  flag
1620001   3   0
*    area  length  volume  horz vert  delz  rough  diam  fe
1620101  0.0  .675   0.18609  0.0  90.  0.675  4.57e-5 .249  00
*     flag  pressure  quality
1620200  0     6811310. 1248667.  2583378.  .0809316
*     jun from  jun to     area      f-loss r-loss vcahs
1621101  162010000  168000000  .502655   5.0   5.0   01000
1622101  162000000  163000000  44.915e-2  0.0   0.0   01002
1623101  161010000  162000000  4.8695e-2  0.0   0.0   01000
* junction flows
1621201  -.1421347  .357748  0.  * .512754
1622201  .0447507   -.39579   0.  * 13.73207
1623201  .483922   1.40115   0.  * 14.32257
*     Hyd.D.  F.C.  G.I.  S.
1621110  .800   0.   1.  1.
1622110  .539   0.   1.  1.
1623110  .249   0.   1.  1.
*
*=*=*=*=*=*=*=
*
*  component 163 - upper downcomer
*
*     name   type
1630000  updwnc  sng1vol
*    area    length   volume  horz vert  delz  rough  diam  fe
1630101   0.0  0.3375  .14922  0.0  -90.  -.3375  4.57e-5 .539  00
*     flag  pressure  quality
1630200  0     6812539.  1248567.  2583397. 0.
*
*=*=*=*=*=*=*=
*
*  component 164 - upper feedwater ring
*
*     name   type
1640000  ufwring  snglvol
*    area    length   volume  horz vert  delz  rough  diam  fe
1640101  0.0   1.6055  0.15856  0.0  -90.  -1.6055  4.57e-5 0.176  00
*     flag  pressure  quality
1640200  0     6819609. 1248256.  2583338. 0.
*
*=*=*=*=*=*=*=
*
*  component 165 - lower feedwater ring
*
*     name   type
1650000  lfwring  branch
*     njun  flag
1650001   2   0
*    area    length   volume  horz vert  delz  rough  diam  fe
1650101  0.0   .8275    .08172   0.0  -90.  -.8275  4.57e-5 .176  00
*     flag  pressure  quality
1650200  0     6828487. 1241620.  2583264. 0.
*     jun from  jun to     area      f-loss r-loss vcahs
1651101  164010000  165000000  .09648     0.0  0.0   01000
```

```
1652101 165010000 166000000 3.0415e-2 .339 .459 01000
* junction flows
1651201 .1914484 .2370296 0. * 13.73372
1652201 .629509 .629509 0. * 14.28432
*    Hyd.D. F.C. G.I. S.
1651110 .176 0. 1. 1.
1652110 .05983 0. 1. 1.
*
*=*=*=*=*=*=*=*=
*
* component 166 - 11 tube region
*
*    name   type
1660000 dc11tube snglvol
*   area  length volume  horz vert  delz   rough   diam fe
1660101 0.0 1.9815 0.06336 0.0 -90. -1.9815 4.57e-5 .05983 00
*    flag  pressure  quality
1660200 0     6838541. 1241164.  2583180. 0.
*
*=*=*=*=*=*=*=*=*=
*
* component 167 - sg-dc bottom part (4 tube region and bottom annulus)
*    name   type
1670000 dc4tube pipe
*    nvol
1670001  4
1670101 .005836 3    *volume areas
1670102  0.0   4     *volume areas
1670201  0.0   3     *junction areas
*
1670301 1.68725 1    *volume lengths
1670302 2.43125 4    *volume lengths
*
1670401  0.0    3    *volume volumes
1670402 .017078  4   *volume volumes
*
1670601 -90.    4    *vertiical angles
1670801  4.57e-5 0.0431  4 *roughness diam
1670901  0.0   0.0  2 *junction resistance
1670902  0.5   1.0  3 *junction resistance
1671001  00100    4  *flags pvbfe
1671101  01000    3  *flags vcahs
1671201  0    6840399. 1241062. 2583164. 0.     0. 1
1671202  0    6851584. 1240907. 2583071. 0.     0. 2
1671203  0    6864790. 1240751. 2582960. 0.     0. 3
1671204  0    6877911. 1240590. 2582851. 0.     0. 4
1671300  0
1671301  3.28049  3.28049  0. 1 * 14.2874
1671302  3.280385 3.280385 0. 2 * 14.2883
1671303  3.28027  3.28027  0. 3 * 14.28921
*     hyd.d  flood.c gas.intcp slope j#
1671401 .0431    0.     1.     1.  3
*
*=*=*=*=*=*=*=*=
*
* component 469 - feedwater source
*
*    name   type
4690000 feedwtr tmdpvol
*   area    length   volume  horz vert  delz  rough  diam  fe
4690101 1.0e6  1.0  0.0 0.0  0.0  0.0  0.0 0.0  11
4690200  103  0
4690201  0.0 6.84e06  523.15
*
*=*=*=*=*=*=*=*=
*
* component 168 - top of steam dome
*
*    name   type
1680000 tstmdom snglvol
*   area    length  volume  horz vert  delz  rough  diam  fe
1680101 0.0 1.1425  0.50726 0.0  90. 1.1425 4.57e-5 .653  00
*    flag  pressure quality
1680200 0     6808857. 1248426.  2583418. .999943
*
*=*=*=*=*=*=*=*=
*
* component 169 - steamline
*
*    name   type
1690000 stmline pipe
*   nvol
1690001  2
1690101  0.0  2      *volume areas
1690201  0.0  1      *junction areas
1690301  15.825 2       *volume lengths
1690401  34.25e-3 2      *volume volumes
1690601  -90.  2        *vertical angles
1690701  -8.049  2       *delta z
1690801  4.57e-5 0.0525 2  *roughness diam
1690901  2.888  2.888  1  *junction loss coef
1690901  0.     0.     1  *junction loss coef
1691001  00  2         * fe
1691101  01000  1        *vcahs
1691201  0    6803101. 1247897. 2583426. .999415 0. 1
1691202  0    6801338. 1247914. 2583473. .998952 0. 2
1691300  0
1691301  3.69725 6.66587 0. 1 * .513774
*    Hyd.D.  F.C. G.I. S.
1691401  .0525  0.  1.  1.  1
*
*=*=*=*=*=*=*=*=
*
* component 461 - feedwater junction
*
*hydro          component name    component type
4610000           "fedwtr"          tmdpjun
*
*hydro   from        to          area
4610101  469000000   165000000    0.0
*
*hydro   vel/flw  trip
4610200   1     440
*
*      t since SI  flow
4610201    -1.      0.55       0.0         0.0
4610202    0.0      0.0        0.0         0.0
*
*####################################################*
*
* component 462 - junction between 11-tube and 4-tube regions
*
*    name   type
4620000 sgdwnc sngljun
*    jun from  jun to    area  f-loss r-loss vcahs
4620101  166010000 167000000 .005836 1.5  1.5  01000
*junction flows
4620201  0  3.280534 3.280534   0. * 14.28683
*    Hyd.D. F.C. G.I. S.
4620110  .0431  0.  1.  1.
*
*=*=*=*=*=*=*=*=
*
* component 463 - downcomer to tube bundle
*
*    name   type
4630000 sgdcbot sngljun
*    jun from  jun to    area  f-loss r-loss vcahs
4630101 167010000 160000000 .025761 1.0  0.5   01000
*junction initial flows
4630201  0 .7431    .551596   0. * 14.29014
*    Hyd.D. F.C. G.I. S.
4630110  .02   0.  1.  1.
*
*=*=*=*=*=*=*=*=
*
* component 464 - steamdome to downcomer
*
*    name   type
4640000 sgdctop sngljun
*    jun from  jun to    area  f-loss r-loss vcahs
4640101 163010000 164000000 .09648 0.0  0.0   01000
*junction initial flows
4640201  0 .191461   .237046   0. * 13.73228
*    Hyd.D. F.C. G.I. S.
4640110  .176  0.  1.  1.
*
*=*=*=*=*=*=*=*=
*
* component 465 - tube bundle to steam dome
*
*    name   type
4650000 ristodm  sngljun
*    jun from    jun to    area  f-loss r-loss vcahs
4650101  160010000  161000000 .084496  0.0  0.0  01000
*
4650201  0  .332596    .498248  0. * 14.34045
*
*    Hyd.D.  F.C. G.I. S.
4650110 0.328   0.  1.  1.
```

```
*
*=*=*=*=*=*=*=*=
*
*  component 468 - top steam dome to steam line
*
*    name    type
4680000  tostmln  sngljun
*    jun from  jun to    area    f-loss r-loss vcahs
4680101 168010000 169000000 .0011401   0.0  0.0  01100
*junction initial flows
4680201  0   5.99085 6.65865 0.  *  .510995
*     Hyd.D.  F.C.  G.I.  S.
4680110  .0381  0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 466 - steamline outlet
*
*    name     type
4660000  "trb st n" sngljun
*hydro   from        to          area     f loss   r loss   vcahs
4660101  169010000   470000000   1.14e-3   0.0      0.0     00000
*junction initial flows
*hydro   vel/flw     f flowrate    g flowrate    j flowrate
4660201  0           11.6602       12.66374      0.  *  .520628
*      Hyd.D.  F.C.  G.I.  S.
4660110   .0525   0.   1.   1.
*
*=*=*=*=*=*=*=
*
*steam generator tubes heat structures (loop 1)
*
*=*=*=*=*=*=*=
*
*     nh   np  geo   ss   left bound
11341000   8   4   2   1   0.00984
*      mesh flags
11341100   0   1
*      nint  right coord
11341101   3   0.01111
*      composition*interval no
11341201   3   3
*      source*interval
11341301   0.0  3
*      temperature*mesh no
11341401   560.   4
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11341501   134020000  10000   1   0   5.1107  8
*right boundary data
11341601   160010000  10000   1   0   5.7704  4
11341602   160040000  -10000  1   0   5.7704  8
*
*source data
11341701   0   0.0   0.0   0.0    8
*additional boundary data
*      hyd diam
11341801  0.01968 10. 10. 0. 0. 0. 0. 1.0  8
11341901  .01028  10. 10. 0. 0. 0. 0. 1.0  8 * inter tube dist = .01028
*=*=*=*=*=*=*=*=
*
*  control variables for loop 1
*
*=*=*=*=*=*=*=*
*
*  loop 1 masses
*
20510100  hl1mas   sum   1.0   33.9488  1
20510101  0.0    1.305868e-2   rho 131010000
20510102         5.46800e-3    rho 132010000
20510103         8.724194e-3   rho 133010000
20510104         1.583533e-2   rho 133020000
20510105         6.021362e-3   rho 133030000
*
20510200  sg1mas  sum   1.0   200.6336  1
20510201   0.0    0.0350607     rho 134010000
20510202          2.514399e-2   rho 134020000
20510203          2.514399e-2   rho 134030000
20510204          2.514399e-2   rho 134040000
20510205          2.514399e-2   rho 134050000
20510206          2.514399e-2   rho 134060000
20510207          2.514399e-2   rho 134070000
20510208          2.514399e-2   rho 134080000
20510209          2.514399e-2   rho 134090000
20510210          0.0350607     rho 134100000
*
20510300  ls1mas   sum   1.0   33.6294  1
20510301   0.0     4.581090e-3   rho 135010000
20510302           8.911746e-3   rho 135020000
20510303           8.911746e-3   rho 135030000
20510304           2.531684e-3   rho 135040000
20510305           5.068836e-3   rho 135050000
20510306           3.548732e-3   rho 135060000
20510307           3.827600e-3   rho 135070000
20510308           2.148924e-3   rho 135080000
20510309           2.148924e-3   rho 135090000
20510310           2.854296e-3   rho 135100000
*
20519300  ls1mas1   sum   1.0   30.0625  1
20519301   0.0     2.900227e-3   rho 135110000
20519302           2.717596e-3   rho 135120000
20519303           8.967520e-3   rho 135130000
20519304           2.717596e-3   rho 135140000
20519305           2.900227e-3   rho 135150000
20519306           2.854296e-3   rho 135160000
20519307           2.148924e-3   rho 135170000
20519308           2.148924e-3   rho 135180000
20519309           3.827600e-3   rho 135190000
20519310           3.548782e-3   rho 135200000
20519311           5.068836e-3   rho 135210000
*
20510400  cl1mas   sum   1.0   44.5315  1
20510401   0.0     7.813000e-3   rho 136010000
20510402           5.144000e-3   rho 442010000
20510403           1.668943e-2   rho 137010000
20510404           9.394024e-3   rho 137020000
20510405           5.468000e-3   rho 138010000
20510406           8.574480e-3   rho 139010000
20510407           5.860165e-3   rho 139020000
*
*------------------------------------------------------------*
*
*  steam generator 1 parameters
*
*------------------------------------------------------------*
*
*  steam generator 1 - primary delta T
*
20510500  dtsg1    sum    1.0   30.1695  1
20510501   0.0      1.0    tempf 133030000
20510502           -1.0    tempf 135010000
*
*------------------------------------------------------------*
*
*  Steam generator level from height times void in riser
*
20511000  sg1lv    sum    1.0   10.49895 1
20511001   0.0   2.43125   voidf  160010000
20511002         2.43125   voidf  160020000
20511003         2.43125   voidf  160030000
20511004         3.50875   voidf  160040000
20511005         0.9875    voidf  161010000
20511006         0.80275   voidf  161020000
20511007         0.80275   voidf  161030000
20511008         0.675     voidf  162010000
20511009         1.1425    voidf  168010000
*
*------------------------------------------------------------*
*
*  Steam generator level from height times void in downcomer
*
20511100  sg1lvd   sum    1.0   14.04325 1
20511101   0.0   1.68725   voidf  167010000
20511102         2.43125   voidf  167020000
20511103         2.43125   voidf  167030000
20511104         2.43125   voidf  167040000
20511112         1.9815    voidf  166010000
20511113         0.8275    voidf  165010000
20511114         1.6055    voidf  164010000
20511115         0.3375    voidf  163010000
20511116         0.3375    voidf  162010000
20511117         1.1425    voidf  168010000
*
*------------------------------------------------------------*
*
*  Steam generator level from dp4r1
*
20540100  s1lvdp1a  sum   1.0   7725.18  1
20540101   0.0   10.1937  cntrlvar 149
*
```

```
20540200 s1lvdp1b sum 1.0 709.736 1
20540201 0.0 0.1 rhof 167040000
20540202 +0.1 rhof 167030000
20540203 +0.1 rhof 167020000
20540204 +0.1 rhof 167010000
20540205 +0.1 rhof 166010000
20540206 +0.1 rhof 165010000
20540207 +0.1 rhof 164010000
20540208 +0.1 rhof 163010000
20540209 +0.1 rhof 162010000
20540210 +0.1 rhof 168010000
20540211 -1.0 rhog 168010000
*
20540300 s1lvdp1c div 1.0 10.8846 1
20540301 cntrlvar 402 cntrlvar 401
*
20540400 sg1lvdp1 sum 1.0 11.18459 1
20540401 0.3 1.0 cntrlvar 403
*
* Steam generator level from dp5r1
*
20540500 s2lvdp1a sum 1.0 7732.5 1
20540501 0.0 10.1937 cntrlvar 249
*
20540600 s2lvdp1b sum 1.0 709.74 1
20540601 0.0 0.1 rhof 267040000
20540602 +0.1 rhof 267030000
20540603 +0.1 rhof 267020000
20540604 +0.1 rhof 267010000
20540605 +0.1 rhof 266010000
20540606 +0.1 rhof 265010000
20540607 +0.1 rhof 264010000
20540608 +0.1 rhof 263010000
20540609 +0.1 rhof 262010000
20540610 +0.1 rhof 268010000
20540611 -1.0 rhog 268010000
*
20540700 s2lvdp1c div 1.0 10.89484 1
20540701 cntrlvar 406 cntrlvar 405
*
20540800 sg2lvdp1 sum 1.0 11.19484 1
20540801 0.3 1.0 cntrlvar 407
*
* Steam generator level from dp4r1
*
20540900 s3lvdp1a sum 1.0 7702.03 1
20540901 0.0 10.1937 cntrlvar 349
*
20541000 s3lvdp1b sum 1.0 709.724 1
20541001 0.0 0.1 rhof 367040000
20541002 +0.1 rhof 367030000
20541003 +0.1 rhof 367020000
20541004 +0.1 rhof 367010000
20541005 +0.1 rhof 366010000
20541006 +0.1 rhof 365010000
20541007 +0.1 rhof 364010000
20541008 +0.1 rhof 363010000
20541009 +0.1 rhof 362010000
20541010 +0.1 rhof 368010000
20541011 -1.0 rhog 368010000
*
20541100 s3lvdp1c div 1.0 10.85215 1
20541101 cntrlvar 410 cntrlvar 409
*
20541200 sg3lvdp1 sum 1.0 11.15215 1
20541201 0.3 1.0 cntrlvar 411
*
*
*------------------------------------------------*
* Steam generator level from dp4r2
*
20511200 s1lvdpa sum 1.0 1971.207 1
20511201 0.0 10.1937 cntrlvar 138
* NOTE: cntrlvar 138 is presently in hPa thus the factor in front
*     has been multiplied by 100. When cntrlvar is later
*     expressed in kPa, the factor will have to be multiplied
*     by 1000.
20511202 -3.458 rhog 168010000
*
20511300 s1lvdpb sum 1.0 708.54 1
20511301 0.0 0.2 rhof 165010000
20511302 +0.2 rhof 164010000
20511303 +0.2 rhof 163010000
20511304 +0.2 rhof 162010000
20511305 +0.2 rhof 168010000
20511306 -1.0 rhog 168010000
*
20511400 s1lvdpc div 1.0 2.78207 1
20511401 cntrlvar 113 cntrlvar 112
*
20511500 sg1lvdp sum 1.0 14.03707 1
20511501 11.255 1.0 cntrlvar 114
*
*------------------------------------------------*
*
* Loop 1 differential pressures
*
20513100 dp1 sum 1.e-2 33.28 1
20513101 0.0 1.0 p 139020000
20513102 -1.0 p 131010000
20513103 +.0981 rho 139020000
*
20513200 dp12pg sum 1.e-2 -18.22197 1
20513201 0.0 1.0 p 135210000
20513202 -1.0 p 137010000
20513203 -1.219874 rho 135210000
*
20513300 dp12vg sum 1.e-2 241.454 1
20513301 0.0 1.0 p 135120000
20513302 -1.0 p 135020000
20513303 +0.13734 rho 135120000
20513304 -3.140672 rho 135020000
*
20513400 dp12vp sum 1.e-2 133.37 1
20513401 0.0 1.0 p 135120000
20513402 -1.0 p 135210000
20513403 +0.13734 rho 135120000
20513404 -1.219874 rho 135210000
*
20513500 dp4 sum 1.e-2 24.26746 1
20513501 0.0 1.0 p 134010000
20513502 -1.0 p 134100000
20513503 -2.4132 rho 134010000
20513504 +2.4132 rho 134100000
*
20513600 dp41 sum 1.e-2 69.0573 1
20513601 0.0 1.0 p 133030000
20513602 -1.0 p 134010000
20513603 +1.4731 rho 133030000
20513604 +2.4132 rho 134010000
*
20513700 dp426 sum 1.e-2 795.879 1
20513701 0.0 1.0 p 134010000
20513702 -1.0 p 134050000
20513703 -2.4132 rho 134010000
20513704 +20.479 rho 134050000
*
20513800 dp4r2 sum 1.e-2 205.417 1
20513801 0.0 1.0 p 165010000
20513802 -1.0 p 168010000
20513803 +1.18946 rho 165010000
20513804 +0.69896 rho 168010000
*
20514100 dp11h sum 1.e-2 1.356812 1
20514101 0.0 1.0 p 131010000
20514102 -1.0 p 133010000
20514103 +0.1177 rho 133010000
*
20514200 dp11v sum 1.e-2 100.709 1
20514201 0.0 1.0 p 133010000
20514202 -1.0 p 133030000
20514203 -0.1177 rho 133010000
20514204 -1.9214 rho 133030000
*
20514300 dp436 sum 1.e-2 777. 1
20514301 0.0 1.0 p 134100000
20514302 -1.0 p 134060000
20514303 -2.4132 rho 134100000
20514304 +20.479 rho 134060000
*
20514400 dp44 sum 1.e-2 73.7685 1
20514401 0.0 1.0 p 135010000
20514402 -1.0 p 134100000
20514403 +2.07825 rho 135010000
20514404 +2.4132 rho 134100000
*
20514500 dp13h sum 1.e-2 1.13096 1
20514501 0.0 1.0 p 137010000
20514502 -1.0 p 139020000
*
```

```
20514600 dp423   sum  1.e-2  717.657 1
20514601  0.0    1.0    p 134010000
20514602        -1.0    p 134050000
20514603       -2.4132  rho 134010000
20514604      +10.0317  rho 134050000
*
20514700 dp433   sum  1.e-2  698.46   1
20514701  0.0    1.0    p 134100000
20514702        -1.0    p 134060000
20514703       -2.4132  rho 134100000
20514704      +10.0317  rho 134060000
*
20514800 dp4     sum  1.e-2  -24.26746 1
20514801  0.0    1.0    p 134100000
20514802        -1.0    p 134010000
20514803       -2.4132  rho 134100000
20514804       +2.4132  rho 134010000
*
*=*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=*=
*
*=*=*=*=*=*=*=*=*=
*
*
*primary loop piping components loop 2
*
*=*=*=*=*=*=*=*=*=*=*=
*
*  component 231 - loop 2 hot leg
*
*      name    type
2310000  hotlgb1  snglvol
*      area     length  volume horiz vert delz rough diam flags
2310101  1.0936e-2  1.1941  0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*          pressure  temperature
2310200  0    15452560. 1404560.    2448997. 0.
*
*=*=*=*=*=*=*=*=*=
*
*  component 232 - pressure surge line nozzle in loop 2
*
*      name    type
2320000  hotlgb2  branch
*    njun  flag
2320001  0  0
*      area    length  vol horiz vert delz rough diam  flags
2320101  1.0936e-2  0.5   0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*          pressure  temperature
2320200  0    15452537. 1404491.    2448997. 0.
*
*=*=*=*=*=*=*=*=*=
*
*  component 233 - loop 2  hot leg to sg
*
*      name    type
2330000  hotlgb3  pipe
*      nvol
2330001  3
2330101  1.0936e-2  3  *volume area
2330201  1.0936e-2  2  *junction area
2330301  0.79775    1  *volume length
2330302  1.44800    2
2330303  0.5506     3
2330401  0.0        3  *volume volumes
2330601  0.0        1  *vert angle
2330602  90.        2
2330603  50.        3
2330701  0.0        1  *delta z
2330702  1.44800    2
2330703  0.4637     3
2330801  4.57e-5  .118  3  *rough  diam
2330901  0.117  0.117  1  *junction  f-loss  r-loss
2330902  0.065  0.065  2  *junction  f-loss  r-loss
2331001  00000  3        * vol flags
*
*>>>> jjj, ccfl on
2331101  101000  1       * vcahs
2331102   01000  2       * vcahs
*
2331201  0    15452520. 1404379. 2.449+6  0.      0. 1
2331202  0    15447558. 1404176. 2449116. 0.      0. 2
2331203  0    15441038. 1404099. 2449272. 0.      0. 3
2331300  0
2331301  .733884  .733884  0. 1  *  5.54821
2331302  .733843  .822722  0. 2  *  5.54855
*     Hyd.D.  F.C.  G.I.  S.
2331401  .118   0.   0.55  0.785  2
*
*=*=*=*=*=*=*=*=*=
*
*  component 501 - Lp 2. h.l. junction to pressurizer surge nozzle
*
*      name    type
5010000  hotlg4b  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
5010101  231010000  232000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
5010201  0  .733928  .733928  0.  *  5.54791
*     Hyd.D.  F.C.  G.I.  S.
5010110  .118    0.    1.   1.
*
*=*=*=*=*=*=*=*=*=
*
*  component 502 - Lp 2. h.l. junction from pressurizer surge nozzle
*
*      name    type
5020000  hotlg5b  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
5020101  232010000  233000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
5020201  0  .733911  .733911  0.  *  5.54803
*     Hyd.D.  F.C.  G.I.  S.
5020110  .118    0.    1.   1.
*
*=*=*=*=*=*=*=*=*=
*
*  component 235 - loop 2  cold leg pump suction piping
*
*   name    type
2350000 pumpsb  pipe
*         nvol
2350001       21
2350101  1.0936e-2  21   *volume areas
2350201  1.0936e-2  20   *junction areas
2350301  0.4189    1   *volume lengths
2350302  0.8149    2
2350303  0.8149    3
2350304  0.2315    4
2350305  0.4635    5
2350306  0.3245    6
2350307  0.3500    7
2350308  0.1965    8
2350309  0.1965    9
2350310  0.2610    10
2350311  0.2652    11
2350312  0.2485    12
2350313  0.8200    13
2350314  0.2485    14
2350315  0.2652    15
2350316  0.2610    16
2350317  0.1965    17
2350318  0.1965    18
2350319  0.3500    19
2350320  0.3245    20
2350321  0.4635    21
2350401  0.0      21
2350601  -54.35    1   *vertical angle
2350602  -90.     10
2350603  -79.8    11
2350604  -36.0    12
2350605   0.0     13
2350606   36.0    14
2350607   79.8    15
2350608   90.0    21
2350701 -0.3403    1   *delta z
2350702 -0.8149    2
2350703 -0.8149    3
2350704 -0.2315    4
2350705 -0.4635    5
2350706 -0.3245    6
2350707 -0.3500    7
2350708 -0.1965    8
2350709 -0.1965    9
2350710 -0.2610    10
2350711 -0.2610    11
2350712 -0.1260    12  * reduced by 2 cm to cause first lsc
2350713  0.00      13
2350714  0.1260    14  * reduced by 2 cm to cause first lsc
2350715  0.2610    15
```

```
2350716 0.2610    16
2350717 0.1965    17
2350718 0.1965    18
2350719 0.3500    19
2350720 0.3245    20
2350721 0.4635    21
2350801  4.57e-5  0.0  21 *volume roughnes diam
2350901  .065    .065    1 *f-loss  r-loss
2350902  0.0     0.0    11 *f-loss  r-loss
2350903  .117    .117   12
2350904  .117    .117   13
2350905  0.0     0.0    20
2351001  00000  21     * volume flags
2351101  01000  20     *junction vcahs
2351201  0    15438536. 1239742. 2449332. 0.     0. 1
2351202  0    15442785. 1239641. 2449230. 0.     0. 2
2351203  0    15448797. 1239539. 2449087. 0.     0. 3
2351204  0    15452657. 1239510. 2448995. 0.     0. 4
2351205  0    15455221. 1239453. 2448933. 0.     0. 5
2351206  0    15458128. 1239412. 2448864. 0.     0. 6
2351207  0    15460616. 1239369. 2448805. 0.     0. 7
2351208  0    15462632. 1239344. 2448757. 0.     0. 8
2351209  0    15464082. 1239320. 2448722. 0.     0. 9
2351210  0    15465770. 1239287. 2448682. 0.     0. 10
2351211  0    15467696. 1239254. 2448636. 0.     0. 11
2351212  0    15469122. 1239223. 2448602. 0.     0. 12
2351213  0    15469553. 1239121. 2448592. 0.     0. 13
2351214  0    15469051. 1239090. 2448604. 0.     0. 14
2351215  0    15467611. 1239057. 2448638. 0.     0. 15
2351216  0    15465670. 1239024. 2448684. 0.     0. 16
2351217  0    15463969. 1.239+6  2448725. 0.     0. 17
2351218  0    15462508. 1238975. 2448760. 0.     0. 18
2351219  0    15460477. 1238931. 2448808. 0.     0. 19
2351220  0    15457969. 1238891. 2448868. 0.     0. 20
2351221  0    15455039. 1238833. 2448938. 0.     0. 21
2351300  0
2351301  .671666 .742966 0. 1 * 5.54614
2351302  .671646 .758696 0. 2 * 5.54627
2351303  .671624 .758656 0. 3 * 5.5464
2351304  .671616 .758636 0. 4 * 5.54644
2351305  .671605 .758617 0. 5 * 5.54651
2351306  .671595 .758599 0. 6 * 5.54656
2351307  .671586 .758582 0. 7 * 5.54662
2351308  .67158  .75857  0. 8 * 5.54665
2351309  .671575 .758561 0. 9 * 5.54668
2351310  .671568 .758549 0. 10 * 5.54672
2351311  .671561 .758536 0. 11 * 5.54676
2351312  .671555 .685005 0. 12 * 5.5468
2351313  .671538 .671538 0. 13 * 5.54693
2351314  .671533 .684983 0. 14 * 5.54697
2351315  .671529 .758506 0. 15 * 5.54701
2351316  .671525 .758508 0. 16 * 5.54706
2351317  .671522 .758511 0. 17 * 5.54709
2351318  .67152  .758513 0. 18 * 5.54712
2351319  .671514 .758514 0. 19 * 5.54717
2351320  .671509 .758518 0. 20 * 5.54722
*    Hyd.D.  F.C.  G.I.  S.
2351401  .118   0.   1.   1.  20
*
*=*=*=*=*=*=*=*=
*
*  component 542 - outlet portion of loop 2  pump
*
*     name     type
5420000  pmpoutb  branch
*    njun  flag
5420001  1  0
*     area  length  volume  horiz  vert  delz  rough  diam  pvbfe
5420101  0.0   .0715  5.144e-3  0.0  -90. -.0715 4.57e-5  .118 00000
*          pressure  temperature
5420200  0    15455839.  1238739.   2448919. 0.
*    jun from   jun to     area   f loss  r loss vcahs
5421101 542010000 237000000 .087185  0.0   0.0  01000
*     flow-f  flow-g  velj
5421201   .0842267 .0876818 0.  * 5.54737
*    Hyd.D.  F.C.  G.I.  S.
5421110  .118   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 237 - loop 2  pump discharge piping
*
*       name   type
2370000  cldlgb1  pipe
*     nvol
2370001  2
2370101  1.0936e-2  2  *volume areas
2370201  1.0936e-2  1  *juntion areas
2370301  1.5261     1  *volume lengths
2370302  1.005      2  *volume lengths
2370401  0.0        2  *volume volumes
2370501  0.0        2  *horiz angle
2370601  0.0        2  *vertical angle
2370701  0.0        2  *delta z
2370801  4.57e-5 0.0  2  *roughness  diam
2370901  0.0    0.0  1  *junction f-loss  r-loss
2371001  00   2      *volume fe
2371101  01000  1      *junction vcahs
2371201  0    15455916. 1238586. 2448917. 0.     0. 1
2371202  0    15455880. 1238482. 2448918. 0.     0. 2
2371300  0
2371301  .671451  .671451  0. 1 * 5.54753
*    Hyd.D.  F.C.  G.I.  S.
2371401  .118   0.   1.   1.  1
*
*=*=*=*=*=*=*=*=
*
*  component 238 - loop 2  accumulator nozzle in cold leg
*
*      name     type
2380000  emx21   branch
*     njun  flag
2380001  2  0
*      area     length  volume horiz vert delz rough diam  flags
2380101  1.0936e-2 0.354   0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*          pressure  temperature
2380200  0    15454526. 1238440.    2448950. 0.
2380200  0    15455860. 1238446.    2448918. 0.
*      vol from   vol to  area f-loss r-loss  vcahs
2381101  237010000 238000000 1.0936e-2 0.0 0.0 01000
2382101  238010000 239000000 1.0936e-2 0.0 0.0 01000
*        l-flow  g-flow  velj
2381201   .671429 .671429 0.  * 5.54763
2381201   -1.33658-5 -1.33658-5 0. * -1.143492-5
2382201   .671417 .671417 0.  * 5.54763
2382201   .671431 .671431 0.  * 5.54765
*    Hyd.D.  F.C.  G.I.  S.
2381110  .118   0.   1.   1.
2382110  .118   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 239 - loop 2  cold leg piping
*
*      name     type
2390000  cldlgb2  pipe
*     nvol
2390001  2
2390101  1.0936e-2   2 *volume areas
2390201  1.0936e-2   1 *junction areas
2390301  .78406      1 *volume lengths
2390302  .53586      2
2390401  0.0         2 *=volume volumes
2390601  0.0         2 *vertical angle
2390701  0.0         2 *delta z
2390801  4.57e-5  0.0  2 *roughness  diam
2390901  .144   .144   1 *junction f-loss  r-loss
2391001  00000 2       *volume flags
2391101  01000 1       *junction vcahs
2391201  0    15455844. 1238364. 2448919. 0.     0. 1
2391202  0    15455801. 1238309. 2448920. 0.     0. 2
2391300  0
2391301  .671408  .671408  0. 1 * 5.54777
*    Hyd.D.  F.C.  G.I.  S.
2391401  .118   0.   1.   1.  1
*
*=*=*=*=*=*=*=*=*=*=*=
*
*  loop 2 - pump
*
*=*=*=*=*=*=*=*=*=*=*=
*
*  component 236 - primary pump - loop 2
*
*     name   type
2360000  pumpb   pump
*    area    length volume  horiz vert  delz   flags
2360101 0.0     0.0715 7.813e-3 0.0 90.0 0.0715  00000
*     inlet vol    area    kf   kr  flags
2360108  235010000   1.0936e-2  0.0  0.0  01000
```

```
2360109 542000000 .017717  0.0 0.0 01000
*     flag pressure temperature
2360200 0    15454530.    1238751.    2448950. 0.
*     flag liq   vap  interface
2360201  0  .671502 .75852  0.  * 5.5473
2360202  0  .414483 .414483 0.  * 5.5474
*     Hyd.D.  F.C. G.I. S.
2360110  .118    0.   1.  1.
2360111  .118    0.   1.  1.
*
*    table   2phase  2phase diff  torque  time   pump   reverse
*   indicator  index    table     table  index  trip  indicator
2360301  136   136      136      -1      0    0      1
*
* pump rated conditions
*
*    velocity initial  flow   head  torque inert dens  mot tf2 tf0 tfl tf
*    rad/sec  ratio  m3/sec    m    n-m   kg-m2 kg/m3 torq
2360302 311.  .0798 6.3056e-2  78.0 144.75  37.3  750.0  0.  0. 4.65e-2 0. 0
*
* pump coastdown velocity table
*      trip
2366100  440
*      t since SI    v (rad/s)
2366101      -1.       24.818
2366102       0.         0.0
*
*$##########################################################
*
*    loop  2 - steam generator primary components
*
*$################################################################
*
*  SG plena and U-tubes
*
*        name    type
2340000  stmgenb  pipe
*      number volumes
2340001    10
*      flow areas
2340101 0.0      1
2340102 1.0342e-2  9
2340103 0.0       10
*      junction flow areas
2340201  1.0342e-2  9
*      lengths
2340301 0.798     1
2340302  2.43125   9
2340303  0.798     10
*      volumes
2340401  35.0607e-3 1
2340402  0.0        9
2340403  35.0607e-3 10
*      vertical angles
2340601  90.       5
2340602  -90.      10
*      elevation changes
2340701  0.798     1
2340702  2.43125   4
2340703  2.39125   5
2340704 -2.39125   6
2340705  -2.43125  9
2340706  -0.798    10
*      rough   diam
2340801 4.57e-5  .229  1
2340802  1.5e-6   1.968e-2 9
2340803  4.57e-5  .229  10
*    forward   reverse  losses
2340901  .041    .120  1
2340901  0.0     0.0   1
2340902  0.0     0.0   4
2340903  .0176   .0176 5
2340903  0.0     0.0   5
2340904  0.0     0.0   8
2340905  .120    .041  9
2340905  0.0     0.0   9
*      volume control flags
2341001  00      10
*      junction control flags
2341101  01000   1  *ccfl on
2341102  01000   8  *ccfl off for j's 2-8
2341103  01000   9  *ccfl on
*
*
*       initial pressure  temperature
2341201 0      15436820. 1403225. 2449373. 0.      0. 1
2341202 0      15425055. 1334845. 2449653. 0.      0. 2
2341203 0      15407195. 1294914. 2450080. 0.      0. 3
2341204 0      15389054. 1271419. 2450514. 0.      0. 4
2341205 0      15370897. 1257183. 2450949. 0.      0. 5
2341206 0      15370422. 1248597. 2450960. 0.      0. 6
2341207 0      15387709. 1243671. 2450546. 0.      0. 7
2341208 0      15405178. 1240851. 2450129. 0.      0. 8
2341209 0      15422667. 1239123. 2449710. 0.      0. 9
2341210 0      15434549. 1239789. 2449427. 0.      0. 10
*     junction initial condition flag
2341300 0
*     initial junction veloc
2341301 .77554  .77554  0.  1  * 5.5485
2341302 .745501 .745501 0.  2  * 5.54818
2341303 .730017 .730017 0.  3  * 5.54787
2341304 .721367 .721367 0.  4  * 5.54758
2341305 .71638  .71638  0.  5  * 5.5473
2341306 .713437 .713437 0.  6  * 5.54702
2341307 .711704 .711704 0.  7  * 5.54675
2341308 .710693 .710693 0.  8  * 5.54649
2341309 .71006  .71006  0.  9  * 5.54623
*
*
*      Hyd.D.   F.C.  G.I.   S   J#
2341401 1.968e-2  0.   1.0   1.  1  *ccfl on
2341402 1.968e-2  0.   1.    1.  8  *ccfl off for j's 2-8
2341403 1.968e-2  0.   1.0   1.  9  *ccfl on
*
*=*=*=*=*=*=*=*=
*
*  steam generator inlet junction
*
5040000 sginb  sngljun
5040101 233010000 234000000 1.0936e-2  0.0  0.0  001100
5040201  0  .733833 .788378 0.  * 5.54868
*      Hyd.D.  F.C.  G.I.  S.
5040110  .118    0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  steam generator outlet junction

5050000  sgoutb  sngljun
5050101  234010000  235000000 1.093578e-2  0.0  0.0  01100
5050201  0  .671678 .747478 0.  * 5.54609
*      Hyd.D.  F.C.  G.I.  S.
5050110  .118    0.   1.  1.
*
*=*=*=*=*=*=*=*=*=*=
*
*steam generator secondary system components - loop 2
*
*=*=*=*=*=*=*=*=*=*=
*
*  component 260 - sg riser
*
*      name    type
2600000 tubebun  pipe
*      nvol
2600001    4
2600101    0.0    4        *volume areas
2600201    0.0    3        *junction areas
2600301    2.43125 3       *volume lengths
2600302    3.50875 4
2600401    0.13995 3       *volume volumes
2600402    0.20198 4
2600601    90.     4       *vertiical angles
2600801    4.57e-5  0.03503  4  *roughness diam
2600901    2.127   2.127  3  *junction resistance
2601001    00100     4     *flags pvbfe
2601101    01000     3     *flags vcahs
*
2601201    0     6880088. 1251149. 2582833.  .1490688 0.  1
2601202    0     6865531. 1251265. 2582953.  .2530195 0.  2
2601203    0     6852320. 1250623. 2583058.  .3135756 0.  3
2601204    0     6837077. 1249856. 2583183.  .336882  0.  4
2601300    0
2601301   .388552    .507477  0. 1 *  14.28736
2601302   .438318    .594926  0. 2 *  14.30246
2601303   .473631    .647634  0. 3 *  14.31562
*      hyd.d   flood.c  gas.intcp  slope  j#
2601401   .03503     0.       1.      1.   3  * d from J50 p46
*
*=*=*=*=*=*=*=*=
```

```
*
*  component 261 - lower steam dome
*
*     name    type
2610000 lstmdom  pipe
*     nvol
2610001 3
2610101 0.0       3  *volume area
2610201 0.0       2  *junction area
2610301 0.9875    1  *volume length
2610302 0.80275   2
2610303 0.80275   3
2610401 5.0807e-2  1  *volume volumes
2610402 3.9111e-2  2  *volume volumes
2610403 3.9111e-2  3  *volume volumes
2610601 90.      3
2610801 4.57e-5 .249  3  *rough  diam
2610901 0.0   0.0    2 *junction  f-loss  r-loss
2611001 00000  3       * vol flags
2611101 01000 2      * vcahs
2611201 0     6825452. 1249294. 2583288.  .232761  0. 1
2611202 0     6820395. 1249015. 2583331.  .237025  0. 2
2611203 0     6815800. 1248781. 2583370.  .212002  0. 3
2611300 0
2611301  .497617    1.259055 0. 1  *  14.33063
2611302  .49986     1.24189  0. 2 *  14.31926
*     Hyd.D.  F.C.  G.I.  S.
2611401  .249    0.   1.   1.  2
*
*=*=*=*=*=*=*=*=
*
*  component 262 - middle steam dome and separator
*
*     name    type
2620000 mstmdom  branch
*     njun  flag
2620001  3   0
*   area   length  volume  horz vert  delz   rough   diam  fe
2620101 0.0  .675   0.18609  0.0  90.  0.675  4.57e-5 .249  00
*     flag   pressure   quality
2620200 0     6811255. 1248662.  2583380. .0721042
*     jun from   jun to    area      f-loss  r-loss  vcahs
2621101 262010000 268000000 .502655   5.0    5.0    01000
2622101 262000000 263000000 44.915e-2 0.0    0.0    01002
2623101 261010000 262000000 4.8695e-2 0.0    0.0    01000
* junction flows
2621201  -.141021  .4004136 0.  *  .511328
2622201  .0442759   -.373333  0.  *  13.7169
2623201  .48372     1.39389   0.  *  14.3071
*     Hyd.D.  F.C.  G.I.  S.
2621110  .800   0.   1.   1.
2622110  .539   0.   1.   1.
2623110  .249   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 263 - upper downcomer
*
*     name    type
2630000 updwnc  snglvol
*   area    length   volume  horz vert  delz   rough   diam  fe
2630101  0.0   0.3375  .14922  0.0  -90.   -.3375  4.57e-5 .539  00
*     flag   pressure   quality
2630200 0    6812485.  1248563.   2583398.  0.
*
*=*=*=*=*=*=*=*=
*
*  component 264 - upper feedwater ring
*
*     name    type
2640000 ufwring  snglvol
*   area    length   volume  horz vert  delz  rough  diam  fe
2640101 0.0   1.6055  0.15856  0.0  -90.  -1.6055  4.57e-5 0.176  00
*   flag  pressure  quality
2640200 0    6819554.  1248251.   2583339.  0.
*
*=*=*=*=*=*=*=*=
*
*  component 265 - lower feedwater ring
*
*     name    type
2650000  lfwring  branch
*     njun  flag
2650001  2   0
*   area    length   volume   horz vert  delz  rough   diam  fe
2650101  0.0   .8275    .08172   0.0  -90.   -.8275  4.57e-5 .176  00
*     flag   pressure   quality
2650200 0      6828432.  1241608.  2583264.  0.
*     jun from   jun to       area       f-loss  r-loss  vcahs
2651101  264010000  265000000   .09648      0.0   0.0    01000
2652101  265010000  266000000   3.0415e-2    .339  .459   01000
* junction flows
2651201    .1912365   .2367554   0.  *  13.71855
2652201    .628837   .628837    0.  *  14.26915
*      Hyd.D.  F.C.  G.I.  S.
2651110   .176   0.   1.   1.
2652110   .05983   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 266 - 11 tube region
*
*     name    type
2660000  dc11tube  snglvol
*     area   length  volume  horz   vert   delz     rough     diam  fe
2660101  0.0   1.9815  0.06336   0.0  -90.   -1.9815  4.57e-5  .05983 00
*     flag   pressure   quality
2660200 0      6838486.  1241152.   2583180.  0.
*
*=*=*=*=*=*=*=*=*=
*
*  component 267 - sg-dc bottom part (4 tube region and bottom annulus)
*     name    type
2670000  dc4tube  pipe
*     nvol
2670001   4
2670101   .005836  3      *volume areas
2670102   0.0    4       *volume areas
2670201   0.0    3       *junction areas
*
2670301   1.68725  1      *volume lengths
2670302   2.43125  4      *volume lengths
*
2670401   0.0     3      *volume volumes
2670402  .017078   4      *volume volumes
*
2670601  -90.     4      *vertiical angles
2670801   4.57e-5  0.0431   4  *roughness  diam
2670901   0.0    0.0   2  *junction resistance
2670902   0.5    1.0   3  *junction resistance
2671001   00100     4   *flags pvbfe
2671101   01000     3   *flags vcahs
2671201   0    6840370. 1241050. 2583164. 0.      0. 1
2671202   0    6851562. 1240894. 2583071. 0.      0. 2
2671203   0    6864778. 1240738. 2582960. 0.      0. 3
2671204   0    6877909. 1240577. 2582851. 0.      0. 4
2671300   0
2671301   3.276985  3.276985  0. 1 *  14.27224
2671302   3.27688   3.27688   0. 2 *  14.27314
2671303   3.27677   3.27677   0. 3 *  14.27404
*      hyd.d  flood.c  gas.intcp  slope  j#
2671401   .0431    0.      1.      1.   3
*
*=*=*=*=*=*=*=*=
*
*  component 569 - feedwater source
*
*     name    type
5690000  feedwtr  tmdpvol
*    area     length   volume  horz vert  delz  rough   diam   fe
5690101 1.0e6   1.0   0.0  0.0   0.0   0.0   0.0  0.0   11
5690200   103   0
5690201   0.0  6.840e6  523.15
*
*=*=*=*=*=*=*=*=*=
*
*  component 268 - top of steam dome
*
*     name    type
2680000  tstmdom  snglvol
*    area     length   volume  horz vert  delz   rough   diam  fe
2680101  0.0   1.1425   0.50726  0.0  90.  1.1425  4.57e-5 .653   00
*     flag   pressure quality
2680200 0      6808783.  1248423.   2583418.  .999943
*
*=*=*=*=*=*=*=*=
*
*  component 269 - steamline
*
*     name    type
```

```
2690000 stmline pipe
*    nvol
2690001  2
2690101  0.0  2        *volume areas
2690201  0.0  1        *junction areas
2690301  15.825 2      *volume lengths
2690401  34.25e-3 2    *volume volumes
2690601  -90.  2       *vertical angles
2690701  -8.049  2     *delta z
2690801  4.57e-5  0.0525  2  *roughness diam
2690901  2.888  2.888  1  *junction loss coef
2690901  0.0   0.0   1  *junction loss coef
2691001  00  2         * fe
2691101  01000  1      *vcahs
2691201  0   6803066. 1247892. 2583427. .999412 0. 1
2691202  0   6801328. 1247908. 2583474. .99895  0. 2
2691300  0
2691301  3.681786 6.64658  0. 1 *  .512295
*    Hyd.D.  F.C.  G.I.  S.
2691401  .0525   0.   1.  1.  1
*
*=*=*=*=*=*=*=*=
*
*  component 561 - feedwater junction
*
*hydro        component name    component type
5610000          "fedwtr"        tmdpjun
*
*hydro   from        to          area
5610101  569000000   265000000   0.0
*
*hydro   vel/flw   trip
5610200    1       440
*
*       t since SI  flow
5610201   -1.      0.55      0.0        0.0
5610202   0.0      0.0       0.0        0.0
*
*#########################################################*
*
*  component 562 - junction between 11-tube and 4-tube regions
*
*      name    type
5620000  sgdwnc  sngljun
*      jun from   jun to    area   f-loss r-loss vcahs
5620101  266010000 267000000 .005836  1.5   1.5   01000
*junction flows
5620201  0  3.27703  3.27703    0.  *  14.27165
*     Hyd.D.  F.C.  G.I.  S.
5620110  .0431  0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 563 - downcomer to tube bundle
*
*      name    type
5630000  sgdcbot  sngljun
*      jun from   jun to    area  f-loss r-loss vcahs
5630101  267010000  260000000 .025761 1.0   0.5   01000
*junction initial flows
5630201  0  .742306   .551234    0.  *  14.27497
*     Hyd.D.  F.C.  G.I.  S.
5630110  .02    0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 564 - steamdome to downcomer
*
*      name    type
5640000  sgdctop  sngljun
*      jun from   jun to    area  f-loss r-loss vcahs
5640101  263010000  264000000 .09648  0.0   0.0   01000
*junction initial flows
5640201  0  .191249   .2367717   0.  *  13.7171
*     Hyd.D.  F.C.  G.I.  S.
5640110  .176   0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 565 - tube bundle to steam dome
*
*      name    type
5650000  ristodm  sngljun
*      jun from     jun to    area   f-loss r-loss vcahs
5650101  260010000  261000000  .084496  0.0   0.0   01000
*
5650201  0  .332008    .497456   0.  *  14.3246
*
*     Hyd.D.  F.C.  G.I.  S.
5650110  0.328    0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 568 - top steam dome to steam line
*
*      name    type
5680000  tostmln  sngljun
*      jun from   jun to     area     f-loss r-loss vcahs
5680101  268010000  269000000  .0011401   0.0  0.0  01100
*5680101  268010000  269000000  .002       0.0  0.0  01100
*junction initial flows
5680201  0   5.96632  6.63959  0.  *  .509526
*     Hyd.D.  F.C.  G.I.  S.
5680110  .0381  0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 566 - steamline outlet
*
*      name      type
5660000  "trb st n"  sngljun
*hydro   from          to          area     f loss    r loss    vcahs
5660101  269010000     470000000   1.14e-3   0.0       0.0      00000
*5660101  269010000    470000000   5.00e-3   0.0       0.0      00000
*junction initial flows
*hydro   vel/flw      f flowrate   g flowrate   j flowrate
5660201    0            11.61908   12.6269     0.  *  .519134
*          Hyd.D.  F.C.  G.I.  S.
5660110    .0525   0.   1.   1.
*
*=*=*=*=*=*=*=*=*
*
*  component 240 - loop 2  accumulator and line
*
*       name     type
2400000  accum2    accum
*
*      area  lnth  vol  h.angl v.angl  dz   rough    hy.d pvbfe
2400101  0.0  8.376 .423  0.    -90.  -8.376 4.57e-5 .2545 00000
*
*      pressure   temp   boron
2400200  4.20e6   292.95   0.
*
*        to      area   floss rloss  fvcahs
2401101  238000000  .114e-2   19.    19.    000001
*
*      l.vol l.lev  l.lnth  dz  wall.th ht.tfr t.dens t.c  trip
2402200  0.   5.53648  21.0 -9.78 9.27e-3  0    0.   0.  601
*
*=*=*=*=*=*=*=*=
*
*steam generator tubes heat structures (loop 2)
*
*=*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
12341000   8    4    2    1   0.00984
*       mesh flags
12341100   0   1
*       nint  right coord
12341101   3   0.01111
*       composition*interval no
12341201   3   3
*       source*interval
12341301   0.0  3
*       temperature*mesh no
12341401   560.   4
*left boundary data
*          bound vol   incr    bc  area code factor structure no
12341501   234020000   10000    1   0   5.1107   8
*right boundary data
12341601   260010000   10000    1   0   5.7704   4
12341602   260040000  -10000    1   0   5.7704   8
*
*source data
12341701   0   0.0   0.0   0.0   8
*additional boundary data
*        hyd diam
12341801  0.01968  10.  10.  0.  0.  0.  0.  1.0   8
12341901  .01028  10.  10.  0.  0.  0.  0.  1.0   8 * inter tube dist = .01028
```

```
*
*=*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=*=
*
*  control variables for loop 2
*
*=*=*=*=*=*=*=*=*
*
*  loop 2 masses
*
20520100 hl2mas   sum   1.0   33.9487 1
20520101  0.0     1.305868e-2  rho 231010000
20520102          5.46800e-3   rho 232010000
20520103          8.724194e-3  rho 233010000
20520104          1.583533e-2  rho 233020000
20520105          6.021362e-3  rho 233030000
*
20520200 sg2mas  sum   1.0   200.6365 1
20520201  0.0    0.0350607    rho 234010000
20520202         2.514399e-2  rho 234020000
20520203         2.514399e-2  rho 234030000
20520204         2.514399e-2  rho 234040000
20520205         2.514399e-2  rho 234050000
20520206         2.514399e-2  rho 234060000
20520207         2.514399e-2  rho 234070000
20520208         2.514399e-2  rho 234080000
20520209         2.514399e-2  rho 234090000
20520210         0.0350607    rho 234100000
*
20520300 ls2mas  sum   1.0   33.6296 1
20520301  0.0    4.581090e-3  rho 235010000
20520302         8.911746e-3  rho 235020000
20520303         8.911746e-3  rho 235030000
20520304         2.531684e-3  rho 235040000
20520305         5.068836e-3  rho 235050000
20520306         3.548732e-3  rho 235060000
20520307         3.827600e-3  rho 235070000
20520308         2.148924e-3  rho 235080000
20520309         2.148924e-3  rho 235090000
20520310         2.854296e-3  rho 235100000
*
20529300 ls2mas1  sum   1.0   30.0627 1
20529301 0.0     2.900227e-3  rho 235110000
20529302         2.717596e-3  rho 235120000
20529303         8.967520e-3  rho 235130000
20529304         2.717596e-3  rho 235140000
20529305         2.900227e-3  rho 235150000
20529306         2.854296e-3  rho 235160000
20529307         2.148924e-3  rho 235170000
20529308         2.148924e-3  rho 235180000
20529309         3.827600e-3  rho 235190000
20529310         3.548782e-3  rho 235200000
20529311         5.068836e-3  rho 235210000
*
20520400 cl2mas  sum   1.0   44.5319 1
20520401  0.0    7.813000e-3  rho 236010000
20520402         5.144000e-3  rho 542010000
20520403         1.668943e-2  rho 237010000
20520404         9.394024e-3  rho 237020000
20520405         5.468000e-3  rho 238010000
20520406         8.574480e-3  rho 239010000
20520407         5.860165e-3  rho 239020000
*
*-----------------------------------------------------*
*
*  steam generator 2 parameters
*
*-----------------------------------------------------*
*
*  steam generator 2 - primary delta T
*
20520500 dtsg2   sum   1.0   30.173   1
20520501  0.0    1.0   tempf 233030000
20520502        -1.0   tempf 235010000
*
*-----------------------------------------------------*
*
*  Steam generator level from height times void in riser
*
20521000 sg2lv   sum   1.0   10.5096 1
20521001  0.0  2.43125   voidf 260010000
20521002       2.43125   voidf 260020000
20521003       2.43125   voidf 260030000
20521004       3.50875   voidf 260040000
20521005       0.9875    voidf 261010000
20521006       0.80275   voidf 261020000
20521007       0.80275   voidf 261030000
20521008       0.675     voidf 262010000
20521009       1.1425    voidf 268010000
*
*-----------------------------------------------------*
*
*  Steam generator level from height times void in downcomer
*
20521100 sg2lvd  sum   1.0   14.04623 1
20521101 0.0   1.68725   voidf 267010000
20521102       2.43125   voidf 267020000
20521103       2.43125   voidf 267030000
20521104       2.43125   voidf 267040000
20521112       1.9815    voidf 266010000
20521113       0.8275    voidf 265010000
20521114       1.6055    voidf 264010000
20521115       0.3375    voidf 263010000
20521116       0.3375    voidf 262010000
20521117       1.1425    voidf 268010000
*
*-----------------------------------------------------*
*
*  Steam generator level from dp4r2
*
20521200 s2lvdpa  sum   1.0   1973.19 1
20521201  0.0   10.1937  cntrlvar 238
* NOTE: cntrlvar 238 is presently in hPa thus the factor in front
*    has been multiplied by 100. When cntrlvar is later
*    expressed in kPa, the factor will have to be multiplied
*    by 1000.
20521202        -3.458   rhog  268010000
*
20521300 s2lvdpb  sum   1.0   708.542 1
20521301  0.0    0.2   rhof  265010000
20521302        +0.2   rhof  264010000
20521303        +0.2   rhof  263010000
20521304        +0.2   rhof  262010000
20521305        +0.2   rhof  268010000
20521306        -1.0   rhog  268010000
*
20521400 s2lvdpc  div   1.0   2.784856 1
20521401 cntrlvar 213   cntrlvar 212
*
20521500 sg2lvdp  sum   1.0   14.03986 1
20521501  11.255   1.0   cntrlvar 214
*
*-----------------------------------------------------*
*
*  Loop 2 differential pressures
*
20523100  dp2     sum   1.e-2   33.1482 1
20523101  0.0   1.0   p 239020000
20523102       -1.0   p 231010000
20523103       +.0981  rho 239020000
*
20523200 dp22pg   sum   1.e-2  -17.98042 1
20523201  0.0    1.0     p 235210000
20523202        -1.0     p 237010000
20523203        -1.219874 rho 235210000
*
20523300 dp22vg   sum   1.e-2   240.692 1
20523301  0.0    1.0     p 235120000
20523302        -1.0     p 235020000
20523303        +0.13734  rho 235120000
20523304        -3.140672 rho 235020000
*
20523400 dp22vp   sum   1.e-2   132.6477 1
20523401  0.0    1.0     p 235120000
20523402        -1.0     p 235210000
20523403        +0.13734  rho 235120000
20523404        -1.219874 rho 235210000
*
20523500  dp5     sum   1.e-2   24.231  1
20523501  0.0    1.0     p 234010000
20523502        -1.0     p 234100000
20523503        -2.4132   rho 234010000
20523504        +2.4132   rho 234100000
*
20523600  dp51    sum   1.e-2   69.0626 1
20523601  0.0    1.0     p 233030000
20523602        -1.0     p 234010000
20523603        +1.4731   rho 233030000
20523604        +2.4132   rho 234010000
*
```

```
20523700 dp526    sum  1.e-2  795.865  1
20523701  0.0    1.0    p 234010000
20523702         -1.0    p 234050000
20523703        -2.4132  rho 234010000
20523704        +20.479   rho 234050000
*
20523800  dp5r2    sum  1.e-2  205.6114 1
20523801  0.0    1.0    p 265010000
20523802         -1.0    p 268010000
20523803        +1.18946  rho 265010000
20523804        +0.69896  rho 268010000
*
20524100  dp21h    sum  1.e-2  1.216468 1
20524101  0.0    1.0    p 231010000
20524102         -1.0    p 233010000
20524103        +0.1177  rho 233010000
*
20524200  dp21v    sum  1.e-2  100.7172 1
20524201  0.0    1.0    p 233010000
20524202         -1.0    p 233030000
20524203        -0.1177  rho 233010000
20524204        -1.9214  rho 233030000
*
20524300  dp536    sum  1.e-2  777.017  1
20524301  0.0    1.0    p 234100000
20524302         -1.0    p 234060000
20524303        -2.4132  rho 234100000
20524304        +20.479   rho 234060000
*
20524400  dp54     sum  1.e-2  73.778   1
20524401  0.0    1.0    p 235010000
20524402         -1.0    p 234100000
20524403        +2.07825  rho 235010000
20524404        +2.4132  rho 234100000
*
20524500  dp23h    sum  1.e-2  1.150618 1
20524501  0.0    1.0    p 237010000
20524502         -1.0    p 239020000
*
20524600  dp523    sum  1.e-2  717.642  1
20524601  0.0    1.0    p 234010000
20524602         -1.0    p 234050000
20524603        -2.4132  rho 234010000
20524604        +10.0317  rho 234050000
*
20524700  dp533    sum  1.e-2  698.475  1
20524701  0.0    1.0    p 234100000
20524702         -1.0    p 234060000
20524703        -2.4132  rho 234100000
20524704        +10.0317  rho 234060000
*
20524800  dp5      sum  1.e-2  -24.231  1
20524801  0.0    1.0    p 234100000
20524802         -1.0    p 234010000
20524803        -2.4132  rho 234100000
20524804        +2.4132  rho 234010000
*
*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=
*
*=*=*=*=*=*=*=*=
*
*primary loop piping components loop 3
*
*=*=*=*=*=*=*=*=*=*=*=
*
*   component 331 - loop 3 hot leg
*
*      name     type
3310000  hotlgc1  snglvol
*      area     length  volume horiz vert delz rough diam flags
3310101  1.0936e-2  1.1941  0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*           pressure  temperature
3310200  0    15452553. 1404561.    2448997. 0.
*
*=*=*=*=*=*=*=*=
*
*   component 332 - pressure surge line nozzle in loop 3
*
*      name    type
3320000  hotlgc2  branch
*    njun  flag
3320001  0   0
*      area    length  vol horiz vert delz rough diam  flags
3320101  1.0936e-2  0.5   0.0  0.0  0.0  0.0  4.57e-5 .118 00000
*          pressure  temperature
3320200  0     15452529. 1404492.   2.449+6  0.
*
*=*=*=*=*=*=*=*=
*
*   component 333 - loop 3  hot leg to sg
*
*      name    type
3330000  hotlgc3  pipe
*     nvol
3330001  3
3330101  1.0936e-2  3  *volume area
3330201  1.0936e-2  2  *junction area
3330301  0.79775    1  *volume length
3330302  1.44800    2
3330303  0.5506     3
3330401  0.0        3  *volume volumes
3330601  0.0        1  *vert angle
3330602  90.        2
3330603  50.        3
3330701  0.0        1  *delta z
3330702  1.44800    2
3330703  0.4637     3
3330801  4.57e-5  .118  3  *rough  diam
3330901  0.117  0.117  1 *junction  f-loss  r-loss
3330902  0.065  0.065  2 *junction  f-loss  r-loss
3331001  00000  3        * vol flags
*
*>>> jjj, ccfl on
3331101  101000 1       * vcahs
3331102   01000 2       * vcahs
*
3331201  0    15452511. 1404382. 2.449+6  0.      0. 1
3331202  0    15447548. 1404182. 2449116. 0.      0. 2
3331203  0    15441027. 1404106. 2449272. 0.      0. 3
3331300  0
3331301  .741874  .741874  0. 1  *  5.6086
3331302  .741832  .831273  0. 2  *  5.60894
*
*    Hyd.D.  F.C.  G.I.  S.
3331401  .118   0.  0.55  0.785  2
*
*=*=*=*=*=*=*=*=
*
*   component 601 - Lp 3. h.l. junction to pressurizer surge nozzle
*
*      name     type
6010000  hotlg4c  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
6010101  331010000  332000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
6010201  0  .741917  .741917  0.  *  5.6083
*    Hyd.D.  F.C.  G.I.  S.
6010110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*   component 602 - Lp 3. h.l. junction from pressurizer surge nozzle
*
*      name     type
6020000  hotlg5c  sngljun
*     vol from   vol to  area f-loss r-loss  vcahs
6020101  332010000  333000000 0.0 0.0 0.0 01000
*        l-flow  g-flow  velj
6020201  0  .7419   .7419   0.  *  5.60842
*    Hyd.D.  F.C.  G.I.  S.
6020110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*   component 335 - loop 3  cold leg pump suction piping
*
*    name     type
3350000 pumpsc   pipe
*         nvol
3350001       21
3350101 1.0936e-2 21   *volume areas
3350201 1.0936e-2 20   *junction areas
3350301 0.4189     1   *volume lengths
3350302 0.8149     2
3350303 0.8149     3
3350304 0.2315     4
3350305 0.4635     5
3350306 0.3245     6
```

```
3350307 0.3500    7
3350308 0.1965    8
3350309 0.1965    9
3350310 0.2610    10
3350311 0.2652    11
3350312 0.2485    12
3350313 0.8200    13
3350314 0.2485    14
3350315 0.2652    15
3350316 0.2610    16
3350317 0.1965    17
3350318 0.1965    18
3350319 0.3500    19
3350320 0.3245    20
3350321 0.4635    21
3350401 0.0     21
3350601 -54.35    1   *vertical angle
3350602 -90.    10
3350603 -79.8    11
3350604 -36.0    12
3350605  0.0     13
3350606  36.0    14
3350607  79.8    15
3350608  90.0    21
3350701 -0.3403    1   *delta z
3350702 -0.8149    2
3350703 -0.8149    3
3350704 -0.2315    4
3350705 -0.4635    5
3350706 -0.3245    6
3350707 -0.3500    7
3350708 -0.1965    8
3350709 -0.1965    9
3350710 -0.2610    10
3350711 -0.2610    11
3350712 -0.1460    12
3350713 0.00     13
3350714 0.1460    14
3350715 0.2610    15
3350716 0.2610    16
3350717 0.1965    17
3350718 0.1965    18
3350719 0.3500    19
3350720 0.3245    20
3350721 0.4635    21
3350801  4.57e-5 0.0  21 *volume roughnes diam
3350901  .065   .065   1 *f-loss r-loss
3350902  0.0    0.0   11 *f-loss r-loss
3350903  .117   .117   12
3350904  .117   .117   13
3350905  0.0    0.0   20
3351001  00000 21     * volume flags
3351101  01000 20     *junction vcahs
3351201  0    15438437. 1239800. 2449334. 0.     0. 1
3351202  0    15442686. 1239699. 2449232. 0.     0. 2
3351203  0    15448697. 1239599. 2449089. 0.     0. 3
3351204  0    15452557. 1239570. 2448997. 0.     0. 4
3351205  0    15455121. 1239513. 2448936. 0.     0. 5
3351206  0    15458027. 1239473. 2448867. 0.     0. 6
3351207  0    15460516. 1239430. 2448807. 0.     0. 7
3351208  0    15462532. 1239406. 2448759. 0.     0. 8
3351209  0    15463981. 1239382. 2448725. 0.     0. 9
3351210  0    15465669. 1239350. 2448684. 0.     0. 10
3351211  0    15467595. 1239317. 2448638. 0.     0. 11
3351212  0    15469095. 1239286. 2448603. 0.     0. 12
3351213  0    15469600. 1239185. 2448591. 0.     0. 13
3351214  0    15469023. 1239154. 2448604. 0.     0. 14
3351215  0    15467509. 1239122. 2448640. 0.     0. 15
3351216  0    15465568. 1239089. 2448687. 0.     0. 16
3351217  0    15463867. 1239065. 2448727. 0.     0. 17
3351218  0    15462406. 1239041. 2448762. 0.     0. 18
3351219  0    15460375. 1238998. 2448811. 0.     0. 19
3351220  0    15457867. 1238957. 2448870. 0.     0. 20
3351221  0    15454937. 1238900. 2448940. 0.     0. 21
3351300  0
3351301  .678991 .750754  0. 1  * 5.60647
3351302  .67897  .766571  0. 2  * 5.6066
3351303  .678948 .766531  0. 3  * 5.60673
3351304  .67894  .766511  0. 4  * 5.60676
3351305  .678928 .766491  0. 5  * 5.60683
3351306  .67892  .766473  0. 6  * 5.60689
3351307  .67891  .766457  0. 7  * 5.60694
3351308  .678904 .766445  0. 8  * 5.60697
3351309  .678899 .766435  0. 9  * 5.607
3351310  .678892 .766423  0. 10 * 5.60704
3351311  .678885 .76641   0. 11 * 5.60708
3351312  .678878 .692431  0. 12 * 5.60712
3351313  .678861 .678861  0. 13 * 5.60725
3351314  .678856 .692409  0. 14 * 5.60729
3351315  .678852 .766379  0. 15 * 5.60733
3351316  .678848 .766382  0. 16 * 5.60737
3351317  .678845 .766384  0. 17 * 5.6074
3351318  .678842 .766386  0. 18 * 5.60743
3351319  .678837 .766387  0. 19 * 5.60749
3351320  .678832 .766391  0. 20 * 5.60754
*     Hyd.D.  F.C.  G.I.  S.
3351401  .118    0.   1.  1.  20
*
*=*=*=*=*=*=*=*=
*
*  component 642 - outlet portion of loop 3  pump
*
*      name     type
6420000  pmpoutc branch
*     njun  flag
6420001  1  0
*      area  length  volume  horiz  vert  delz  rough  diam  pvbfe
6420101  0.0    .0715  5.144e-3  0.0  -90. -.0715 4.57e-5  .118 00000
*           pressure  temperature
6420200  0     15455843. 1238807.  2448919. 0.
*      jun from   jun to     area   f loss  r loss vcahs
6421101  642010000 337000000 .087185  0.0   0.0  01000
*      flow-f  flow-g  velj
6421201   .0851452 .0887145 0.  * 5.60768
*     Hyd.D.  F.C.  G.I.  S.
6421110  .118    0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  component 337 - loop 3  pump discharge piping
*
*       name   type
3370000  cldlgc1  pipe
*     nvol
3370001  2
3370101  1.0936e-2  2  *volume areas
3370201  1.0936e-2  1  *juntion areas
3370301  1.5261     1  *volume lengths
3370302  1.005      2  *volume lengths
3370401  0.0        2  *volume volumes
3370501  0.0        2  *horiz angle
3370601  0.0        2  *vertical angle
3370701  0.0        2  *delta z
3370801  4.57e-5 0.0 2  *roughness diam
3370901  0.0   0.0 1  *junction f-loss r-loss
3371001  00  2       *volume fe
3371101  01000  1      *junction vcahs
3371201  0    15455916. 1238656. 2448917. 0.      0. 1
3371202  0    15455880. 1238554. 2448918. 0.      0. 2
3371300  0
3371301  .678773 .678773  0. 1 * 5.60785
*     Hyd.D.  F.C.  G.I.  S.
3371401  .118    0.   1.  1.  1
*
*=*=*=*=*=*=*=*=
*
*  component 338 - loop 3  accumulator nozzle in cold leg
*
*      name     type
3380000  emx31   branch
*     njun  flag
3380001  2  0
*      area     length  volume horiz vert delz rough diam  flags
3380101  1.0936e-2 0.354   0.0 0.0 0.0 0.0 4.57e-5 .118 00000
*          pressure  temperature
3380200  0    15454527. 1238511.    2448950. 0.
3380200  0    15455861. 1238517.    2448918. 0.
*       vol from   vol to  area f-loss r-loss  vcahs
3381101  337010000 338000000 1.0936e-2 0.0 0.0 01000
3382101  338010000 339000000 1.0936e-2 0.0 0.0 01000
*        l-flow  g-flow  velj
3381201   .678861 .678861  0.  * 5.60885
3381201   -1.342155-5 -1.342154-5 0. * -1.148262-5
3382201   .67885   .67885   0.  * 5.60885
3382201   .678754 .678754  0.  * 5.60796
*     Hyd.D.  F.C.  G.I.  S.
3381110  .118    0.   1.  1.
3382110  .118    0.   1.  1.
*
*=*=*=*=*=*=*=*=
```

```
*
*   component 339 - loop 3  cold leg piping
*
*       name    type
3390000  cldlgc2  pipe
*     nvol
3390001  2
3390101  1.0936e-2   2 *volume areas
3390201  1.0936e-2   1 *junction areas
3390301  .78406      1 *volume lengths
3390302  .53586      2
3390401  0.0         2 *=volume volumes
3390601  0.0         2 *vertical angle
3390701  0.0         2 *delta z
3390801  4.57e-5  0.0  2 *roughness diam
3390901  .144  .144  1 *junction f-loss r-loss
3391001  00000 2       *volume flags
3391101  01000 1       *junction vcahs
3391201  0    15455844. 1238437. 2448919. 0.     0. 1
3391202  0    15455800. 1238382. 2448920. 0.     0. 2
3391300  0
3391301  .67873  .67873  0. 1 * 5.60808
*     Hyd.D.  F.C.  G.I.  S.
3391401  .118   0.   1.  1.  1
*
*=*=*=*=*=*=*=*=*=*=
*
*  loop 3 - pump
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 336 - primary pump - loop 3
*
*      name   type
3360000 pumpc  pump
*     area   length volume horiz vert  delz   flags
3360101 0.0    0.0715 7.813e-3 0.0  90.0  0.0715  00000
*     inlet vol    area    kf  kr  flags
3360108 335010000  1.0936e-2  0.0  0.0  01000
3360109 642000000  .017717   0.0  0.0  01000
*     flag  pressure  temperature
3360200 0    15454483.    1238819.    2448951. 0.
*     flag  liq    vap   interface
3360201   0  .678825  .766393  0.   * 5.60761
3360202   0  .419003  .419003  0.   * 5.60771
*     Hyd.D.   F.C.  G.I.  S.
3360110  .118    0.   1.   1.
3360111  .118    0.   1.   1.
*
*     table  2phase  2phase diff  torque  time   pump   reverse
*   indicator  index   table    table  index  trip  indicator
3360301 136     136      136      -1      0     0      1
*
*  pump rated conditions
*
*     velocity initial   flow   head  torque inert dens   mot tf2 tf0 tf1 tf
*     rad/sec  ratio  m3/sec   m    n-m   kg-m2 kg/m3 torq
3360302 311.  .0811  6.3056e-2  78.0 144.75  37.3  750.0  0.  0. 4.65e-2 0. 0
*
*  pump coastdown velocity table
*        trip
3366100   440
*      t since SI    v (rad/s)
3366101     -1.        25.222
3366102      0.         0.0
*
*$###################################################
*
*    loop 3 - steam generator primary components
*
*$###################################################
*
*  SG plena and U-tubes
*
*       name    type
3340000  stmgenc  pipe
*       number volumes
3340001   10
*      flow areas
3340101  0.0        1
3340102  1.0342e-2  9
3340103  0.0        10
*      junction flow areas
3340201  1.0342e-2  9
*      lengths
3340301  0.798     1
3340302  2.43125   9
3340303  0.798     10
*      volumes
3340401  35.0607e-3  1
3340402  0.0        9
3340403  35.0607e-3  10
*      vertical angles
3340601  90.      5
3340602  -90.     10
*      elevation changes
3340701  0.798     1
3340702  2.43125   4
3340703  2.39125   5
3340704  -2.39125  6
3340705  -2.43125  9
3340706  -0.798    10
*      rough   diam
3340801  4.57e-5  .229  1
3340802  1.5e-6   1.968e-2  9
3340803  4.57e-5  .229  10
*    forward  reverse  losses
3340901  .041    .120  1
3340901  0.0     0.0   1
3340902  0.0     0.0   4
3340903  .0176   .0176  5
3340903  0.0     0.0   5
3340904  0.0     0.0   8
3340905  .120    .041  9
3340905  0.0     0.0   9
*      volume control flags
3341001  00      10
*      junction control flags
3341101  01000   1   *ccfl on
3341102  01000   8   *ccfl off for j's 2-8
3341103  01000   9   *ccfl on
*
*
*      initial pressure  temperature
3341201  0       15436809. 1403242. 2449373. 0.       0. 1
3341202  0       15425035. 1335072. 2449654. 0.       0. 2
3341203  0       15407166. 1295177. 2450081. 0.       0. 3
3341204  0       1.5389+7  1271655. 2450515. 0.       0. 4
3341205  0       15370850. 1257376. 2450950. 0.       0. 5
3341206  0       15370363. 1248748. 2450962. 0.       0. 6
3341207  0       15387639. 1243784. 2450548. 0.       0. 7
3341208  0       15405097. 1240935. 2450130. 0.       0. 8
3341209  0       15422575. 1239187. 2449713. 0.       0. 9
3341210  0       15434456. 1239846. 2449429. 0.       0. 10
*      junction initial condition flag
3341300  0
*      initial junction veloc
3341301  .783988  .783988  0.  1  * 5.60889
3341302  .753708  .753708  0.  2  * 5.60855
3341303  .738061  .738061  0.  3  * 5.60824
3341304  .729301  .729301  0.  4  * 5.60794
3341305  .724242  .724242  0.  5  * 5.60766
3341306  .72125   .72125   0.  6  * 5.60737
3341307  .719486  .719486  0.  7  * 5.6071
3341308  .718454  .718454  0.  8  * 5.60683
3341309  .717806  .717806  0.  9  * 5.60657
*
*
*      Hyd.D.    F.C.  G.I.   S    J#
3341401  1.968e-2  0.    1.0    1.0  1  *ccfl on
3341402  1.968e-2  0.    1.     1.0  8  *ccfl off for j's 2-8
3341403  1.968e-2  0.    1.0    1.0  9  *ccfl on
*
*=*=*=*=*=*=*=*=*=*=
*
*    steam generator inlet junction
*
6040000  sginc  sngljun
6040101  333010000  334000000  1.0936e-2  0.0  0.0  001100
6040201  0  .741823  .796746  0.  * 5.60906
*      Hyd.D.  F.C.  G.I.  S.
6040110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=*=*=
*
*   steam generator outlet junction

6050000  sgoutc  sngljun
6050101  334010000  335000000  1.093578e-2  0.0  0.0  01100
6050201  0  .679003  .755325  0.  * 5.60642
```

```
*     Hyd.D.  F.C.  G.I.  S.
6050110  .118    0.   1.   1.
*
*=*=*=*=*=*=*=*=*=*=
*
*steam generator secondary system components - loop 3
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 360 - sg riser
*
*     name    type
3600000  tubebun  pipe
*      nvol
3600001  4
3600101   0.0   4      *volume areas
3600201   0.0   3      *junction areas
3600301   2.43125  3      *volume lengths
3600302   3.50875  4
3600401   0.13995  3      *volume volumes
3600402   0.20198  4
3600601   90.    4     *vertiical angles
3600801   4.57e-5  0.03503  4  *roughness  diam
3600901   2.127   2.127  3   *junction resistance
3601001   00100     4    *flags pvbfe
3601101   01000     3    *flags vcahs
*
3601201   0    6880124. 1251156. 2582833.  .150214  0.  1
3601202   0    6865588. 1251268. 2582952.  .254632  0.  2
3601203   0    6852403. 1250627. 2583057.  .315464  0.  3
3601204   0    6837198. 1249862. 2583182.  .3390026 0.  4
3601300   0
3601301   .390813    .51051   0. 1 *  14.35255
3601302   .441189    .598602  0. 2 *  14.3676
3601303   .477033    .652041  0. 3 *  14.38228
*      hyd.d   flood.c  gas.intcp  slope  j#
3601401   .03503    0.      1.      1.    3  * d from J50 p46
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 361 - lower steam dome
*
*      name    type
3610000  lstmdom  pipe
*      nvol
3610001  3
3610101  0.0       3   *volume area
3610201  0.0       2   *junction area
3610301  0.9875     1   *volume length
3610302  0.80275    2
3610303  0.80275    3
3610401  5.0807e-2  1   *volume volumes
3610402  3.9111e-2  2   *volume volumes
3610403  3.9111e-2  3   *volume volumes
3610601  90.       3
3610801  4.57e-5  .249  3  *rough diam
3610901  0.0    0.0    2  *junction f-loss r-loss
3611001  00000  3        * vol flags
3611101  01000  2      * vcahs
3611201  0     6825603. 1249301. 2583287.  .234546  0. 1
3611202  0     6820558. 1249023. 2583330.  .238994  0. 2
3611203  0     6815964. 1248790. 2583368.  .2104715 0. 3
3611300  0
3611301   .500928    1.265737 0. 1  *  14.3968
3611302   .50331     1.247632 0. 2 *  14.38527
*     Hyd.D.   F.C.  G.I.  S.
3611401  .249    0.   1.   1.  2
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 362 - middle steam dome and separator
*
*      name    type
3620000  mstmdom   branch
*     njun  flag
3620001    3    0
*    area   length  volume  horz vert  delz   rough   diam   fe
3620101  0.0   .675    0.18609  0.0  90.  0.675  4.57e-5 .249   00
*      flag   pressure   quality
3620200  0      6811496. 1248680.  2583372.  .106539
*      jun from   jun to      area        f-loss r-loss vcahs
3621101  362010000  368000000  .502655    5.0    5.0    01000
3622101  362000000  363000000  44.915e-2  0.0    0.0    01002
3623101  361010000  362000000  4.8695e-2  0.0    0.0    01000
* junction flows
```

```
3621201  -.1455743  .274297  0.   *  .5176
3622201  .046199    -.452045  0.  *  13.78143
3623201  .484855    1.422199  0.  *  14.3729
*     Hyd.D.  F.C.  G.I.  S.
3621110  .800    0.    1.   1.
3622110  .539    0.    1.   1.
3623110  .249    0.    1.   1.
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 363 - upper downcomer
*
*     name    type
3630000  updwnc  snglvol
*    area    length   volume  horz vert  delz   rough   diam   fe
3630101   0.0   0.3375  .14922  0.0  -90.   -.3375  4.57e-5 .539  00
*      flag    pressure   quality
3630200  0      6812725.  1248580.  2583396. 0.
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 364 - upper feedwater ring
*
*     name    type
3640000  ufwring  snglvol
*    area    length   volume  horz vert  delz   rough   diam   fe
3640101 0.0    1.6055   0.15856  0.0  -90.  -1.6055  4.57e-5 0.176  00
*     flag  pressure  quality
3640200  0     6819795.  1248270.   2583337. 0.
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 365 - lower feedwater ring
*
*     name    type
3650000  lfwring   branch
*     njun  flag
3650001   2    0
*    area    length   volume  horz vert  delz   rough   diam   fe
3650101 0.0    .8275     .08172   0.0  -90.   -.8275  4.57e-5 .176  00
*      flag    pressure   quality
3650200  0      6828672.  1241656.   2583262. 0.
*      jun from   jun to      area        f-loss r-loss vcahs
3651101  364010000  365000000   .09648      0.0  0.0   01000
3652101  365010000  366000000  3.0415e-2   .339  .459  01000
* junction flows
3651201   .192138    .2379218   0.  *  13.7831
3652201   .631697   .631697    0.  *  14.3337
*     Hyd.D.  F.C.  G.I.  S.
3651110   .176   0.    1.   1.
3652110   .05983   0.   1.   1.
*
*=*=*=*=*=*=*=*=*=*=
*
*   component 366 - 11 tube region
*
*     name    type
3660000  dc11tube  snglvol
*     area   length  volume   horz   vert   delz    rough    diam  fe
3660101  0.0   1.9815  0.06336   0.0   -90.   -1.9815  4.57e-5  .05983 00
*      flag    pressure   quality
3660200  0      6838725.  1241202.   2583178. 0.
*
*=*=*=*=*=*=*=*=*=*=*=
*
*   component 367 - sg-dc bottom part (4 tube region and bottom annulus)
*     name    type
3670000  dc4tube  pipe
*      nvol
3670001   4
3670101   .005836  3       *volume areas
3670102   0.0    4       *volume areas
3670201   0.0    3       *junction areas
*
3670301   1.68725  1      *volume lengths
3670302   2.43125  4      *volume lengths
*
3670401   0.0     3     *volume volumes
3670402  .017078   4      *volume volumes
*
3670601   -90.    4      *vertiical angles
3670801   4.57e-5  0.0431   4  *roughness  diam
3670901   0.0     0.0    2  *junction resistance
3670902   0.5     1.0    3  *junction resistance
3671001   00100      4   *flags pvbfe
```

```
3671101  01000    3   *flags vcahs
3671201  0    6840503. 1241100. 2583163. 0.       0. 1
3671202  0    6851662. 1240945. 2583070. 0.       0. 2
3671203  0    6864838. 1240790. 2582960. 0.       0. 3
3671204  0    6877927. 1240630. 2582851. 0.       0. 4
3671300  0
3671301  3.29189   3.29189   0. 1 * 14.3368
3671302  3.29179   3.29179   0. 2 * 14.3377
3671303  3.291675  3.291675  0. 3 * 14.3386
*     hyd.d  flood.c  gas.intcp  slope  j#
3671401  .0431   0.     1.     1.  3
*
*=*=*=*=*=*=*=*=
*
*  component 669 - feedwater source
*
*     name    type
6690000  feedwtr  tmdpvol
*   area    length   volume  horz vert  delz  rough  diam  fe
6690101 1.0e6  1.0  0.0  0.0  0.0  0.0  0.0  0.0  11
6690200  103  0
6690201  0.0  6.840e6  523.15
*
*=*=*=*=*=*=*=*=
*
*  component 368 - top of steam dome
*
*     name    type
3680000  tstmdom   snglvol
*   area    length   volume  horz vert  delz  rough  diam  fe
3680101  0.0  1.1425   0.50726  0.0  90.  1.1425  4.57e-5 .653  00
*     flag   pressure quality
3680200 0       6809100. 1248439.  2583415. .999945
*
*=*=*=*=*=*=*=*=
*
*  component 369 - steamline
*
*     name    type
3690000  stmline  pipe
*    nvol
3690001  2
3690101   0.0  2        *volume areas
3690201   0.0  1        *junction areas
3690301  15.825 2        *volume lengths
3690401  34.25e-3 2      *volume volumes
3690601  -90.  2        *vertical angles
3690701  -8.049  2       *delta z
3690801  4.57e-5  0.0525  2  *roughness  diam
3690901  2.888  2.888  1  *junction loss coef
3690901  0.    0.     1  *junction loss coef
3691001  00  2          * fe
3691101  01000  1        *vcahs
3691201  0    6803212. 1247912. 2583424. .999422 0. 1
3691202  0    6801368. 1247931. 2583472. .99896  0. 2
3691300  0
3691301  3.7509  6.73015  0. 1 * .518717
*     Hyd.D.  F.C.  G.I.  S.
3691401  .0525   0.   1.   1.  1
*
*=*=*=*=*=*=*=*=
*
*  component 661 - feedwater junction
*
*hydro          component name     component type
6610000             "fedwtr"          tmdpjun
*
*hydro    from          to           area
6610101  669000000    365000000    0.0
*
*hydro   vel/flw   trip
6610200     1      440
*
*       t since SI  flow
6610201     -1.       0.55        0.0          0.0
6610202     0.0       0.0         0.0          0.0
*
*
*####################################################################
#####*
*
*  component 662 - junction between 11-tube and 4-tube regions
*
*     name    type
6620000  sgdwnc   sngljun
```

```
*      jun from    jun to      area    f-loss r-loss vcahs
6620101  366010000 367000000 .005836  1.5   1.5  01000
*junction flows
6620201  0  3.291935 3.291935    0.  *  14.3362
*     Hyd.D.  F.C.  G.I.  S.
6620110  .0431  0.    1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 663 - downcomer to tube bundle
*
*     name    type
6630000  sgdcbot  sngljun
*      jun from    jun to      area   f-loss r-loss vcahs
6630101 367010000 360000000 .025761 1.0   0.5   01000
*junction initial flows
6630201  0  .745683   .552786    0.  * 14.33953
*     Hyd.D.  F.C.  G.I.  S.
6630110  .02   0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  component 664 - steamdome to downcomer
*
*     name    type
6640000  sgdctop  sngljun
*      jun from   jun to     area   f-loss r-loss vcahs
6640101 363010000 364000000 .09648 0.0   0.0   01000
*junction initial flows
6640201  0  .1921505  .237938    0.  * 13.78165
*     Hyd.D.  F.C.  G.I.  S.
6640110  .176   0.   1.  1.
*
*=*=*=*=*=*=*=*=
*
*  component 665 - tube bundle to steam dome
*
*     name    type
6650000  ristodm   sngljun
*      jun from    area    f-loss r-loss vcahs
6650101   360010000   361000000  .084496  0.0  0.0  01000
*
6650201  0  .334507     .500832  0.  *  14.39068
*
*     Hyd.D.  F.C.  G.I.  S.
6650110 0.328    0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 668 - top steam dome to steam line
*
*     name    type
6680000  tostmln  sngljun
*      jun from   jun to     area      f-loss r-loss vcahs
6680101 368010000 369000000 .0011401    0.0  0.0  01100
*6680101 368010000 369000000 .002       0.0  0.0  01100
*junction initial flows
6680201  0   6.07046  6.72222  0.  * .515878
*     Hyd.D.  F.C.  G.I.  S.
6680110  .0381  0.   1.   1.
*
*=*=*=*=*=*=*=*=
*
*  component 666 - steamline outlet
*
*      name     type
6660000  "trb st n" sngljun
*hydro   from        to          area     f loss   r loss   vcahs
6660101  369010000    470000000   1.14e-3  0.0     0.0     00000
*6660101  369010000    470000000   5.00e-3  0.0     0.0     00000
*junction initial flows
*hydro   vel/flw      f flowrate    g flowrate    j flowrate
6660201    0            11.7969     12.78613     0.  * .525608
*        Hyd.D.  F.C.  G.I.  S.
6660110     .0525   0.   1.   1.
*
*=*=*=*=*=*=*=*=*
*
*  component 340 - loop 3  accumulator and line
*
*       name     type
3400000  accum3     accum
*
*      area  lnth  vol  h.angl v.angl  dz  rough   hy.d pvbfe
3400101  0.0  8.376 .423  0.    -90.  -8.376 4.57e-5 .2545 00000
```

```
*
*    pressure  temp  boron
3400200 4.21e6   292.25  0.
*
*      to     area   floss rloss  fvcahs
3401101 338000000  .114e-2  19.    19.      000001
*
*    l.vol l.lev  l.lnth  dz  wall.th ht.tfr t.dens t.c  trip
3402200 0.   5.44634 21.75 -9.78 9.27e-3  0    0.   0.  602
*
*=*=*=*=*=*=*=
*
*steam generator tubes heat structures (loop 3)
*
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
13341000   8   4   2   1   0.00984
*      mesh flags
13341100   0   1
*      nint  right coord
13341101   3   0.01111
*      composition*interval no
13341201   3   3
*      source*interval
13341301   0.0  3
*      temperature*mesh no
13341401   560.   4
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13341501   334020000  10000   1   0   5.1107  8
*right boundary data
13341601   360010000  10000   1   0   5.7704  4
13341602   360040000  -10000   1   0   5.7704  8
*
*source data
13341701   0   0.0   0.0    0.0    8
*additional boundary data
*      hyd diam
13341801  0.01968  10.  10.  0.  0.  0.  0.  1.0   8
13341901  .01028  10.  10.  0.  0.  0.  0.  1.0   8 * inter tube dist = .01028
*
*=*=*=*=*=*=*=*=*=
*=*=*=*=*=*=*=*=*=
*
*  control variables for loop 3
*
*=*=*=*=*=*=*=*=*
*
*  loop 3 masses
*
20530100  hl3mas   sum    1.0    33.9486  1
20530101  0.0      1.305868e-2  rho 331010000
20530102           5.46800e-3   rho 332010000
20530103           8.724194e-3  rho 333010000
20530104           1.583533e-2  rho 333020000
20530105           6.021362e-3  rho 333030000
*
20530200  sg3mas  sum    1.0    200.623  1
20530201   0.0    0.0350607    rho 334010000
20530202          2.514399e-2  rho 334020000
20530203          2.514399e-2  rho 334030000
20530204          2.514399e-2  rho 334040000
20530205          2.514399e-2  rho 334050000
20530206          2.514399e-2  rho 334060000
20530207          2.514399e-2  rho 334070000
20530208          2.514399e-2  rho 334080000
20530209          2.514399e-2  rho 334090000
20530210          0.0350607    rho 334100000
*
20530300  ls3mas   sum    1.0    33.62865 1
20530301  0.0     4.581090e-3   rho 335010000
20530302          8.911746e-3   rho 335020000
20530303          8.911746e-3   rho 335030000
20530304          2.531684e-3   rho 335040000
20530305          5.068836e-3   rho 335050000
20530306          3.548732e-3   rho 335060000
20530307          3.827600e-3   rho 335070000
20530308          2.148924e-3   rho 335080000
20530309          2.148924e-3   rho 335090000
20530310          2.854296e-3   rho 335100000
*
20539300  ls3mas1  sum   1.0    30.06176 1
20539301  0.0     2.900227e-3   rho 335110000
20539302          2.717596e-3   rho 335120000
20539303          8.967520e-3   rho 335130000
20539304          2.717596e-3   rho 335140000
20539305          2.900227e-3   rho 335150000
20539306          2.854296e-3   rho 335160000
20539307          2.148924e-3   rho 335170000
20539308          2.148924e-3   rho 335180000
20539309          3.827600e-3   rho 335190000
20539310          3.548782e-3   rho 335200000
20539311          5.068836e-3   rho 335210000
*
20530400  cl3mas   sum    1.0    44.5304  1
20530401   0.0     7.813000e-3   rho 336010000
20530402           5.144000e-3   rho 642010000
20530403           1.668943e-2   rho 337010000
20530404           9.394024e-3   rho 337020000
20530405           5.468000e-3   rho 338010000
20530406           8.574480e-3   rho 339010000
20530407           5.860165e-3   rho 339020000
*
*-------------------------------------------------------------*
*
*  steam generator 3 parameters
*
*-------------------------------------------------------------*
*
*  steam generator 3 - primary delta T
*
20530500  dtsg3    sum    1.0   30.1628  1
20530501  0.0      1.0    tempf 333030000
20530502          -1.0    tempf 335010000
*
*-------------------------------------------------------------*
*
*  Steam generator level from height times void in riser
*
20531000  sg3lv    sum    1.0   10.4655  1
20531001  0.0  2.43125   voidf 360010000
20531002       2.43125   voidf 360020000
20531003       2.43125   voidf 360030000
20531004       3.50875   voidf 360040000
20531005       0.9875    voidf 361010000
20531006       0.80275   voidf 361020000
20531007       0.80275   voidf 361030000
20531008       0.675     voidf 362010000
20531009       1.1425    voidf 368010000
*
*-------------------------------------------------------------*
*
*  Steam generator level from height times void in downcomer
*
20531100  sg3lvd   sum    1.0   14.0346  1
20531101  0.0   1.68725   voidf 367010000
20531102        2.43125   voidf 367020000
20531103        2.43125   voidf 367030000
20531104        2.43125   voidf 367040000
20531112        1.9815    voidf 366010000
20531113        0.8275    voidf 365010000
20531114        1.6055    voidf 364010000
20531115        0.3375    voidf 363010000
20531116        0.3375    voidf 362010000
20531117        1.1425    voidf 368010000
*
*-------------------------------------------------------------*
*
*  Steam generator level from dp4r2
*
20531200  s3lvdpa  sum    1.0   1965.447 1
20531201  0.0   10.1937  cntrlvar 338
* NOTE:  cntrlvar 338 is presently in hPa thus the factor in front
*     has been multiplied by 100.  When cntrlvar is later
*     expressed in kPa, the factor will have to be multiplied
*     by 1000.
20531202        -3.458    rhog  368010000
*
20531300  s3lvdpb  sum    1.0   708.532  1
20531301  0.0     0.2    rhof  365010000
20531302         +0.2    rhof  364010000
20531303         +0.2    rhof  363010000
20531304         +0.2    rhof  362010000
20531305         +0.2    rhof  368010000
20531306         -1.0    rhog  368010000
*
20531400  s3lvdpc  div    1.0   2.77397  1
20531401  cntrlvar 313   cntrlvar 312
*
```

```
20531500 sg3lvdp sum 1.0 14.02897 1
20531501 11.255 1.0 cntrlvar 314
*
*------------------------------------------------------------*
*
* Loop 3 differential pressures
*
20533100 dp3 sum 1.e-2 33.20906 1
20533101 0.0 1.0 p 339020000
20533102 -1.0 p 331010000
20533103 +.0981 rho 339020000
*
20533200 dp32pg sum 1.e-2 -19.00217 1
20533201 0.0 1.0 p 335210000
20533202 -1.0 p 337010000
20533203 -1.219874 rho 335210000
*
20533300 dp32vg sum 1.e-2 241.416 1
20533301 0.0 1.0 p 335120000
20533302 -1.0 p 335020000
20533303 +0.13734 rho 335120000
20533304 -3.140672 rho 335020000
*
20533400 dp32vp sum 1.e-2 133.399 1
20533401 0.0 1.0 p 335120000
20533402 -1.0 p 335210000
20533403 +0.13734 rho 335120000
20533404 -1.219874 rho 335210000
*
20533500 dp6 sum 1.e-2 25.06285 1
20533501 0.0 1.0 p 334010000
20533502 -1.0 p 334100000
20533503 -2.4132 rho 334010000
20533504 +2.4132 rho 334100000
*
20533600 dp61 sum 1.e-2 69.0506 1
20533601 0.0 1.0 p 333030000
20533602 -1.0 p 334010000
20533603 +1.4731 rho 333030000
20533604 +2.4132 rho 334010000
*
20533700 dp626 sum 1.e-2 796.225 1
20533701 0.0 1.0 p 334010000
20533702 -1.0 p 334050000
20533703 -2.4132 rho 334010000
20533704 +20.479 rho 334050000
*
20533800 dp6r2 sum 1.e-2 204.85 1
20533801 0.0 1.0 p 365010000
20533802 -1.0 p 368010000
20533803 +1.18946 rho 365010000
20533804 +0.69896 rho 368010000
*
20534100 dp31h sum 1.e-2 1.233763 1
20534101 0.0 1.0 p 331010000
20534102 -1.0 p 333010000
20534103 +0.1177 rho 333010000
*
20534200 dp31v sum 1.e-2 100.7485 1
20534201 0.0 1.0 p 333010000
20534202 -1.0 p 333030000
20534203 -0.1177 rho 333010000
20534204 -1.9214 rho 333030000
*
20534300 dp636 sum 1.e-2 776.655 1
20534301 0.0 1.0 p 334100000
20534302 -1.0 p 334060000
20534303 -2.4132 rho 334100000
20534304 +20.479 rho 334060000
*
20534400 dp64 sum 1.e-2 73.7269 1
20534401 0.0 1.0 p 335010000
20534402 -1.0 p 334100000
20534403 +2.07825 rho 335010000
20534404 +2.4132 rho 334100000
*
20534500 dp33h sum 1.e-2 1.159817 1
20534501 0.0 1.0 p 337010000
20534502 -1.0 p 339020000
*
20534600 dp623 sum 1.e-2 718.008 1
20534601 0.0 1.0 p 334010000
20534602 -1.0 p 334050000
20534603 -2.4132 rho 334010000
20534604 +10.0317 rho 334050000
*
20534700 dp633 sum 1.e-2 698.118 1
20534701 0.0 1.0 p 334100000
20534702 -1.0 p 334060000
20534703 -2.4132 rho 334100000
20534704 +10.0317 rho 334060000
*
20534800 dp6 sum 1.e-2 -25.06285 1
20534801 0.0 1.0 p 334100000
20534802 -1.0 p 334010000
20534803 -2.4132 rho 334100000
20534804 +2.4132 rho 334010000
*******************************************************
* Control Variables for BETHSY test 6.2 TC by Chul. J. Choi
************************************************************
*
* Primary pressure at Pressurizer Top (bar)
*
20505200 ppb sum 1.e-5 153.8273 1
20505201 0.0 1.0 p 051050000
20505202 +10.1582 rho 051050000
*
* Secondary Pressure at S/G Dome (bar)
*
20515000 p47b sum 1.e-5 68.0888 1
20515001 0.0 1.0 p 168010000
20515002 +0.69896 rho 168010000
*
20525000 p57b sum 1.e-5 68.0881 1
20525001 0.0 1.0 p 268010000
20525002 +0.69896 rho 268010000
*
20535000 p67b sum 1.e-5 68.0912 1
20535001 0.0 1.0 p 368010000
20535002 +0.69896 rho 368010000
*
* Steam Generator DP (wide range) (hPa)
*
20514900 dp4r1 sum 1.e-2 757.839 1
20514901 0.0 1.0 p 167040000
20514902 -1.0 p 168010000
20514903 +8.98228 rho 167040000
20514904 +0.69896 rho 168010000
*
20524900 dp5r1 sum 1.e-2 758.556 1
20524901 0.0 1.0 p 267040000
20524902 -1.0 p 268010000
20524903 +8.98228 rho 267040000
20524904 +0.69896 rho 268010000
*
20534900 dp6r1 sum 1.e-2 755.568 1
20534901 0.0 1.0 p 367040000
20534902 -1.0 p 368010000
20534903 +8.98228 rho 367040000
20534904 +0.69896 rho 368010000
*
* Accumulator DP (hPa)
*
20526100 dpsm2a sum 1.0 951.914 1
20526101 0.0 +1.0 rhof 240010000
20526102 -1.0 rhog 240010000
*
20526200 dpsm2b mult 1.0 5270.25 1
20526201 cntrlvar 260
20526202 cntrlvar 261
*
20526300 dpsm2 sum 9.81e-2 555.923 1
20526301 0.0 1.0 cntrlvar 262
20526302 +8.211 rhog 240010000
*
20536100 dpsm3a sum 1.0 951.832 1
20536101 0.0 +1.0 rhof 340010000
20536102 -1.0 rhog 340010000
*
20536200 dpsm3b mult 1.0 5184. 1
20536201 cntrlvar 360
20536202 cntrlvar 361
*
20536300 dpsm3 sum 9.81e-2 547.648 1
20536301 0.0 1.0 cntrlvar 362
20536302 +8.211 rhog 340010000
*
* Vapor volumetric flow rate at S/Gs (l/s)
*
20515600 qgvl1 div 1000. 14.42602 1
```

```
20515601 rhogj   468000000  mflowj 468000000
*
20525600 qgv12   div   1000.   14.3847 1
20525601 rhogj   568000000  mflowj 568000000
*
20535600 qgv13   div   1000.   14.38394 1
20535601 rhogj   668000000  mflowj 568000000
*
*  Integrateed Break mass flow (kg)
*
20507000  intqmb  integral  1.0  0.  1
20507001  mflowj  153000000
*
******************************************************
*    Control Variables for ISP27 by Chul. J. Choi
******************************************************
*
*  Integrated LPSI Mass Flow (kg)
*
*20507100  intqmsi2  integral  1.0  0.0  1
*20507101  mflowj   586000000
*20507200  intqmsi3  integral  1.0  0.0  1
*20507201  mflowj   686000000
*20507300  intqmsi  sum     1.0  0.0  1
*20507301  0.0     1.0     cntrlvar 71
*20507302        +1.0     cntrlvar 72
*
*  Steam Generator Secondary Side Mass Inventory (kg)
*
20517000  mgv1    sum     1.0  941.81  1
20517001  0.0     0.13995   rho  160010000
20517002        +0.13995   rho  160020000
20517003        +0.13995   rho  160030000
20517004        +0.20198   rho  160040000
20517005        +5.0807e-2 rho  161010000
20517006        +3.9111e-2 rho  161020000
20517007        +3.9111e-2 rho  161030000
20517008        +0.18609   rho  162010000
20517009        +0.14922   rho  163010000
20517010        +0.15856   rho  164010000
20517011        +8.172e-2  rho  165010000
20517012        +6.336e-2  rho  166010000
20517013        +9.84679e-3 rho  167010000
20517014        +1.41888e-2 rho  167020000
20517015        +1.41888e-2 rho  167030000
20517016        +1.7078e-2 rho  167040000
20517017        +0.50726   rho  168010000
*
20527000  mgv2    sum     1.0  943.163  1
20527001  0.0     0.13995   rho  260010000
20527002        +0.13995   rho  260020000
20527003        +0.13995   rho  260030000
20527004        +0.20198   rho  260040000
20527005        +5.0807e-2 rho  261010000
20527006        +3.9111e-2 rho  261020000
20527007        +3.9111e-2 rho  261030000
20527008        +0.18609   rho  262010000
20527009        +0.14922   rho  263010000
20527010        +0.15856   rho  264010000
20527011        +8.172e-2  rho  265010000
20527012        +6.336e-2  rho  266010000
20527013        +9.84679e-3 rho  267010000
20527014        +1.41888e-2 rho  267020000
20527015        +1.41888e-2 rho  267030000
20527016        +1.7078e-2 rho  267040000
20527017        +0.50726   rho  268010000
*
20537000  mgv3    sum     1.0  937.78  1
20537001  0.0     0.13995   rho  360010000
20537002        +0.13995   rho  360020000
20537003        +0.13995   rho  360030000
20537004        +0.20198   rho  360040000
20537005        +5.0807e-2 rho  361010000
20537006        +3.9111e-2 rho  361020000
20537007        +3.9111e-2 rho  361030000
20537008        +0.18609   rho  362010000
20537009        +0.14922   rho  363010000
20537010        +0.15856   rho  364010000
20537011        +8.172e-2  rho  365010000
20537012        +6.336e-2  rho  366010000
20537013        +9.84679e-3 rho  367010000
20537014        +1.41888e-2 rho  367020000
20537015        +1.41888e-2 rho  367030000
20537016        +1.7078e-2 rho  367040000
20537017        +0.50726   rho  368010000
```

```
*
*  Accumulator mass inventory (kg)
*
20527100  msm2i   integral  1.0  0.  1
20527101  mflowj  240010000
20527200  msm2    sum  1.  292.879  1
20527201  292.87878    -1.  cntrlvar 271
*
20537100  msm3i   integral  1.0  0.  1
20537101  mflowj  340010000
20537200  msm3    sum  1.  292.879  1
20537201  292.87878    -1.  cntrlvar 371
*
*  Primary pressure at Pressurizer Top (MPa)
*
20507400  pp     sum  1.e-6  15.38172  1
20507401  0.0    1.0     p  051050000
20507402       +0.1422   rho 051050000
*
*  Secondary Pressure at S/G Dome (MPa)
*
20517300  p47    sum  1.e-6  6.80888  1
20517301  0.0    1.0     p  168010000
20517302       +0.69896  rho 168010000
*
20527300  p57    sum  1.e-6  6.80881  1
20527301  0.0    1.0     p  268010000
20527302       +0.69896  rho 268010000
*
20537300  p67    sum  1.e-6  6.80912  1
20537301  0.0    1.0     p  368010000
20537302       +0.69896  rho 368010000
*
*  Accumulator gas phase pressure (MPa)
*
20527400  psm2   sum  1.e-6  4.17156  1
20527401  0.0    1.0     p  240010000
20527402       -40.93713  rho 240010000
*
20537400  psm3   sum  1.e-6  4.18193  1
20537401  0.0    1.0     p  340010000
20537402       -40.93713  rho 340010000
*
*  Specific Enthalpy at Break (KJ/kg)
*
20507500  seb1   sum  1.0    1196297. 1
20507501  0.0    1.0     ug  152010000
20507502       -1.0      uf  152010000
*
20507600  seb2   mult 1.0   -438118.  1
20507601  quale  152010000
20507602  cntrlvar 75
*
20507700  seb3   div  1.0   20595.47 1
20507701  rho     152010000
20507702  p       152010000
*
20507800  sebreak sum  1.0e-3 835.098  1
20507801  0.0    1.0     uf  152010000
20507802        +1.0     cntrlvar  76
20507803        +1.0     cntrlvar  77
*
*  Fluid temperature (K)
*
20507900  tf012al sum  1.0   557.784  1
20507901  0.0    0.2749   tempf 012010000
20507902       +0.7251   tempf 013010000
*
20508000  tf012ag sum  1.0   617.87  1
20508001  0.0    0.2749   tempg 012010000
20508002       +0.7251   tempg 013010000
*
20508100  tf0304l sum  1.0   588.779  1
20508101  0.0    0.2816   tempf 099010000
20508102       +0.7184   tempf 015010000
*
20508200  tf0304g sum  1.0   617.674  1
20508201  0.0    0.2816   tempg 099010000
20508202       +0.7184   tempg 015010000
*
20508300  tf041f  sum  1.0   581.152  1
20508301  0.0    0.7731   tempf 016010000
20508302       +0.2269   tempf 018010000
*
20508400  tf041g  sum  1.0   617.604  1
```

```
20508401 0.0    0.7731  tempg 016010000
20508402        +0.2269 tempg 018010000
*
20508500 tf042f sum  1.0  577.43  1
20508501 0.0    0.5484  tempf 016010000
20508502        +0.4516 tempf 018010000
*
20508600 tf042g sum  1.0  617.591 1
20508601 0.0    0.5484  tempg 016010000
20508602        +0.4516 tempg 018010000
*
20517500 tf454cf sum  1.0  555.601 1
20517501 0.0    1.3766  tempf 167040000
20517502        -0.3766 tempf 167030000
*
20517600 tf454cg sum  1.0  557.8  1
20517601 0.0    1.3766  tempg 167040000
20517602        -0.3766 tempg 167030000
*
20527500 tf554cf sum  1.0  555.598 1
20527501 0.0    1.3766  tempf 267040000
20527502        -0.3766 tempf 267030000
*
20527600 tf554cg sum  1.0  557.8  1
20527601 0.0    1.3766  tempg 267040000
20527602        -0.3766 tempg 267030000
*
20537500 tf654cf sum  1.0  555.608 1
20537501 0.0    1.3766  tempf 367040000
20537502        -0.3766 tempf 367030000
*
20537600 tf654cg sum  1.0  557.8  1
20537601 0.0    1.3766  tempg 367040000
20537602        -0.3766 tempg 367030000
*
*  Rod temperature (K)
*
20508700 ts0209l sum  1.0  593.619 1
20508701 0.0    0.7644  httemp 013100708
20508702        +0.2356 httemp 013100808
*
20508800 ts0215l sum  1.0  596.338 1
20508801 0.0    0.772   httemp 013100908
20508802        +0.228  httemp 013101008
*
20508900 ts0219l sum  1.0  595.012 1
20508901 0.0    0.2395  httemp 013101008
20508902        +0.7605 httemp 013101108
*
20509000 ts0220l sum  1.0  594.505 1
20509001 0.0    0.7797  httemp 013101108
20509002        +0.2203 httemp 013101208
*
20509100 ts0224l sum  1.0  593.717 1
20509101 0.0    0.3238  httemp 013101208
20509102        +0.6762 httemp 013101308
*
20509200 ts0228l sum  1.0  594.709 1
20509201 0.0    1.215   httemp 013101408
20509202        -0.215  httemp 013101308
*
*  Pump velocity (rpm)
*
20517700 vp1  . sum   9.5493  237.8836  1
20517701 0.0    1.0   pmpvel  136
*
20527700 vp2    sum   9.5493  236.9926  1
20527701 0.0    1.0   pmpvel  236
*
20537700 vp3    sum   9.5493  240.8534  1
20537701 0.0    1.0   pmpvel  336
*
*  Core $ Lower Plenum Collapsed Level from DP0200 (m)
*
20506000 clpdpa sum    1.0    3844.5    1
20506001 0.0    10.1937    cntrlvar    25
20506002        -5.81      rhog    099010000
*
20506100 clpdpb sum    1.0    620.979   1
20506101 0.0    0.05263157    rhof    011010000
20506102        +0.05263157   rhof    012010000
20506103        +0.05263157   rhof    013010000
20506104        +0.05263157   rhof    013020000
20506105        +0.05263157   rhof    013030000
20506106        +0.05263157   rhof    013040000
20506107        +0.05263157   rhof    013050000
20506108        +0.05263157   rhof    013060000
20506109        +0.05263157   rhof    013070000
20506110        +0.05263157   rhof    013080000
20506111        +0.05263157   rhof    013090000
20506112        +0.05263157   rhof    013100000
20506113        +0.05263157   rhof    013110000
20506114        +0.05263157   rhof    013120000
20506115        +0.05263157   rhof    013130000
20506116        +0.05263157   rhof    013140000
20506117        +0.05263157   rhof    013150000
20506118        +0.05263157   rhof    013160000
20506119        +0.05263157   rhof    099010000
20506120        -1.0          rhog    099010000
*
20506200 clpdpc div    1.0    6.19103   1
20506201 cntrlvar 61    cntrlvar 60
*
20506300 zt0200 sum    1.0    6.59103   1
20506301 0.4    1.0    cntrlvar    62
*
*  Core Collapsed Liquid Level in the heated Length from DP0200
*
20506400 dpch    sum    1.0e-2  256.3864  1
20506401 0.0     1.0     p     013020000
20506402         -1.0    p     013150000
20506403         +1.60148  rho    013020000
20506404         -0.96383  rho    013150000
*
20506500 clhdpa  sum    1.0    2242.27   1
20506501 0.0     10.1937   cntrlvar    64
20506502         -3.656    rhog    013150000
*
*
20506600 clhdpb  sum    1.0    618.178   1
20506601 0.0     0.071429    rhof    013020000
20506602         +0.071429   rhof    013030000
20506603         +0.071429   rhof    013040000
20506604         +0.071429   rhof    013050000
20506605         +0.071429   rhof    013060000
20506606         +0.071429   rhof    013070000
20506607         +0.071429   rhof    013080000
20506608         +0.071429   rhof    013090000
20506609         +0.071429   rhof    013100000
20506610         +0.071429   rhof    013110000
20506611         +0.071429   rhof    013120000
20506612         +0.071429   rhof    013130000
20506613         +0.071429   rhof    013140000
20506614         +0.071429   rhof    013150000
20506615         -1.0        rhog    013150000
*
20506700 clevhdp div    1.0    3.62722   1
20506701 cntrlvar 66    cntrlvar 65
*
*  Swollen Level in the Core (m)
*
480    httemp  014100201  le  sattemp  013010000  0.0 n
481    httemp  014100301  le  sattemp  013020000  0.0 n
482    httemp  014100401  le  sattemp  013030000  0.0 n
483    httemp  014100501  le  sattemp  013040000  0.0 n
484    httemp  014100601  le  sattemp  013050000  0.0 n
485    httemp  014100701  le  sattemp  013060000  0.0 n
486    httemp  014100801  le  sattemp  013070000  0.0 n
487    httemp  014100901  le  sattemp  013080000  0.0 n
488    httemp  014101001  le  sattemp  013090000  0.0 n
489    httemp  014101101  le  sattemp  013100000  0.0 n
490    httemp  014101201  le  sattemp  013110000  0.0 n
491    httemp  014101301  le  sattemp  013120000  0.0 n
492    httemp  014101401  le  sattemp  013130000  0.0 n
493    httemp  014101501  le  sattemp  013140000  0.0 n
*
20548000 sw00   tripunit  1.0   1.    1
20548001 480
20548100 sw01   tripunit  1.0   1.    1
20548101 481
20548200 sw02   tripunit  1.0   1.    1
20548201 482
20548300 sw03   tripunit  1.0   1.    1
20548301 483
20548400 sw04   tripunit  1.0   1.    1
20548401 484
20548500 sw05   tripunit  1.0   1.    1
20548501 485
20548600 sw06   tripunit  1.0   1.    1
20548601 486
```

```
20548700 sw07    tripunit  1.0   1.     1
20548701 487
20548800 sw08    tripunit  1.0   1.     1
20548801 488
20548900 sw09    tripunit  1.0   1.     1
20548901 489
20549000 sw10    tripunit  1.0   1.     1
20549001 490
20549100 sw11    tripunit  1.0   1.     1
20549101 491
20549200 sw12    tripunit  1.0   1.     1
20549201 492
20549300 sw13    tripunit  1.0   1.     1
20549301 493
*
20509300 zscore sum      1.0  5.82    1
20509301 2.164  0.3265     cntrlvar    480
20509302       +0.3265    cntrlvar    481
20509303       +0.261    cntrlvar    482
20509304       +0.261    cntrlvar    483
20509305       +0.261    cntrlvar    484
20509306       +0.261    cntrlvar    485
20509307       +0.261    cntrlvar    486
20509308       +0.261    cntrlvar    487
20509309       +0.261    cntrlvar    488
20509310       +0.261    cntrlvar    489
20509311       +0.261    cntrlvar    490
20509312       +0.261    cntrlvar    491
20509313       +0.1965    cntrlvar    492
20509314       +0.1965    cntrlvar    493
*
20509400 corelvl sum       1.0  3.656   1
20509401 0.0    0.3265    voidf   013020000
20509402       +0.3265    voidf   013030000
20509403       +0.261     voidf   013040000
20509404       +0.261     voidf   013050000
20509405       +0.261     voidf   013060000
20509406       +0.261     voidf   013070000
20509407       +0.261     voidf   013080000
20509408       +0.261     voidf   013090000
20509409       +0.261     voidf   013100000
20509410       +0.261     voidf   013110000
20509411       +0.261     voidf   013120000
20509412       +0.261     voidf   013130000
20509413       +0.1965    voidf   013140000
20509414       +0.1965    voidf   013150000
*
*  Control variables for the quality at the break
*
20550100  liq-pflw  mult  1.0936e-2  5.56144  1  1  1.0e-20
20550101         voidf    137010000
20550102         rhof     137010000
20550103         velf     137010000
*
20550200  vap-pflw  mult  1.0936e-2  1.-20   1  1  1.0e-20
20550201         voidg    137010000
20550202         rhog     137010000
20550203         velg     137010000
*
20550300  tot-pflw   sum       1.0     5.56144   1
20550301  0.0      1.0     cntrlvar   501
20550302          +1.0     cntrlvar   502
*
*  Flow quality at the main pipe
*
20550400  x-pipe     div   1.0  1.798095-21 1  3    0.0   1.0
20550401          cntrlvar  503
20550402          cntrlvar  502
*
20550500  liq-jflw  mult   1.88205e-4  8.91312-6  1  1  1.0e-20
20550501         voidfj    151000000
20550502         rhofj     151000000
20550503         velfj     151000000
*
20550600  vap-jflw  mult   1.88205e-4  1.-20    1  1  1.0e-20
20550601         voidgj    151000000
20550602         rhogj     151000000
20550603         velgj     151000000
*
20550700  tot-jflw   sum       1.0     8.91312-6  1
20550701  0.0      1.0     cntrlvar   505
20550702          +1.0     cntrlvar   506
*
*  Flow quality at the break junction
*
```

```
20550800  x-jun     div   1.0  1.121942-15 1  3   0.0  1.0
20550801          cntrlvar  507
20550802          cntrlvar  506
*
20550900  gdrho    sum       9.81     6416.25  1
20550901  0.0      1.0     rhof    137010000
20550902          -1.0     rhog    137010000
*
20551000  wfwf     mult      1.0    30.92963  1  1  1.0e-20
20551001  cntrlvar  501    cntrlvar  501
*
20551100  wgwg     mult     1.0    1.-20    1  1  1.0e-20
20551101  cntrlvar  502    cntrlvar  502
*
20551200  rfgdrho   mult     1.0    4847599.  1  1  1.0e-20
20551201  cntrlvar  509    rhof     137010000
*
20551300  rggdrho   mult     1.0    651032.  1  1  1.0e-20
20551301  cntrlvar  509    rhog     137010000
*
20551400  wfwfrfgd  div     1.0    6.3804-6  1  1  1.0e-20
20551401  cntrlvar  512    cntrlvar  510
*
20551500  wgwgrggd  div     1.0    1.-20    1  1  1.0e-20
20551501  cntrlvar  513    cntrlvar  511
*
*  Calculate for critical height/depth hb
*
20551600  wfwfp2   powerr  0.75   .059    1  3  5.64e-3  0.059
20551601  cntrlvar  514    0.2
*
20551700  wgwgp2   powerr  0.69   .00564  1  3  5.64e-3  0.059
20551701  cntrlvar  515    0.2
*
*   Calculate for level height above main pipe center
*
20552000  lhgt    function  1.0  .5   1  3  -0.5  0.5
20552001  voidg   137010000  002
*
*   Table to relate liquid height to void fraction
*
20200200  reac-t  0
*       void fraction       height from center
20200201  0.000000000000e+00  5.000000000000e-01
20200202  8.184178458320e-04  4.938441702975e-01
20200203  6.451071621177e-03  4.755282581475e-01
20200204  2.124094630001e-02  4.455032620938e-01
20200205  4.863465427216e-02  4.045084971869e-01
20200206  9.084505690862e-02  3.535533905924e-01
20200207  1.486346542727e-01  2.938926261450e-01
20200208  2.212409463010e-01  2.269952498682e-01
20200209  3.064510716225e-01  1.545084971855e-01
20200210  4.008184178474e-01  7.821723251785e-02
20200211  5.000000000000e-01  0.000000000000e+00
20200212  5.991815821557e-01  -7.821723252289e-02
20200213  6.935489283801e-01  -1.545084971904e-01
20200214  7.787590537009e-01  -2.269952498727e-01
20200215  8.513653457283e-01  -2.938926261491e-01
20200216  9.091549430914e-01  -3.535533905960e-01
20200217  9.513653457268e-01  -4.045084971899e-01
20200218  9.787590536981e-01  -4.455032620962e-01
20200219  9.935489283762e-01  -4.755282581490e-01
20200220  9.991815821511e-01  -4.938441702983e-01
20200221  1.000000000000e+00  -5.000000000000e-01
*
20552100  h       sum      0.118   .059    1
20552101  0.0     1.0     cntrlvar  520
*
20552200  unitvpt  tripunit  1.0    1.    1
20552201  501
501     cntrlvar  521  ge    null  0    0.0    n
*
20552300  unitlige  sum     1.0    0.    1
20552301  1.0    -1.0     cntrlvar  522
*
20552400  uwfwfp2   mult     1.0   .059     1
20552401  cntrlvar  516    cntrlvar  522
*
20552500  uwgwgp2   mult     1.0   0.      1
20552501  cntrlvar  517    cntrlvar  523
*
20552600  hb      sum      1.0   .059    1
20552601  0.0     1.0     cntrlvar  524
20552602         +1.0     cntrlvar  525
*
```

```
20552700  h/hb    div   1.0   1.    1  3  -1.0  1.0
20552701  cntrlvar   526     cntrlvar  521
*
*   Calculate the environmental heat loss
*
20553000   heatloss   sum      1.0e-3   54.6814  1
20553001   0.0        1.0      q       900010000
*
****************************************************
*
*        PASSIVE HEAT STRUCTURES
*
********************************************************
*
*=*=*=*=*=*=*=
*  heat structure (0071)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10071000   1   5   1   1   0.0
*      mesh flags
10071100   0  1
*     number intervals  right bound
10071101    3          .07213
10071102    1          .17213
*      composition
10071201     1  3
10071202     4  4
*     source interval
10071301   0.0  4
*     temperature mesh no
10071401   558.8  4
10071402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10071501   011010000  00000   1   0   1.5424   1
*right boundary data
10071601   900010000     0   1   0   1.5424   1
*source data
10071701   0   0.0   0.0   0.0  1
*additional boundary data
*             hyd diam
10071801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10071901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0121)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10121000   1   5   1   1   0.0
*      mesh flags
10121100   0  1
*     number intervals  right bound
10121101    3          .00237
10121102    1          .10237
*      composition
10121201     1  3
10121204     4  4
*     source interval
10121301   0.0  4
*     temperature mesh no
10121401   558.8  4
10121402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10121501   012010000    0     1   0   14.51002  1
*right boundary data
10121601   900010000     0   1   0   14.51002  1
*source data
10121701   0   0.0   0.0   0.0  1
*additional boundary data
*             hyd diam
10121801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10121901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0031)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10031000   1   5   1   1   0.0
*      mesh flags
10031100   0  1
*      number intervals  right bound
10031101    3          .00232
10031102    1          .10232
*      composition
10031201     1  3
10031202     4  4
*     source interval
10031301   0.0  4
*     temperature mesh no
10031401   558.8  4
10031402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10031501   013010000  00000   1   0   1.5254   1
*right boundary data
10031601   900010000     0   1   0   1.5254   1
*source data
10031701   0   0.0   0.0   0.0  1
*additional boundary data
*             hyd diam
10031801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10031901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0161)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10161000   1   5   1   1   0.0
*      mesh flags
10161100   0  1
*     number intervals  right bound
10161101    3          .00215
10161102    1          .10215
*      composition
10161201     1  3
10161202     4  4
*     source interval
10161301   0.0  4
*     temperature mesh no
10161401   558.8  4
10161402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10161501   013160000  00000   1   0   3.610   1
*right boundary data
10161601   900010000     0   1   0   3.610   1
*source data
10161701   0   0.0   0.0   0.0  1
*additional boundary data
*             hyd diam
10161801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10161901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0041)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10041000   1   5   1   1   0.0
*      mesh flags
10041100   0  1
*     number intervals  right bound
10041101    3          .08588
10041102    1          .18588
*      composition
10041201     1  3
10041202     4  4
*     source interval
10041301   0.0  4
*     temperature mesh no
10041401   558.8  4
10041402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10041501   014010000  00000   1   0   0.11851  1
*right boundary data
10041601   900010000     0   1   0   0.11851  1
*source data
10041701   0   0.0   0.0   0.0  1
*additional boundary data
*             hyd diam
10041801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10041901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
```

```
* heat structure (0051)
*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10051000   1   5   1   1   0.0
*     mesh flags
10051100   0  1
*     number intervals  right bound
10051101    3       .05071
10051102    1       .15071
*     composition
10051201    1  3
10051202    4  4
*     source interval
10051301   0.0  4
*     temperature mesh no
10051401   558.8  4
10051402   500.0  5
*left boundary data
*     bound vol   incr   bc  area code factor structure no
10051501   014020000   00000   1   0   0.35181  1
*right boundary data
10051601   900010000      0   1   0   0.35181  1
*source data
10051701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
10051801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10051901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=*=
* heat structure (0061)
*=*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10061000  14   5   1   1   0.0
*     mesh flags
10061100   0  1
*     number intervals  right bound
10061101    3       .03029
10061102    1       .13029
*     composition
10061201    1  3
10061202    4  4
*     source interval
10061301   0.0  4
*     temperature mesh no
10061401   558.8  4
10061402   500.0  5
*left boundary data
*     bound vol   incr   bc  area code factor structure no
10061501   014030000   10000   1   0   0.28125  11
10061502   014140000   10000   1   0   0.21174  13
10061503   014160000   00000   1   0   0.37715  14
*right boundary data
10061601   900010000      0   1   0   0.28125  11
10061602   900010000      0   1   0   0.21174  13
10061603   900010000      0   1   0   0.37715  14
*source data
10061701   0   0.0   0.0   0.0  14
*additional boundary data
*          hyd diam
10061801  0.0 10. 10. 0. 0. 0. 0. 1.0 14
10061901  0.0 10. 10. 0. 0. 0. 0. 1.0 14
*
*=*=*=*=*=*=*=*=
* heat structure (0991)
*=*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10991000   1   5   1   1   0.0
*     mesh flags
10991100   0  1
*     number intervals  right bound
10991101    3       .03123
10991102    1       .13123
*     composition
10991201    1  3
.10991202    4  4
*     source interval
10991301   0.0  4
*     temperature mesh no
10991401   558.8  4
10991402   500.0  5
*left boundary data
*     bound vol   incr   bc  area code factor structure no
10991501   099010000   00000   1   0   1.08765  1
*right boundary data
10991601   900010000      0   1   0   1.08765  1
*source data
10991701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
10991801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10991901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=*=
* heat structure (0151)
*=*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10151000   1   5   1   1   0.0
*     mesh flags
10151100   0  1
*     number intervals  right bound
10151101    3       .03189
10151102    1       .13189
*     composition
10151201    1  3
10151202    4  4
*     source interval
10151301   0.0  4
*     temperature mesh no
10151401   558.8  4
10151402   500.0  5
*left boundary data
*     bound vol   incr   bc  area code factor structure no
10151501   015010000   00000   1   0   0.11509  1
*right boundary data
10151601   900010000      0   1   0   0.11509  1
*source data
10151701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
10151801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10151901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=*=
* heat structure (0161)
*=*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10161000   1   5   1   1   0.0
*     mesh flags
10161100   0  1
*     number intervals  right bound
10161101    3       .03226
10161102    1       .13226
*     composition
10161201    1  3
10161202    4  4
*     source interval
10161301   0.0  4
*     temperature mesh no
10161401   558.8  4
10161402   500.0  5
*left boundary data
*     bound vol   incr   bc  area code factor structure no
10161501   016010000   00000   1   0   1.3356   1
*right boundary data
10161601   900010000      0   1   0   1.3356   1
*source data
10161701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
10161801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10161901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=*=
* heat structure (0181)
*=*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
10181000   1   5   1   1   0.0
*     mesh flags
10181100   0  1
*     number intervals  right bound
10181101    3       .04986
10181102    1       .14986
*     composition
```

```
10181201    1  3
10181202    4  4
*       source interval
10181301   0.0  4
*       temperature mesh no
10181401   558.8   4
10181402   500.0   5
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10181501   018010000   00000    1    0    0.54926  1
*right boundary data
10181601   900010000      0    1    0    0.54926  1
*source data
10181701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10181801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10181901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0191)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10191000   1   5   1   1   0.0
*       mesh flags
10191100   0  1
*       number intervals  right bound
10191101    3          .05941
10191102    1          .15941
*          composition
10191201    1  3
10191202    4  4
*       source interval
10191301   0.0  4
*       temperature mesh no
10191401   558.8   4
10191402   500.0   5
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10191501   019010000   00000    1    0    1.67134  1
*right boundary data
10191601   900010000      0    1    0    1.67134  1
*source data
10191701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10191801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10191901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0081)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10081000   1   4   1   1   0.0
*       mesh flags
10081100   0  1
*       number intervals  right bound
10081101    3          .005
*          composition
10081201    1  3
*       source interval
10081301   0.0  3
*       temperature mesh no
10081401   558.8   4
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10081501   012010000   00000    1    0    1.1525   1
*right boundary data
10081601   022100000   00000    1    0    1.1525   1
*source data
10081701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10081801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10081901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0091)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10091000   1   4   1   1   0.0
*       mesh flags
10091100   0  1
*       number intervals  right bound
10091101    3          .01414
*          composition
10091201    1  3
*       source interval
10091301   0.0  3
*       temperature mesh no
10091401   558.8   4
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10091501   016010000   00000    1    0    1.16725  1
*right boundary data
10091601   019010000   00000    1    0    1.16725  1
*source data
10091701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10091801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10091901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0201)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10201000   1   5   1   1   0.0
*       mesh flags
10201100   0  1
*       number intervals  right bound
10201101    3          .04823
10201102    1          .14823
*          composition
10201201    1  3
10201202    4  4
*       source interval
10201301   0.0  4
*       temperature mesh no
10201401   558.8   4
10201402   500.0   5
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10201501   020010000   00000    1    0    72.0995e-2   1
*right boundary data
10201601   900010000      0    1    0    72.0995e-2   1
*source data
10201701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10201801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10201901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0211)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10211000   1   5   1   1   0.0
*       mesh flags
10211100   0  1
*       number intervals  right bound
10211101    3          .01069
10211102    1          .11069
*          composition
10211201    1  3
10211202    4  4
*       source interval
10211301   0.0  4
*       temperature mesh no
10211401   558.8   4
10211402   500.0   5
*left boundary data
*          bound vol   incr    bc  area code factor structure no
10211501   021010000   00000    1    0   27.8406e-2   1
*right boundary data
10211601   900010000      0    1    0   27.8406e-2   1
*source data
10211701   0   0.0    0.0     0.0  1
*additional boundary data
*              hyd diam
10211801  0.0 10.  10. 0. 0. 0. 0. 1.0 1
10211901  0.0 10.  10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0311)
```

```
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10311000   1   5   1   1   0.0
*      mesh flags
10311100   0  1
*      number intervals  right bound
10311101     3          .00648
10311102     1          .10648
*      composition
10311201     1  3
10311202     4  4
*      source interval
10311301   0.0  4
*      temperature mesh no
10311401   558.8  4
10311402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10311501   021020000  00000   1   0   18.5692e-2   1
*right boundary data
10311601   900010000      0   1   0   18.5692e-2   1
*source data
10311701   0   0.0   0.0   0.0  1
*additional boundary data
*         hyd diam
10311801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10311901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0321)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10321000   1   5   1   1   0.0
*      mesh flags
10321100   0  1
*      number intervals  right bound
10321101     3          .2165
10321102     1          .3165
*      composition
10321201     1  3
10321202     4  4
*      source interval
10321301   0.0  4
*      temperature mesh no
10321401   558.8  4
10321402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10321501   021030000  00000   1   0   5.2909e-2   1
*right boundary data
10321601   900010000      0   1   0   5.2909e-2   1
*source data
10321701   0   0.0   0.0   0.0  1
*additional boundary data
*         hyd diam
10321801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10321901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0331)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10331000   1   5   1   1   0.0
*      mesh flags
10331100   0  1
*      number intervals  right bound
10331101     3          .06788
10331102     1          .16788
*      composition
10331201     1  3
10331202     4  4
*      source interval
10331301   0.0  4
*      temperature mesh no
10331401   558.8  4
10331402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10331501   022010000  00000   1   0   18.6840e-2   1
*right boundary data
10331601   900010000      0   1   0   18.6840e-2   1
*source data
10331701   0   0.0   0.0   0.0  1
*additional boundary data
*         hyd diam
10331801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10331901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0221)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10221000   6   5   1   1   0.0
*      mesh flags
10221100   0  1
*      number intervals  right bound
10221101     3          .02048
10221102     1          .12048
*      composition
10221201     1  3
10221202     4  4
*      source interval
10221301   0.0  4
*      temperature mesh no
10221401   558.8  4
10221402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10221501   022020000  00000   1   0   29.6908e-2   1
10221502   022030000  00000   1   0   24.8600e-2   2
10221503   022040000  10000   1   0   28.3649e-2   6
*right boundary data
10221601   900010000      0   1   0   29.6908e-2   1
10221602   900010000      0   1   0   24.8600e-2   2
10221603   900010000      0   1   0   28.3649e-2   6
*source data
10221701   0   0.0   0.0   0.0  6
*additional boundary data
*         hyd diam
10221801  0.0 10. 10. 0. 0. 0. 0. 1.0 6
10221901  0.0 10. 10. 0. 0. 0. 0. 1.0 6
*
*=*=*=*=*=*=*=
*  heat structure (0341)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10341000   1   5   1   1   0.0
*      mesh flags
10341100   0  1
*      number intervals  right bound
10341101     3          .04854
10341102     1          .14854
*      composition
10341201     1  3
10341202     4  4
*      source interval
10341301   0.0  4
*      temperature mesh no
10341401   558.8  4
10341402   500.0  5
*left boundary data
*      bound vol   incr    bc  area code factor structure no
10341501   022080000  00000   1   0   32.2422e-2   1
*right boundary data
10341601   900010000      0   1   0   32.2422e-2   1
*source data
10341701   0   0.0   0.0   0.0  1
*additional boundary data
*         hyd diam
10341801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
10341901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0351)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
10351000   1   5   1   1   0.0
*      mesh flags
10351100   0  1
*      number intervals  right bound
10351101     3          .04559
10351102     1          .14559
*      composition
10351201     1  3
```

```
10351202    4  4
*       source interval
10351301   0.0  4
*       temperature mesh no
10351401   558.8   4
10351402   500.0   5
*left boundary data
*         bound vol   incr    bc  area code factor structure no
10351501   022090000   00000   1   0   24.2230e-2   1
*right boundary data
10351601   900010000      0   1   0   24.2230e-2   1
*source data
10351701   0   0.0    0.0    0.0  1
*additional boundary data
*            hyd diam
10351801  0.0 10.  10.  0.  0.  0.  0.  1.0 1
10351901  0.0 10.  10.  0.  0.  0.  0.  1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0361)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10361000    1   5    1    1    0.0
*       mesh flags
10361100    0  1
*       number intervals  right bound
10361101     3          .04098
10361102     1          .14098
*         composition
10361201     1  3
10361202     4  4
*       source interval
10361301   0.0  4
*       temperature mesh no
10361401   558.8   4
10361402   500.0   5
*left boundary data
*         bound vol   incr    bc  area code factor structure no
10361501   022100000   00000   1   0  131.6400e-2   1
*right boundary data
10361601   900010000      0   1   0  131.6400e-2   1
*source data
10361701   0   0.0    0.0    0.0  1
*additional boundary data
*            hyd diam
10361801  0.0 10.  10.  0.  0.  0.  0.  1.0 1
10361901  0.0 10.  10.  0.  0.  0.  0.  1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0501)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10501000    3   5    1    1    0.0
*       mesh flags
10501100    0  1
*       number intervals  right bound
10501101     3          .01046
10501102     1          .11046
*         composition
10501201     1  3
10501202     4  4
*       source interval
10501301   0.0  4
*       temperature mesh no
10501401   558.8   4
10501402   500.0   5
*left boundary data
*         bound vol   incr    bc  area code factor structure no
10501501   050010000   00000   1   0    11.460e-2   1
10501502   050020000   00000   1   0    84.350e-2   2
10501503   050030000   00000   1   0    36.270e-2   3
*right boundary data
10501601   900010000      0   1   0    11.460e-2   1
10501602   900010000      0   1   0    84.350e-2   2
10501603   900010000      0   1   0    36.270e-2   3
*source data
10501701   0   0.0    0.0    0.0  3
*additional boundary data
*            hyd diam
10501801  0.0 10.  10.  0.  0.  0.  0.  1.0 3
10501901  0.0 10.  10.  0.  0.  0.  0.  1.0 3
*
*=*=*=*=*=*=*=
*  heat structure (0511)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10511000    1   5    1    1    0.0
*       mesh flags
10511100    0  1
*       number intervals  right bound
10511101     3          .01725
10511102     1          .11725
*         composition
10511201     1  3
10511202     4  4
*       source interval
10511301   0.0  4
*       temperature mesh no
10511401   558.8   4
10511402   500.0   5
*left boundary data
*         bound vol   incr    bc  area code factor structure no
10511501   051010000   00000   1   0   6.9270e-2   1
*right boundary data
10511601   900010000      0   1   0   6.9270e-2   1
*source data
10511701   0   0.0    0.0    0.0  1
*additional boundary data
*            hyd diam
10511801  0.0 10.  10.  0.  0.  0.  0.  1.0 1
10511901  0.0 10.  10.  0.  0.  0.  0.  1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (0521)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10521000    3   5    1    1    0.0
*       mesh flags
10521100    0  1
*       number intervals  right bound
10521101     3          .01607
10521102     1          .11607
*         composition
10521201     1  3
10521202     4  4
*       source interval
10521301   0.0  4
*       temperature mesh no
10521401   558.8   4
10521402   500.0   5
*left boundary data
*         bound vol   incr    bc  area code factor structure no
10521501   051020000   00000   1   0   58.8502e-2   1
*
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*0521502   051030000   10000   1   0   3.5723e-2   3
10521502   051030000   10000   1   0   3.5723      3
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
*right boundary data
10521601   900010000      0   1   0   58.8502e-2   1
*
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*0521602   900010000      0   1   0   3.5723e-2   3
10521602   900010000      0   1   0   3.5723      3
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
*source data
10521701   0   0.0    0.0    0.0  3
*additional boundary data
*            hyd diam
10521801  0.0 10.  10.  0.  0.  0.  0.  1.0 3
10521901  0.0 10.  10.  0.  0.  0.  0.  1.0 3
*
*=*=*=*=*=*=*=
*  heat structure (0371)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
10371000    1   5    1    1    0.0
*       mesh flags
10371100    0  1
*       number intervals  right bound
10371101     3          .01725
10371102     1          .11725
*         composition
```

```
10371201   1 3
10371202   4 4
*     source interval
10371301  0.0 4
*     temperature mesh no
10371401  558.8  4
10371402  500.0  5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
10371501   051050000  00000   1   0   6.9270e-2   1
*right boundary data
10371601   900010000     0   1   0   6.9270e-2   1
*source data
10371701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
10371801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
10371901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*********************************************************
*******        Passive Heat Structure in Loop 1
**********************************************************
*
*=*=*=*=*=*=*=
* heat structure (1311)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11311000   5   5   1   1   0.0
*      mesh flags
11311100   0  1
*      number intervals  right bound
11311101     3          .02928
11311102     1          .12928
*      composition
11311201    1  3
11311202    4  4
*     source interval
11311301   0.0  4
*      temperature mesh no
11311401   558.8  4
11311402   500.0  5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
11311501   131010000  00000   1   0  44.2491e-2   1
11311502   132010000  00000   1   0  18.5282e-2   2
11311503   133010000  00000   1   0  29.5618e-2   3
11311504   133020000  00000   1   0  53.6577e-2   4
11311505   133030000  00000   1   0  20.4033e-2   5
*right boundary data
11311601   900010000     0   1   0  44.2491e-2   1
11311602   900010000     0   1   0  18.5282e-2   2
11311603   900010000     0   1   0  29.5618e-2   3
11311604   900010000     0   1   0  53.6577e-2   4
11311605   900010000     0   1   0  20.4033e-2   5
*source data
11311701   0   0.0   0.0   0.0  5
*additional boundary data
*          hyd diam
11311801 0.0 10. 10. 0. 0. 0. 0. 1.0 5
11311901 0.0 10. 10. 0. 0. 0. 0. 1.0 5
*
*=*=*=*=*=*=*=
* heat structure (1511)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11511000   1   5   1   1   0.0
*      mesh flags
11511100   0  1
*      number intervals  right bound
11511101     3          .07579
11511102     1          .17579
*      composition
11511201    1  3
11511202    4  4
*     source interval
11511301   0.0  4
*      temperature mesh no
11511401   558.8  4
11511402   500.0  5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
11511501   134010000  00000   1   0  31.6810e-2   1
*right boundary data
11511601   900010000     0   1   0  31.6810e-2   1
*source data
11511701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
11511801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
11511901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (1521)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11521000   1   5   1   1   0.0
*      mesh flags
11521100   0  1
*      number intervals  right bound
11521101     3          .07579
11521102     1          .17579
*      composition
11521201    1  3
11521202    4  4
*     source interval
11521301   0.0  4
*      temperature mesh no
11521401   558.8  4
11521402   500.0  5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
11521501   134100000  00000   1   0  31.6810e-2   1
*right boundary data
11521601   900010000     0   1   0  31.6810e-2   1
*source data
11521701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
11521801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
11521901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (1531)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11531000   1   4   1   1   0.0
*      mesh flags
11531100   0  1
*      number intervals  right bound
11531101     3          .012
*      composition
11531201    1  3
*     source interval
11531301   0.0  3
*      temperature mesh no
11531401   558.8  4
*left boundary data
*       bound vol  incr   bc  area code factor structure no
11531501   134010000  00000   1   0  26.6434e-2   1
*right boundary data
11531601   134100000  00000   1   0  26.6434e-2   1
*source data
11531701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
11531801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
11531901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (1351)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11351000  21   5   1   1   0.0
*      mesh flags
11351100   0  1
*      number intervals  right bound
11351101     3          .02264
11351102     1          .12264
*      composition
11351201    1  3
11351202    4  4
*     source interval
11351301   0.0  4
*      temperature mesh no
11351401   558.8  4
```

```
11351402  500.0  5
*left boundary data
*       bound vol  incr    bc  area code factor structure no
11351501   135010000  00000   1   0  16.3520e-2  1
11351502   135020000  00000   1   0  31.8100e-2  2
11351503   135030000  00000   1   0  31.8100e-2  3
11351504   135040000  00000   1   0   9.0369e-2  4
11351505   135050000  00000   1   0  18.0930e-2  5
11351506   135060000  00000   1   0  12.6670e-2  6
11351507   135070000  00000   1   0  13.6630e-2  7
11351508   135080000  00000   1   0   7.6706e-2  8
11351509   135090000  00000   1   0   7.6706e-2  9
11351510   135100000  00000   1   0  10.1880e-2  10
11351511   135110000  00000   1   0  10.3520e-2  11
11351512   135120000  00000   1   0   9.7005e-2  12
11351513   135130000  00000   1   0  32.0100e-2  13
11351514   135140000  00000   1   0   9.7005e-2  14
11351515   135150000  00000   1   0  10.3520e-2  15
11351516   135160000  00000   1   0  10.1880e-2  16
11351517   135170000  00000   1   0   7.6706e-2  17
11351518   135180000  00000   1   0   7.6706e-2  18
11351519   135190000  00000   1   0  13.6630e-2  19
11351520   135200000  00000   1   0  12.6670e-2  20
11351521   135210000  00000   1   0  18.0930e-2  21
*right boundary data
11351601   900010000  00000   1   0  16.3520e-2  1
11351602   900010000  00000   1   0  31.8100e-2  2
11351603   900010000  00000   1   0  31.8100e-2  3
11351604   900010000  00000   1   0   9.0369e-2  4
11351605   900010000  00000   1   0  18.0930e-2  5
11351606   900010000  00000   1   0  12.6670e-2  6
11351607   900010000  00000   1   0  13.6630e-2  7
11351608   900010000  00000   1   0   7.6706e-2  8
11351609   900010000  00000   1   0   7.6706e-2  9
11351610   900010000  00000   1   0  10.1880e-2  10
11351611   900010000  00000   1   0  10.3520e-2  11
11351612   900010000  00000   1   0   9.7005e-2  12
11351613   900010000  00000   1   0  32.0100e-2  13
11351614   900010000  00000   1   0   9.7005e-2  14
11351615   900010000  00000   1   0  10.3520e-2  15
11351616   900010000  00000   1   0  10.1880e-2  16
11351617   900010000  00000   1   0   7.6706e-2  17
11351618   900010000  00000   1   0   7.6706e-2  18
11351619   900010000  00000   1   0  13.6630e-2  19
11351620   900010000  00000   1   0  12.6670e-2  20
11351621   900010000  00000   1   0  18.0930e-2  21
*source data
11351701  0  0.0  0.0  0.0 21
*additional boundary data
*          hyd diam
11351801  0.0 10. 10. 0. 0. 0. 0. 1.0 21
11351901  0.0 10. 10. 0. 0. 0. 0. 1.0 21
*
*=*=*=*=*=*=*=
* heat structure (1361)
*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
11361000  1  5  1  1  0.0
*     mesh flags
11361100  0 1
*     number intervals  right bound
11361101    3        .33
11361102    1        .43
*       composition
11361201    1  3
11361202    4  4
*     source interval
11361301  0.0 4
*     temperature mesh no
11361401  558.8  4
11361402  500.0  5
*left boundary data
*       bound vol  incr    bc  area code factor structure no
11361501   136010000  00000   1   0  30.3030e-2  1
*right boundary data
11361601   900010000      0   1   0  30.3030e-2  1
*source data
11361701  0  0.0  0.0  0.0 1
*additional boundary data
*          hyd diam
11361801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11361901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (1381)
*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
11381000  6  5  1  1  0.0 ·
*     mesh flags
11381100  0 1
*     number intervals  right bound
11381101    3        .02711
11381102    1        .12711
*       composition
11381201    1  3
11381202    4  4
*     source interval
11381301  0.0 4
*     temperature mesh no
11381401  558.8  4
11381402  500.0  5
*left boundary data
*       bound vol  incr    bc  area code factor structure no
11381501   442010000  00000   1   0   2.3123e-2  1
11381502   137010000  00000   1   0  49.3531e-2  2
11381503   137020000  00000   1   0  32.5011e-2  3
11381504   138010000  00000   1   0  11.4481e-2  4
11381505   139010000  00000   1   0  25.3560e-2  5
11381506   139020000  00000   1   0  17.3294e-2  6
*right boundary data
11381601   900010000  00000   1   0   2.3123e-2  1
11381602   900010000  00000   1   0  49.3531e-2  2
11381603   900010000  00000   1   0  32.5011e-2  3
11381604   900010000  00000   1   0  11.4481e-2  4
11381605   900010000  00000   1   0  25.3560e-2  5
11381606   900010000  00000   1   0  17.3294e-2  6
*source data
11381701  0  0.0  0.0  0.0 6
*additional boundary data
*          hyd diam
11381801  0.0 10. 10. 0. 0. 0. 0. 1.0 6
11381901  0.0 10. 10. 0. 0. 0. 0. 1.0 6
*
*=*=*=*=*=*=*=
* heat structure (1601)
*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
11601000  1  5  1  1  0.0
*     mesh flags
11601100  0 1
*     number intervals  right bound
11601101    3        .02521
11601102    1        .12521
*       composition
11601201    1  3
11601202    4  4
*     source interval
11601301  0.0 4
*     temperature mesh no
11601401  558.8  4
11601402  500.0  5
*left boundary data
*       bound vol  incr    bc  area code factor structure no
11601501   160010000  00000   1   0  2.5329     1
*right boundary data
11601601   900010000      0   1   0  2.5329     1
*source data
11601701  0  0.0  0.0  0.0 1
*additional boundary data
*          hyd diam
11601801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11601901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (1611)
*=*=*=*=*=*=*=
*
*     nh  np  geo  ss  left bound
11611000  3  5  1  1  0.0
*     mesh flags
11611100  0 1
*     number intervals  right bound
11611101    3        .01411
11611102    1        .11411
*       composition
11611201    1  3
11611202    4  4
```

```
*     source interval
11611301   0.0  4
*     temperature mesh no
11611401   558.8  4
11611402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
11611501   160020000  00000   1   0   2.5052    1
11611502   160030000  00000   1   0   2.5052    2
11611503   160040000  00000   1   0   3.6154    3
*right boundary data
11611601   900010000  00000   1   0   2.5052    1
11611602   900010000  00000   1   0   2.5052    2
11611603   900010000  00000   1   0   3.6154    3
*source data
11611701   0   0.0   0.0   0.0  3
*additional boundary data
*            hyd diam
11611801  0.0 10. 10. 0. 0. 0. 0. 1.0 3
11611901  0.0 10. 10. 0. 0. 0. 0. 1.0 3
*
*=*=*=*=*=*=*=
*  heat structure (1621)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11621000   1   5   1   1   0.0
*      mesh flags
11621100   0  1
*     number intervals  right bound
11621101     3          .05357
11621102     1          .15557
*       composition
11621201     1  3
11621202     4  4
*     source interval
11621301   0.0  4
*     temperature mesh no
11621401   558.8  4
11621402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
11621501   161010000  00000   1   0   15.2000e-2   1
*right boundary data
11621601   900010000      0   1   0   15.2000e-2   1
*source data
11621701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
11621801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11621901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (1631)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11631000   4   4   1   1   0.0
*      mesh flags
11631100   0  1
*     number intervals  right bound
11631101     3          .0006
*       composition
11631201     1  3
*     source interval
11631301   0.0  3
*     temperature mesh no
11631401   558.8  4
*left boundary data
*       bound vol   incr    bc  area code factor structure no
11631501   161010000  00000   1   0   0.6606    1
11631502   161020000  00000   1   0   0.6430    2
11631503   161030000  00000   1   0   0.6431    3
11631504   162010000  00000   1   0   0.2704    4
*right boundary data
11631601   165010000  00000   1   0   0.6606    1
11631602   164010000  00000   1   0   0.6430    2
11631603   164010000  00000   1   0   0.6431    3
11631604   163010000  00000   1   0   0.2704    4
*source data
11631701   0   0.0   0.0   0.0  4
*additional boundary data
*            hyd diam
11631801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
11631901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (1641)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11641000   8   5   1   1   0.0
*      mesh flags
11641100   0  1
*     number intervals  right bound
11641101     3          .00756
11641102     1          .10756
*       composition
11641201     1  3
11641202     4  4
*     source interval
11641301   0.0  4
*     temperature mesh no
11641401   558.8  4
11641402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
11641501   160010000  00000   1   0   0.8075    1
11641502   160020000  00000   1   0   0.8075    2
11641503   160030000  00000   1   0   1.1654    3
11641504   160040000  00000   1   0   0.4866    4
11641505   161010000  00000   1   0   0.2793    5
11641506   161020000  00000   1   0   0.2666    6
11641507   161030000  00000   1   0   0.2666    7
11641508   163010000  00000   1   0   0.1121    8
*right boundary data
11641601   900010000      0   1   0   0.8075    1
11641602   900010000      0   1   0   0.8075    2
11641603   900010000      0   1   0   1.1654    3
11641604   900010000      0   1   0   0.4866    4
11641605   900010000      0   1   0   0.2793    5
11641606   900010000      0   1   0   0.2666    6
11641607   900010000      0   1   0   0.2666    7
11641608   900010000      0   1   0   0.1121    8
*source data
11641701   0   0.0   0.0   0.0  8
*additional boundary data
*            hyd diam
11641801  0.0 10. 10. 0. 0. 0. 0. 1.0 8
11641901  0.0 10. 10. 0. 0. 0. 0. 1.0 8
*
*=*=*=*=*=*=*=
*  heat structure (1651)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11651000   1   5   1   1   0.0
*      mesh flags
11651100   0  1
*     number intervals  right bound
11651101     3          .03314
11651102     1          .13314
*       composition
11651201     1  3
11651202     4  4
*     source interval
11651301   0.0  4
*     temperature mesh no
11651401   558.8  4
11651402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
11651501   168010000  00000   1   0   2.8713    1
*right boundary data
11651601   900010000      0   1   0   2.8713    1
*source data
11651701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
11651801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11651901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (1661)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
11661000   2   5   1   1   0.0
*      mesh flags
11661100   0  1
```

```
*     number intervals  right bound
11661101    3         .02578
11661102    1         .12578
*      composition
11661201    1  3
11661202    4  4
*     source interval
11661301   0.0  4
*     temperature mesh no
11661401   558.8  4
11661402   500.0  5
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11661501   162010000  00000   1   0   .8483     1
11661502   163010000  00000   1   0   .6724     2
*right boundary data
11661601   900010000     0   1   0   .8483     1
11661602   900010000     0   1   0   .6724     2
*source data
11661701   0   0.0   0.0   0.0  2
*additional boundary data
*            hyd diam
11661801  0.0 10. 10. 0. 0. 0. 0. 1.0 2
11661901  0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
*=*=*=*=*=*=*=
*  heat structure (1671)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
11671000   1   5   1   1   0.0
*      mesh flags
11671100   0  1
*      number intervals  right bound
11671101    3         .03298
11671102    1         .13298
*      composition
11671201    1  3
11671202    4  4
*      source interval
11671301   0.0  4
*      temperature mesh no
11671401   558.8  4
11671402   500.0  5
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11671501   164010000  00000   1   0   2.5407     1
*right boundary data
11671601   900010000     0   1   0   2.5407     1
*source data
11671701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
11671801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11671901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (1681)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
11681000   1   5   1   1   0.0
*      mesh flags
11681100   0  1
*      number intervals  right bound
11681101    3         .03310
11681102    1         .13310
*      composition
11681201    1  3
11681202    4  4
*      source interval
11681301   0.0  4
*      temperature mesh no
11681401   558.8  4
11681402   500.0  5
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11681501   165010000  00000   1   0   1.1504     1
*right boundary data
11681601   900010000     0   1   0   1.1504     1
*source data
11681701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
11681801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11681901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (1691)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
11691000   1   5   1   1   0.0
*      mesh flags
11691100   0  1
*      number intervals  right bound
11691101    3         .00418
11691102    1         .10418
*      composition
11691201    1  3
11691202    4  4
*      source interval
11691301   0.0  4
*      temperature mesh no
11691401   558.8  4
11691402   500.0  5
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11691501   166010000  00000   1   0   3.7374     1
*right boundary data
11691601   900010000     0   1   0   3.7374     1
*source data
11691701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
11691801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
11691901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (1701)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
11701000   4   5   1   1   0.0
*      mesh flags
11701100   0  1
*      number intervals  right bound
11701101    3         .00276
11701102    1         .10276
*      composition
11701201    1  3
11701202    4  4
*      source interval
11701301   0.0  4
*      temperature mesh no
11701401   558.8  4
11701402   500.0  5
*left boundary data
*        bound vol   incr   bc  area code factor structure no
11701501   167010000  00000   1   0   0.9039     1
11701502   167020000  00000   1   0   1.3024     2
11701503   167030000  00000   1   0   1.3024     3
11701504   167040000  00000   1   0   1.3024     4
*right boundary data
11701601   900010000     0   1   0   0.9039     1
11701602   900010000     0   1   0   1.3024     2
11701603   900010000     0   1   0   1.3024     3
11701604   900010000     0   1   0   1.3024     4
*source data
11701701   0   0.0   0.0   0.0  4
*additional boundary data
*            hyd diam
11701801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
11701901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (1711)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
11711000   2   5   1   1   0.0
*      mesh flags
11711100   0  1
*      number intervals  right bound
11711101    3         .00420
11711102    1         .10420
*      composition
11711201    1  3
11711202    4  4
*      source interval
```

```
11711301   0.0 4
*      temperature mesh no
11711401   558.8  4
11711402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
11711501   169010000  10000   1   0   2.61       2
*right boundary data
11711601   900010000      0    1    0    2.61       2
*source data
11711701   0   0.0   0.0   0.0 2
*additional boundary data
*            hyd diam
11711801  0.0 10. 10. 0. 0. 0. 0. 1.0 2
11711901  0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
*
**********************************************
*******        Passive Heat Structure in Loop 2
****************************************************
*
*=*=*=*=*=*=*=
*  heat structure (2311)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
12311000   5   5   1   1   0.0
*      mesh flags
12311100   0  1
*      number intervals  right bound
12311101     3            .02928
12311102     1            .12928
*       composition
12311201     1  3
12311202     4  4
*      source interval
12311301   0.0  4
*      temperature mesh no
12311401   558.8  4
12311402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12311501   231010000  00000   1   0   44.2491e-2  1
12311502   232010000  00000   1   0   18.5282e-2  2
12311503   233010000  00000   1   0   29.5618e-2  3
12311504   233020000  00000   1   0   53.6577e-2  4
12311505   233030000  00000   1   0   20.4033e-2  5
*right boundary data
12311601   900010000      0    1    0   44.2491e-2   1
12311602   900010000      0    1    0   18.5282e-2   2
12311603   900010000      0    1    0   29.5618e-2   3
12311604   900010000      0    1    0   53.6577e-2   4
12311605   900010000      0    1    0   20.4033e-2   5
*source data
12311701   0   0.0   0.0   0.0  5
*additional boundary data
*            hyd diam
12311801  0.0 10. 10. 0. 0. 0. 0. 1.0 5
12311901  0.0 10. 10. 0. 0. 0. 0. 1.0 5
*
*=*=*=*=*=*=*=
*  heat structure (2511)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
12511000   1   5   1   1   0.0
*      mesh flags
12511100   0  1
*      number intervals  right bound
12511101     3            .07579
12511102     1            .17579
*       composition
12511201     1  3
12511202     4  4
*      source interval
12511301   0.0  4
*      temperature mesh no
12511401   558.8  4
12511402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12511501   234010000  00000   1   0   31.6810e-2   1
*right boundary data
12511601   900010000      0    1    0   31.6810e-2   1
*source data
12511701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
12511801  0.0 10. 10. 0. 0., 0. 0. 1.0 1
12511901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2521)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
12521000   1   5   1   1   0.0
*      mesh flags
12521100   0  1
*      number intervals  right bound
12521101     3            .07579
12521102     1            .17579
*       composition
12521201     1  3
12521202     4  4
*      source interval
12521301   0.0  4
*      temperature mesh no
12521401   558.8  4
12521402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12521501   234100000  00000   1   0   31.6810e-2   1
*right boundary data
12521601   900010000      0    1    0   31.6810e-2   1
*source data
12521701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
12521801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12521901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2531)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
12531000   1   4   1   1   0.0
*      mesh flags
12531100   0  1
*      number intervals  right bound
12531101     3            .012
*       composition
12531201     1  3
*      source interval
12531301   0.0  3
*      temperature mesh no
12531401   558.8  4
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12531501   234010000  00000   1   0   26.6434e-2   1
*right boundary data
12531601   234100000  00000   1   0   26.6434e-2   1
*source data
12531701   0   0.0   0.0   0.0  1
*additional boundary data
*            hyd diam
12531801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12531901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2351)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
12351000  21   5   1   1   0.0
*      mesh flags
12351100   0  1
*      number intervals  right bound
12351101     3            .02264
12351102     1            .12264
*       composition
12351201     1  3
12351202     4  4
*      source interval
12351301   0.0  4
*      temperature mesh no
12351401   558.8  4
12351402   500.0  5
*left boundary data
```

```
*       bound vol  incr   bc  area code factor structure no
12351501   235010000  00000   1   0  16.3520e-2  1
12351502   235020000  00000   1   0  31.8100e-2  2
12351503   235030000  00000   1   0  31.8100e-2  3
12351504   235040000  00000   1   0   9.0369e-2  4
12351505   235050000  00000   1   0  18.0930e-2  5
12351506   235060000  00000   1   0  12.6670e-2  6
12351507   235070000  00000   1   0  13.6630e-2  7
12351508   235080000  00000   1   0   7.6706e-2  8
12351509   235090000  00000   1   0   7.6706e-2  9
12351510   235100000  00000   1   0  10.1880e-2  10
12351511   235110000  00000   1   0  10.3520e-2  11
12351512   235120000  00000   1   0   9.7005e-2  12
12351513   235130000  00000   1   0  32.0100e-2  13
12351514   235140000  00000   1   0   9.7005e-2  14
12351515   235150000  00000   1   0  10.3520e-2  15
12351516   235160000  00000   1   0  10.1880e-2  16
12351517   235170000  00000   1   0   7.6706e-2  17
12351518   235180000  00000   1   0   7.6706e-2  18
12351519   235190000  00000   1   0  13.6630e-2  19
12351520   235200000  00000   1   0  12.6670e-2  20
12351521   235210000  00000   1   0  18.0930e-2  21
*right boundary data
12351601   900010000  00000   1   0  16.3520e-2  1
12351602   900010000  00000   1   0  31.8100e-2  2
12351603   900010000  00000   1   0  31.8100e-2  3
12351604   900010000  00000   1   0   9.0369e-2  4
12351605   900010000  00000   1   0  18.0930e-2  5
12351606   900010000  00000   1   0  12.6670e-2  6
12351607   900010000  00000   1   0  13.6630e-2  7
12351608   900010000  00000   1   0   7.6706e-2  8
12351609   900010000  00000   1   0   7.6706e-2  9
12351610   900010000  00000   1   0  10.1880e-2  10
12351611   900010000  00000   1   0  10.3520e-2  11
12351612   900010000  00000   1   0   9.7005e-2  12
12351613   900010000  00000   1   0  32.0100e-2  13
12351614   900010000  00000   1   0   9.7005e-2  14
12351615   900010000  00000   1   0  10.3520e-2  15
12351616   900010000  00000   1   0  10.1880e-2  16
12351617   900010000  00000   1   0   7.6706e-2  17
12351618   900010000  00000   1   0   7.6706e-2  18
12351619   900010000  00000   1   0  13.6630e-2  19
12351620   900010000  00000   1   0  12.6670e-2  20
12351621   900010000  00000   1   0  18.0930e-2  21
*source data
12351701   0   0.0   0.0   0.0  21
*additional boundary data
*          hyd diam
12351801  0.0 10. 10. 0. 0. 0. 0. 1.0 21
12351901  0.0 10. 10. 0. 0. 0. 0. 1.0 21
*
*=*=*=*=*=*=*=
*  heat structure (2361)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12361000   1   5   1   1   0.0
*      mesh flags
12361100   0  1
*      number intervals  right bound
12361101     3          .33
12361102     1          .43
*       composition
12361201     1  3.
12361202     4  4
*      source interval
12361301   0.0  4
*      temperature mesh no
12361401   558.8   4
12361402   500.0   5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
12361501   236010000  00000   1   0  30.3030e-2  1
*right boundary data
12361601   900010000      0   1   0  30.3030e-2  1
*source data
12361701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12361801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12361901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2381)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12381000   6   5   1   1   0.0
*      mesh flags
12381100   0  1
*      number intervals  right bound
12381101     3          .02711
12381102     1          .12711
*       composition
12381201     1  3
12381202     4  4
*      source interval
12381301   0.0  4
*      temperature mesh no
12381401   558.8   4
12381402   500.0   5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
12381501   542010000  00000   1   0   2.3123e-2  1
12381502   237010000  00000   1   0  49.3531e-2  2
12381503   237020000  00000   1   0  32.5011e-2  3
12381504   238010000  00000   1   0  11.4481e-2  4
12381505   239010000  00000   1   0  25.3560e-2  5
12381506   239020000  00000   1   0  17.3294e-2  6
*right boundary data
12381601   900010000  00000   1   0   2.3123e-2  1
12381602   900010000  00000   1   0  49.3531e-2  2
12381603   900010000  00000   1   0  32.5011e-2  3
12381604   900010000  00000   1   0  11.4481e-2  4
12381605   900010000  00000   1   0  25.3560e-2  5
12381606   900010000  00000   1   0  17.3294e-2  6
*source data
12381701   0   0.0   0.0   0.0  6
*additional boundary data
*          hyd diam
12381801  0.0 10. 10. 0. 0. 0. 0. 1.0 6
12381901  0.0 10. 10. 0. 0. 0. 0. 1.0 6
*
*=*=*=*=*=*=*=
*  heat structure (2601)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12601000   1   5   1   1   0.0
*      mesh flags
12601100   0  1
*      number intervals  right bound
12601101     3          .02521
12601102     1          .12521
*       composition
12601201     1  3
12601202     4  4
*      source interval
12601301   0.0  4
*      temperature mesh no
12601401   558.8   4
12601402   500.0   5
*left boundary data
*       bound vol  incr   bc  area code factor structure no
12601501   260010000  00000   1   0   2.5329     1
*right boundary data
12601601   900010000      0   1   0   2.5329     1
*source data
12601701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12601801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12601901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2611)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12611000   3   5   1   1   0.0
*      mesh flags
12611100   0  1
*      number intervals  right bound
12611101     3          .01411
12611102     1          .11411
*       composition
12611201     1  3
12611202     4  4
*      source interval
12611301   0.0  4
```

```
*     temperature mesh no
12611401   558.8  4
12611402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12611501   260020000  00000   1   0   2.5052    1
12611502   260030000  00000   1   0   2.5052    2
12611503   260040000  00000   1   0   3.6154    3
*right boundary data
12611601   900010000  00000   1   0   2.5052    1
12611602   900010000  00000   1   0   2.5052    2
12611603   900010000  00000   1   0   3.6154    3
*source data
12611701   0   0.0   0.0   0.0  3
*additional boundary data
*          hyd diam
12611801  0.0 10. 10. 0. 0. 0. 0. 1.0 3
12611901  0.0 10. 10. 0. 0. 0. 0. 1.0 3
*
*=*=*=*=*=*=*=
*  heat structure (2621)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss  left bound
12621000   1   5   1   1   0.0
*      mesh flags
12621100   0  1
*     number intervals  right bound
12621101     3          .05357
12621102     1          .15357
*       composition
12621201     1  3
12621202     4  4
*     source interval
12621301   0.0  4
*     temperature mesh no
12621401   558.8  4
12621402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12621501   261010000  00000   1   0   15.2000e-2   1
*right boundary data
12621601   900010000      0   1   0   15.2000e-2   1
*source data
12621701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12621801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12621901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2631)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss  left bound
12631000   4   4   1   1   0.0
*      mesh flags
12631100   0  1
*     number intervals  right bound
12631101     3          .0006
*       composition
12631201     1  3
*     source interval
12631301   0.0  3
*     temperature mesh no
12631401   558.8  4
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12631501   261010000  00000   1   0   0.6606    1
12631502   261020000  00000   1   0   0.6430    2
12631503   261030000  00000   1   0   0.6431    3
12631504   262010000  00000   1   0   0.2704    4
*right boundary data
12631601   265010000  00000   1   0   0.6606    1
12631602   264010000  00000   1   0   0.6430    2
12631603   264010000  00000   1   0   0.6431    3
12631604   263010000  00000   1   0   0.2704    4
*source data
12631701   0   0.0   0.0   0.0  4
*additional boundary data
*          hyd diam
12631801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
12631901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (2641)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss  left bound
12641000   8   5   1   1   0.0
*      mesh flags
12641100   0  1
*     number intervals  right bound
12641101     3          .00756
12641102     1          .10756
*       composition
12641201     1  3
12641202     4  4
*     source interval
12641301   0.0  4
*     temperature mesh no
12641401   558.8  4
12641402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12641501   260010000  00000   1   0   0.8075    1
12641502   260020000  00000   1   0   0.8075    2
12641503   260030000  00000   1   0   1.1654    3
12641504   260040000  00000   1   0   0.4866    4
12641505   261010000  00000   1   0   0.2793    5
12641506   261020000  00000   1   0   0.2666    6
12641507   261030000  00000   1   0   0.2666    7
12641508   263010000  00000   1   0   0.1121    8
*right boundary data
12641601   900010000      0   1   0   0.8075    1
12641602   900010000      0   1   0   0.8075    2
12641603   900010000      0   1   0   1.1654    3
12641604   900010000      0   1   0   0.4866    4
12641605   900010000      0   1   0   0.2793    5
12641606   900010000      0   1   0   0.2666    6
12641607   900010000      0   1   0   0.2666    7
12641608   900010000      0   1   0   0.1121    8
*source data
12641701   0   0.0   0.0   0.0  8
*additional boundary data
*          hyd diam
12641801  0.0 10. 10. 0. 0. 0. 0. 1.0 8
12641901  0.0 10. 10. 0. 0. 0. 0. 1.0 8
*
*=*=*=*=*=*=*=
*  heat structure (2651)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss  left bound
12651000   1   5   1   1   0.0
*      mesh flags
12651100   0  1
*     number intervals  right bound
12651101     3          .03314
12651102     1          .13314
*       composition
12651201     1  3
12651202     4  4
*     source interval
12651301   0.0  4
*     temperature mesh no
12651401   558.8  4
12651402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12651501   268010000  00000   1   0   2.8713    1
*right boundary data
12651601   900010000      0   1   0   2.8713    1
*source data
12651701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12651801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12651901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2661)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss  left bound
12661000   2   5   1   1   0.0
*      mesh flags
12661100   0  1
*     number intervals  right bound
12661101     3          .02578
```

```
12661102    1        .12578
*       composition
12661201    1  3
12661202    4  4
*     source interval
12661301   0.0  4
*     temperature mesh no
12661401   558.8  4
12661402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12661501   262010000  00000   1   0   .8483     1
12661502   263010000  00000   1   0   .6724     2
*right boundary data
12661601   900010000      0   1   0   .8483     1
12661602   900010000      0   1   0   .6724     2
*source data
12661701   0   0.0   0.0   0.0  2
*additional boundary data
*          hyd diam
12661801  0.0 10. 10. 0. 0. 0. 0. 1.0 2
12661901  0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
*=*=*=*=*=*=*=
*  heat structure (2671)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12671000   1   5   1   1   0.0
*      mesh flags
12671100   0  1
*     number intervals  right bound
12671101    3        .03298
12671102    1        .13298
*       composition
12671201    1  3
12671202    4  4
*     source interval
12671301   0.0  4
*     temperature mesh no
12671401   558.8  4
12671402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12671501   264010000  00000   1   0   2.5407     1
*right boundary data
12671601   900010000      0   1   0   2.5407     1
*source data
12671701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12671801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12671901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2681)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12681000   1   5   1   1   0.0
*      mesh flags
12681100   0  1
*     number intervals  right bound
12681101    3        .03310
12681102    1        .13310
*       composition
12681201    1  3
12681202    4  4
*     source interval
12681301   0.0  4
*     temperature mesh no
12681401   558.8  4
12681402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12681501   265010000  00000   1   0   1.1504     1
*right boundary data
12681601   900010000      0   1   0   1.1504     1
*source data
12681701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12681801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12681901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2691)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12691000   1   5   1   1   0.0
*      mesh flags
12691100   0  1
*     number intervals  right bound
12691101    3        .00418
12691102    1        .10418
*       composition
12691201    1  3
12691202    4  4
*     source interval
12691301   0.0  4
*     temperature mesh no
12691401   558.8  4
12691402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12691501   266010000  00000   1   0   3.7374     1
*right boundary data
12691601   900010000      0   1   0   3.7374     1
*source data
12691701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
12691801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
12691901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (2701)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12701000   4   5   1   1   0.0
*      mesh flags
12701100   0  1
*     number intervals  right bound
12701101    3        .00276
12701102    1        .10276
*       composition
12701201    1  3
12701202    4  4
*     source interval
12701301   0.0  4
*     temperature mesh no
12701401   558.8  4
12701402   500.0  5
*left boundary data
*       bound vol   incr   bc  area code factor structure no
12701501   267010000  00000   1   0   0.9039     1
12701502   267020000  00000   1   0   1.3024     2
12701503   267030000  00000   1   0   1.3024     3
12701504   267040000  00000   1   0   1.3024     4
*right boundary data
12701601   900010000      0   1   0   0.9039     1
12701602   900010000      0   1   0   1.3024     2
12701603   900010000      0   1   0   1.3024     3
12701604   900010000      0   1   0   1.3024     4
*source data
12701701   0   0.0   0.0   0.0  4
*additional boundary data
*          hyd diam
12701801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
12701901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (2711)
*=*=*=*=*=*=*=
*
*      nh   np  geo   ss   left bound
12711000   2   5   1   1   0.0
*      mesh flags
12711100   0  1
*     number intervals  right bound
12711101    3        .00420
12711102    1        .10420
*       composition
12711201    1  3
12711202    4  4
*     source interval
12711301   0.0  4
*     temperature mesh no
```

```
12711401   558.8  4
12711402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
12711501   269010000   10000   1   0   2.61       2
*right boundary data
12711601   900010000     0   1   0   2.61       2
*source data
12711701   0   0.0   0.0   0.0 2
*additional boundary data
*           hyd diam
12711801  0.0 10. 10. 0. 0. 0. 0. 1.0 2
12711901  0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
*
*************************************************
*******         Passive Heat Structure in Loop 3
**********************************************************
*
*=*=*=*=*=*=*=
*  heat structure (3311)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13311000   5   5   1   1   0.0
*       mesh flags
13311100   0  1
*      number intervals  right bound
13311101    3          .02928
13311102    1          .12928
*        composition
13311201    1  3
13311202    4  4
*      source interval
13311301   0.0  4
*      temperature mesh no
13311401   558.8  4
13311402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13311501   331010000  00000   1   0  44.2491e-2  1
13311502   332010000  00000   1   0  18.5282e-2  2
13311503   333010000  00000   1   0  29.5618e-2  3
13311504   333020000  00000   1   0  53.6577e-2  4
13311505   333030000  00000   1   0  20.4033e-2  5
*right boundary data
13311601   900010000     0   1   0  44.2491e-2  1
13311602   900010000     0   1   0  18.5282e-2  2
13311603   900010000     0   1   0  29.5618e-2  3
13311604   900010000     0   1   0  53.6577e-2  4
13311605   900010000     0   1   0  20.4033e-2  5
*source data
13311701   0   0.0   0.0   0.0 5
*additional boundary data
*           hyd diam
13311801  0.0 10. 10. 0. 0. 0. 0. 1.0 5
13311901  0.0 10. 10. 0. 0. 0. 0. 1.0 5
*
*=*=*=*=*=*=*=
*  heat structure (3511)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13511000   1   5   1   1   0.0
*       mesh flags
13511100   0  1
*      number intervals  right bound
13511101    3          .07579
13511102    1          .17579
*        composition
13511201    1  3
13511202    4  4
*      source interval
13511301   0.0  4
*      temperature mesh no
13511401   558.8  4
13511402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13511501   334010000  00000   1   0  31.6810e-2  1
*right boundary data
13511601   900010000     0   1   0  31.6810e-2  1
*source data
13511701   0   0.0   0.0   0.0 1
*additional boundary data
*           hyd diam
13511801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13511901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3521)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13521000   1   5   1   1   0.0
*       mesh flags
13521100   0  1
*      number intervals  right bound
13521101    3          .07579
13521102    1          .17579
*        composition
13521201    1  3
13521202    4  4
*      source interval
13521301   0.0  4
*      temperature mesh no
13521401   558.8  4
13521402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13521501   334100000  00000   1   0  31.6810e-2  1
*right boundary data
13521601   900010000     0   1   0  31.6810e-2  1
*source data
13521701   0   0.0   0.0   0.0 1
*additional boundary data
*           hyd diam
13521801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13521901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3531)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13531000   1   4   1   1   0.0
*       mesh flags
13531100   0  1
*      number intervals  right bound
13531101    3          .012
*        composition
13531201    1  3
*      source interval
13531301   0.0  3
*      temperature mesh no
13531401   558.8  4
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13531501   334010000  00000   1   0  26.6434e-2  1
*right boundary data
13531601   334100000  00000   1   0  26.6434e-2  1
*source data
13531701   0   0.0   0.0   0.0 1
*additional boundary data
*           hyd diam
13531801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13531901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3351)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13351000  21   5   1   1   0.0
*       mesh flags
13351100   0  1
*      number intervals  right bound
13351101    3          .02264
13351102    1          .12264
*        composition
13351201    1  3
13351202    4  4
*      source interval
13351301   0.0  4
*      temperature mesh no
13351401   558.8  4
13351402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13351501   335010000  00000   1   0  16.3520e-2  1
```

```
13351502  335020000  00000  1  0  31.8100e-2  2
13351503  335030000  00000  1  0  31.8100e-2  3
13351504  335040000  00000  1  0   9.0369e-2  4
13351505  335050000  00000  1  0  18.0930e-2  5
13351506  335060000  00000  1  0  12.6670e-2  6
13351507  335070000  00000  1  0  13.6630e-2  7
13351508  335080000  00000  1  0   7.6706e-2  8
13351509  335090000  00000  1  0   7.6706e-2  9
13351510  335100000  00000  1  0  10.1880e-2  10
13351511  335110000  00000  1  0  10.3520e-2  11
13351512  335120000  00000  1  0   9.7005e-2  12
13351513  335130000  00000  1  0  32.0100e-2  13
13351514  335140000  00000  1  0   9.7005e-2  14
13351515  335150000  00000  1  0  10.3520e-2  15
13351516  335160000  00000  1  0  10.1880e-2  16
13351517  335170000  00000  1  0   7.6706e-2  17
13351518  335180000  00000  1  0   7.6706e-2  18
13351519  335190000  00000  1  0  13.6630e-2  19
13351520  335200000  00000  1  0  12.6670e-2  20
13351521  335210000  00000  1  0  18.0930e-2  21
*right boundary data
13351601  900010000  00000  1  0  16.3520e-2  1
13351602  900010000  00000  1  0  31.8100e-2  2
13351603  900010000  00000  1  0  31.8100e-2  3
13351604  900010000  00000  1  0   9.0369e-2  4
13351605  900010000  00000  1  0  18.0930e-2  5
13351606  900010000  00000  1  0  12.6670e-2  6
13351607  900010000  00000  1  0  13.6630e-2  7
13351608  900010000  00000  1  0   7.6706e-2  8
13351609  900010000  00000  1  0   7.6706e-2  9
13351610  900010000  00000  1  0  10.1880e-2  10
13351611  900010000  00000  1  0  10.3520e-2  11
13351612  900010000  00000  1  0   9.7005e-2  12
13351613  900010000  00000  1  0  32.0100e-2  13
13351614  900010000  00000  1  0   9.7005e-2  14
13351615  900010000  00000  1  0  10.3520e-2  15
13351616  900010000  00000  1  0  10.1880e-2  16
13351617  900010000  00000  1  0   7.6706e-2  17
13351618  900010000  00000  1  0   7.6706e-2  18
13351619  900010000  00000  1  0  13.6630e-2  19
13351620  900010000  00000  1  0  12.6670e-2  20
13351621  900010000  00000  1  0  18.0930e-2  21
*source data
13351701  0  0.0  0.0  0.0 21
*additional boundary data
*        hyd diam
13351801 0.0 10. 10. 0. 0. 0. 0. 1.0 21
13351901 0.0 10. 10. 0. 0. 0. 0. 1.0 21
*
*=*=*=*=*=*=*=
* heat structure (3361)
*=*=*=*=*=*=*=
*
*     nh  np geo  ss  left bound
13361000  1  5  1  1  0.0
*     mesh flags
13361100  0 1
*     number intervals  right bound
13361101    3         .33
13361102    1         .43
*     composition
13361201    1  3
13361202    4  4
*     source interval
13361301   0.0 4
*     temperature mesh no
13361401   558.8  4
13361402   500.0  5
*left boundary data
*     bound vol  incr   bc  area code factor structure no
13361501  336010000  00000  1  0  30.3030e-2  1
*right boundary data
13361601  900010000     0  1  0  30.3030e-2  1
*source data
13361701  0  0.0  0.0  0.0 1
*additional boundary data
*        hyd diam
13361801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
13361901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (3381)
*=*=*=*=*=*=*=
*
*     nh  np geo  ss  left bound
13381000  6  5  1  1  0.0
*     mesh flags
13381100  0 1
*     number intervals  right bound
13381101    3         .02711
13381102    1         .12711
*     composition
13381201    1  3
13381202    4  4
*     source interval
13381301   0.0 4
*     temperature mesh no
13381401   558.8  4
13381402   500.0  5
*left boundary data
*     bound vol  incr   bc  area code factor structure no
13381501  642010000  00000  1  0   2.3123e-2  1
13381502  337010000  00000  1  0  49.3531e-2  2
13381503  337020000  00000  1  0  32.5011e-2  3
13381504  338010000  00000  1  0  11.4481e-2  4
13381505  339010000  00000  1  0  25.3560e-2  5
13381506  339020000  00000  1  0  17.3294e-2  6
*right boundary data
13381601  900010000  00000  1  0   2.3123e-2  1
13381602  900010000  00000  1  0  49.3531e-2  2
13381603  900010000  00000  1  0  32.5011e-2  3
13381604  900010000  00000  1  0  11.4481e-2  4
13381605  900010000  00000  1  0  25.3560e-2  5
13381606  900010000  00000  1  0  17.3294e-2  6
*source data
13381701  0  0.0  0.0  0.0 6
*additional boundary data
*        hyd diam
13381801 0.0 10. 10. 0. 0. 0. 0. 1.0 6
13381901 0.0 10. 10. 0. 0. 0. 0. 1.0 6
*
*=*=*=*=*=*=*=
* heat structure (3601)
*=*=*=*=*=*=*=
*
*     nh  np geo  ss  left bound
13601000  1  5  1  1  0.0
*     mesh flags
13601100  0 1
*     number intervals  right bound
13601101    3         .02521
13601102    1         .12521
*     composition
13601201    1  3
13601202    4  4
*     source interval
13601301   0.0 4
*     temperature mesh no
13601401   558.8  4
13601402   500.0  5
*left boundary data
*     bound vol  incr   bc  area code factor structure no
13601501  360010000  00000  1  0  2.5329    1
*right boundary data
13601601  900010000     0  1  0  2.5329    1
*source data
13601701  0  0.0  0.0  0.0 1
*additional boundary data
*        hyd diam
13601801 0.0 10. 10. 0. 0. 0. 0. 1.0 1
13601901 0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
* heat structure (3611)
*=*=*=*=*=*=*=
*
*     nh  np geo  ss  left bound
13611000  3  5  1  1  0.0
*     mesh flags
13611100  0 1
*     number intervals  right bound
13611101    3         .01411
13611102    1         .11411
*     composition
13611201    1  3
13611202    4  4
*     source interval
13611301   0.0 4
*     temperature mesh no
13611401   558.8  4
```

```
13611402   500.0  5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13611501    360020000  00000   1   0   2.5052      1
13611502    360030000  00000   1   0   2.5052      2
13611503    360040000  00000   1   0   3.6154      3
*right boundary data
13611601    900010000        0   1   0   2.5052      1
13611602    900010000        0   1   0   2.5052      2
13611603    900010000        0   1   0   3.6154      3
*source data
13611701   0   0.0    0.0    0.0 3
*additional boundary data
*              hyd diam
13611801  0.0 10. 10. 0. 0. 0. 0. 1.0 3
13611901  0.0 10. 10. 0. 0. 0. 0. 1.0 3
*
*=*=*=*=*=*=*=
*  heat structure (3621)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
13621000   1   5   1   1   0.0
*       mesh flags
13621100   0  1
*       number intervals  right bound
13621101     3          .05357
13621102     1          .15357
*        composition
13621201      1  3
13621202      4  4
*       source interval
13621301    0.0  4
*       temperature mesh no
13621401    558.8   4
13621402    500.0   5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13621501    361010000  00000   1   0   15.2000e-2   1
*right boundary data
13621601    900010000        0   1   0   15.2000e-2   1
*source data
13621701   0   0.0    0.0    0.0  1
*additional boundary data
*              hyd diam
13621801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13621901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3631)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
13631000   4   4   1   1   0.0
*       mesh flags
13631100   0  1
*       number intervals  right bound
13631101     3          .0006
*        composition
13631201      1  3
*       source interval
13631301    0.0  3
*       temperature mesh no
13631401    558.8   4
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13631501    361010000  00000   1   0   0.6606      1
13631502    361020000  00000   1   0   0.6430      2
13631503    361030000  00000   1   0   0.6431      3
13631504    362010000  00000   1   0   0.2704      4
*right boundary data
13631601    365010000  00000   1   0   0.6606      1
13631602    364010000  00000   1   0   0.6430      2
13631603    364010000  00000   1   0   0.6431      3
13631604    363010000  00000   1   0   0.2704      4
*source data
13631701   0   0.0    0.0    0.0  4
*additional boundary data
*              hyd diam
13631801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
13631901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (3641)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
13641000   8   5   1   1   0.0
*       mesh flags
13641100   0  1
*       number intervals  right bound
13641101     3          .00756
13641102     1          .10756
*        composition
13641201      1  3
13641202      4  4
*       source interval
13641301    0.0  4
*       temperature mesh no
13641401    558.8   4
13641402    500.0   5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13641501    360010000  00000   1   0   0.8075      1
13641502    360020000  00000   1   0   0.8075      2
13641503    360030000  00000   1   0   1.1654      3
13641504    360040000  00000   1   0   0.4866      4
13641505    361010000  00000   1   0   0.2793      5
13641506    361020000  00000   1   0   0.2666      6
13641507    361030000  00000   1   0   0.2666      7
13641508    363010000  00000   1   0   0.1121      8
*right boundary data
13641601    900010000        0   1   0   0.8075      1
13641602    900010000        0   1   0   0.8075      2
13641603    900010000        0   1   0   1.1654      3
13641604    900010000        0   1   0   0.4866      4
13641605    900010000        0   1   0   0.2793      5
13641606    900010000        0   1   0   0.2666      6
13641607    900010000        0   1   0   0.2666      7
13641608    900010000        0   1   0   0.1121      8
*source data
13641701   0   0.0    0.0    0.0  8
*additional boundary data
*              hyd diam
13641801  0.0 10. 10. 0. 0. 0. 0. 1.0 8
13641901  0.0 10. 10. 0. 0. 0. 0. 1.0 8
*
*=*=*=*=*=*=*=
*  heat structure (3651)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
13651000   1   5   1   1   0.0
*       mesh flags
13651100   0  1
*       number intervals  right bound
13651101     3          .03314
13651102     1          .13314
*        composition
13651201      1  3
13651202      4  4
*       source interval
13651301    0.0  4
*       temperature mesh no
13651401    558.8   4
13651402    500.0   5
*left boundary data
*        bound vol   incr    bc  area code factor structure no
13651501    368010000  00000   1   0   2.8713      1
*right boundary data
13651601    900010000        0   1   0   2.8713      1
*source data
13651701   0   0.0    0.0    0.0  1
*additional boundary data
*              hyd diam
13651801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13651901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3661)
*=*=*=*=*=*=*=
*
*       nh    np  geo   ss   left bound
13661000   2   5   1   1   0.0
*       mesh flags
13661100   0  1
*       number intervals  right bound
13661101     3          .02578
13661102     1          .12578
*        composition
```

```
13661201    1  3
13661202    4  4
*       source interval
13661301   0.0  4
*       temperature mesh no
13661401   558.8  4
13661402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
13661501   362010000  00000   1   0   .8483     1
13661502   363010000  00000   1   0   .6724     2
*right boundary data
13661601   900010000      0   1   0   .8483     1
13661602   900010000      0   1   0   .6724     2
*source data
13661701   0   0.0   0.0   0.0  2
*additional boundary data
*          hyd diam
13661801  0.0 10. 10. 0. 0. 0. 0. 1.0 2
13661901  0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
*=*=*=*=*=*=*=
*  heat structure (3671)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13671000   1   5   1   1   0.0
*       mesh flags
13671100   0  1
*       number intervals  right bound
13671101     3          .03298
13671102     1          .13298
*        composition
13671201    1  3
13671202    4  4
*       source interval
13671301   0.0  4
*       temperature mesh no
13671401   558.8  4
13671402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
13671501   364010000  00000   1   0   2.5407     1
*right boundary data
13671601   900010000      0   1   0   2.5407     1
*source data
13671701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
13671801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13671901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3681)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13681000   1   5   1   1   0.0
*       mesh flags
13681100   0  1
*       number intervals  right bound
13681101     3          .03310
13681102     1          .13310
*        composition
13681201    1  3
13681202    4  4
*       source interval
13681301   0.0  4
*       temperature mesh no
13681401   558.8  4
13681402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
13681501   365010000  00000   1   0   1.1504     1
*right boundary data
13681601   900010000      0   1   0   1.1504     1
*source data
13681701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
13681801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13681901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3691)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13691000   1   5   1   1   0.0
*       mesh flags
13691100   0  1
*       number intervals  right bound
13691101     3          .00418
13691102     1          .10418
*        composition
13691201    1  3
13691202    4  4
*       source interval
13691301   0.0  4
*       temperature mesh no
13691401   558.8  4
13691402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
13691501   366010000  00000   1   0   3.7374     1
*right boundary data
13691601   900010000      0   1   0   3.7374     1
*source data
13691701   0   0.0   0.0   0.0  1
*additional boundary data
*          hyd diam
13691801  0.0 10. 10. 0. 0. 0. 0. 1.0 1
13691901  0.0 10. 10. 0. 0. 0. 0. 1.0 1
*
*=*=*=*=*=*=*=
*  heat structure (3701)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13701000   4   5   1   1   0.0
*       mesh flags
13701100   0  1
*       number intervals  right bound
13701101     3          .00276
13701102     1          .10276
*        composition
13701201    1  3
13701202    4  4
*       source interval
13701301   0.0  4
*       temperature mesh no
13701401   558.8  4
13701402   500.0  5
*left boundary data
*       bound vol   incr    bc  area code factor structure no
13701501   367010000  00000   1   0   0.9039     1
13701502   367020000  00000   1   0   1.3024     2
13701503   367030000  00000   1   0   1.3024     3
13701504   367040000  00000   1   0   1.3024     4
*right boundary data
13701601   900010000      0   1   0   0.9039     1
13701602   900010000      0   1   0   1.3024     2
13701603   900010000      0   1   0   1.3024     3
13701604   900010000      0   1   0   1.3024     4
*source data
13701701   0   0.0   0.0   0.0  4
*additional boundary data
*          hyd diam
13701801  0.0 10. 10. 0. 0. 0. 0. 1.0 4
13701901  0.0 10. 10. 0. 0. 0. 0. 1.0 4
*
*=*=*=*=*=*=*=
*  heat structure (3711)
*=*=*=*=*=*=*=
*
*       nh   np  geo   ss   left bound
13711000   2   5   1   1   0.0
*       mesh flags
13711100   0  1
*       number intervals  right bound
13711101     3          .00420
13711102     1          .10420
*        composition
13711201    1  3
13711202    4  4
*       source interval
13711301   0.0  4
*       temperature mesh no
13711401   558.8  4
13711402   500.0  5
```

```
*left boundary data
*       bound vol  incr   bc  area code factor structure no
13711501  369010000  10000  1  0  2.61     2
*right boundary data
13711601  900010000     0  1  0  2.61     2
*source data
13711701  0  0.0  0.0  0.0 2
*additional boundary data
*          hyd diam
13711801 0.0 10. 10. 0. 0. 0. 0. 1.0 2
13711901 0.0 10. 10. 0. 0. 0. 0. 1.0 2
*
************************************************************
* 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.
*
*  component 901 - trip valve -
*
*       name    type
9010000   envvalv   valve
*    vol from  vol to    area    fls  rloss  vcahs  scdc  2pdc  shdc
9010101   470010000   900000000  0.  0.  0.  001000
* junction initial flows
9010201   0        0.        0.  0.  * 0.
9010300   trpvlv
9010301   404
9010110   0.01875   0.        1.  1.
*
*
. * END OF DATA
```

Appendix B:

RELAP5 Input Listing for Modified Discharge Coefficient

The other input data are same as basecase input deck

```
*$##########################################################################
*
*     Break nozzle and associated components
*
*$##########################################################################
*
*     component 151 - junction to nozzle
*
*           name        type
1510000   nozin      sngljun
*
*        vol from     vol to       area      fls rloss fvcahs   scdc   2pdc   shdc
*
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*510101 137010003 152000000 1.88205-4 0.0   0.0   031020   1.0     1.0     1.0
1510101 137010003 152000000 1.88205-4 0.0   0.0   031020   1.0     1.0     1.0
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
*  junction initial flows
1510201    0   6.26866-5    6.26866-5    0.   *   8.91312-6
*
*         Hyd.D.    F.C.   G.I.   S.
1510110    .01548    0.      1.    1.
*
*=*=*=*=*=*=*=*=*
*
*     component 152 - nozzle
*
*          name       type
1520000   brnoz     snglvol
*
*          area             lnth       vol horiz vert delz rough    diam      pvbfe
1520101 1.88205e-4      1.56      0.0   0.0      0.0 0.0    1.5e-6 0.1548    00000
1520101 1.88205e-4      4.68      0.0   0.0      0.0 0.0    1.5e-6 0.4644    00000
*
*              pressure   quality
1520200    0        15455914. 1252620. 2448917. 0.
*
*=*=*=*=*=*=*=*=*
*
*     component 153 - junction from nozzle - trip valve - choking occurs here
*
*            name        type
1530000   nozout       valve
*
*        vol from     vol to       area        fls     rloss   vcahs   scdc   2pdc    shdc
*
*1530101 152010000 154000000 1.88205e-4 0.786 0.786    00020   0.85   1.20     0.96
```

```
1530101 152010000 154000000 1.88205e-4 0.786 0.786   00020   0.85   0.85    0.96
*<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
*
*  junction initial flows
1530201    0   0.          0.              0.    *  0.
*
1530300    trpvlv
1530301    405
*
*          Hyd.D.    F.C.   G.I.   S.
1530110    .01875    0.      1.     1.
*
*=*=*=*=*=*=*=*=*=*
*
*      component 154 - atmospheric sink volume
*
1540000     atmosph     tmdpvol
1540101     1.0e6     1.0     0.0     0.0     0.0     0.0     0.0     0.0     11
1540200     102     0
1540201     0.0   1.0e5   1.0
*
*
*$##############################################################################
```

Modified subroutine for interphase drag force change

```
*define sun
*define doe
*define ieee
*define erf
*define fourbyt
*define in32
*define mmfld
*define threed
*define unix
*define noselap
*define nonpa
*deck fidisj
       subroutine fidisj (fic,c0,i,output,kk,mz,velgjt,velfjt,diamjt,
     * k,l)
*in32 ireg
*in32end
c
*if def,impnon,1
*      implicit none
c
c************************** prologue **********************************
c     title    fidisj - calcs interphase fric coeffs in bubbly/slug flow
c     author   j. m. putney (cerl)
c     purpose
c       this subroutine calculates effective interphase drag
c       coefficient for dispersed vapour flows using best-estimate
c       void fraction correlations. the coefficient is appropriate to a
c       constitutive equation for the interphase friction force which
c       (see ref 3)
c       (a) explicitly accounts for the effects of phase and velocity
c            distribution on the local drag (ie uses the area average of
c            the local relative velocity rather than the difference
c            between the void-fraction-weighted mean values of the local
c            phase velocities)
c       (b) represents the interfacial shear force separately from the
c            drag force
c       the coefficient is determined by
c       (1) reducing the code's momentum equations to the case of steady,
c            fully developed flow
c       (2) eliminating the spatial pressure gradient to obtain a
c            momentum difference equation
c       (3) equating the drag force to the buoyancy force and the shear
c            forces to the wall friction terms
c       (4) applying the appropriate correlation(s) to eliminate the
c            phase and drift velocities in terms of void fraction,
c            mixture mass flux and fluid properties
c       the distribution coefficient is also returned so that the average
c       local relative velocity may be calculated.
c       note that the drift velocity and distribution coefficient
c       calculated by this subroutine may not necessarily comply
c       with the definitions arising from drift flux theory, but
```

```
c       will always provide a total interphase friction force consistent
c       with the best-estimate void fraction correlation(s).
c       the calculational procedure is as follows. depending on the
c       geometry and mass flux, the appropriate correlation(s) is
c       selected and applied to determine the drift velocity and
c       distribution coefficient. this calculation is perfomed by
c       subroutine brycej, eprij, zfslgj, katokj or grdnrj. if the flow
c       channel is a vertical pipe and a transition between high and
c       low flow conditions is taking place, interpolated values are
c       formed. in the case of vertical counter-current flow, a ccfl
c       appropriate to a straight uniform flow channel is imposed (ccfl
c       caused by a singularity in the channel geometry may
c       subsequently be imposed by subroutine ccfl).
c       finally, the calculated forces and velocities are used
c       to determine effective interphase drag
c       from the reduced momentum difference equation.
c
c       the separate geometries and flow conditions considered (indicated
c       by ireg), and the correlations applied in each case, are as
c       follows:
c
c        ireg  geometry and flow conditions              correlations used
c
c          1   horizontal pipes                          bryce
c          2   rod bundles                               epri
c          3   high up/down flows in small pipes         epri
c          4   low up/down/cc flows in small pipes       zuber-findlay slug
c          5   transition regions between 3 and 4        epri & z-f slug
c          6   high up/down flows in very large pipes    epri
c          7   low up/down/cc flows in very large pipes  gardner
c          8   transition regions between 6 and 7        epri & gardner
c          9   high up/down flows in intermed. pipes     epri
c         10   low up/down/cc flows in intermed. pipes   churn-turb bubbly
c         11   transition regions between 10 and 12      c-t bubbly & k-i
c         12   low up/down/cc flows in intermed. pipes   kataoka-ishii
c         13   transition regions between 9 & 10-11-12   epri & c-tbub/k-i
c         14   large pipes                               churn-turb bubbly
c         15   transition regions between 14 and 16      c-t bubbly & k-i
c         16   large pipes                               kataoka-ishii
c
c       this subroutine is called by phantj to calculate junction values
c       of the effective interphase drag   in the
c       vertical bubbly and slug flow regimes, but not the high mixing
c       flow regime (ie pumps). if appropriate, the interpolation
c       procedures in the transition regions leading into
c       the annular-mist and post-dryout regimes
c       are subsequently applied to the calculated drag coefficient
c       in the normal way. the junction effective drag coefficients
c       are also formed in the normal way, as are the various special
c       case modifications, including under-relaxation. appropriate
c       transition and junction values of the shear and distribution
c       coefficients are also calculated.
c
```

```
c       the subroutine is not called for a time dependent volume (tdv) as
c       the interphase friction coefficients for a tdv makes no
c       contribution to the junction interphase friction (and dl(kk) and
c       and dz(kk) are zero for a tdv, which causes problems below).
c       neither is it called for a horizontal
c       volume, as the modelling for this situation
c       (ie interfacial shear from bryce correlation with zero
c       interfacial drag) has not been tested - and the bryce correlation
c       may not be appropriate when non-condensible gases are present.
c       also, the relap5/mod2 bubbly-slug interfacial friction
c       model is believed to be adequate for horizontal flow.
c
c       dlarge is now set to 1.0e6 to force churn-turbulent bubbly
c       and kataoka-ishii correlations to be used for both intermediate
c       and large diameter pipes.
c
c      documentation
c       1. putney, j. m., 1988, proposals for improving interphase drag
c            modelling for the bubbly and slug regimes in relap5.
c            cegb report rd/l/3306/r88, pwr/htwg/p(88)597.
c
c       2. putney. j. m., 1988, implementation of a new bubbly/slug
c            interphase drag model in relap5/mod2.
c            cegb report rd/l/3369/r88, pwr/htwg/p(88)622.
c
c       3. putney. j. m., 1988, equations for calculating interfacial
c            drag and shear from void fraction correlations.
c            cegb report rd/l/3429/r88, pwr/htwg/p(88)630.
c
c       4. putney, j.m., 1988, uk interphase friction model.
c            fax to walt weaver, may 8, 1988.
c
c      argument list
c       fic      = effective interphase drag coefficient
c       c0       = distribution coefficient
c       i        = junction index in junction block arrays
c       output = unit number for error/warning messages
c       kk       = donor volume index in volume block arrays
c       mz       = junction scratch index in scratch block arrays
c       velgjt = physical junction vapor velocity
c       velfjt = physical junction liquid velocity
c       diamjt = physical junction diameter
c       k        = from volume index in volume block arrays
c       l        = to volume index in volume block arrays
c
c      direct outputs
c       fic
c       c0
c
c      note: on input fic is the junction effective interphase drag
c      coeffiecient calculated from the models used in
c      relap5/mod2. this value is not used at present.
c
```

```
c************************* common blocks etc *************************
        include 'comctl.h'
        include 'contrl.h'
        include 'fast.h'
        include 'jundat.h'
        include 'machds.h'
        include 'scrtch.h'
        include 'voldat.h'
c
c************************* declarations ******************************
        real*8 sinbt(1)
        equivalence (sinbt(1),scvfi5(1))
        integer output,i,ireg(2,1),id,kk,mz,k,l,iflag
        equivalence (ireg(1,1),scvfi2(1))
        real*8 dlim
        real*8 kucrit,kuc(7),dst(7),dsmall,dlarge,guhigh,gulow,sinbhv,grav
       #,
       *alpmin,remin,alp1,alp2,alpg,alpf,gflux,vgj,c0,
       *vgjh,c0h,vgjl,c0l,xlow,xhigh,dstar,vc,vgjfld,
       *fic,gdhigh,gdlow,rfg,velgjt,velfjt,diamjt
        logical bundle
        logical hzpipe
        logical upchan
        external brycej,eprij,zfslgj,grdnrj,katokj,wfricj
c
c************************* data *************************************
        data dsmall /0.018d0/
        data dlarge /1.000d6/
        data dlim/0.080d0/
        data guhigh /100.0d0/
        data gulow   /50.0d0/
        data gdhigh /-100.0d0/
        data gdlow   /-50.0d0/
        data sinbhv /0.5d0/
        data grav    /9.80665d0/
        data alpmin/1.0d-02/
        data remin   /4000.0d0/
        data alp1    /0.3d0/
        data alp2    /0.5d0/
        data dst     /2.0d0, 4.0d0, 10.0d0, 14.0d0, 20.0d0, 28.0d0, 50.0d0/
        data kuc     /0.0d0, 1.0d0,  2.1d0,  2.5d0,  2.8d0,  3.0d0,  3.2d0/
        include 'machdf.h'
c
c************************* execution ********************************
c
c determine channel geometry                                          =
c (the channel is deemed to be horizontal if its inclination < 30 deg. =
c   note dz(k)   = elevation change * 1/2 * grav)                     =
        bundle = (iand(vctrl(2,kk),ishft(1,30)).ne.0)
        upchan = (sinbt(mz).gt.sinbhv)
        hzpipe = (abs(sinbt(mz)).le.sinbhv)
c
c======================================================================
```

```
c limit void fraction and determine mixture mass flux                 =
c=====================================================================
c
        alpg = max(voidj(i),alpmin)
        alpf = max(1.0d0-alpg,alpmin)
        gflux = voidgj(i)*rhogj(i)*velgjt + voidfj(i)*rhofj(i)*velfjt
          rfg = max( (rhofj(i) - rhogj(i)), 1.0d-05 )
c
c=====================================================================
c determine geometry and flow conditions and calculate drift velocity =
c and distribution coefficient from appropppriate correlations        =
c=====================================================================
c
c horizontal flow (inclination less than 45 deg)
c
        if(hzpipe) then
          call brycej(vgj,c0,alpg,alpf,gflux,i,kk)
          ireg(2,mz) = 1
c
c vertical flow in rod bundle
c
        elseif(bundle) then
          call eprij(vgj,c0,alpg,alpf,upchan,i,output,kk,velgjt,velfjt,
     *      diamjt)
          ireg(2,mz) = 2
c
c vertical flow in pipe
c
        else
c
c small vertical pipe
c
          if(diamjt.le.dsmall) then
c
c high up or down flow in small vertical pipe
c
            if(gflux.ge.guhigh.or.gflux.le.gdhigh) then
              call eprij(vgj,c0,alpg,alpf,upchan,i,output,kk,velgjt,
     *        velfjt,diamjt)
              ireg(2,mz) = 3
c
c low up, down or counter-current flow in small vertical pipe
c
            elseif(gflux.le.gulow.and.gflux.ge.gdlow) then
              call zfslgj(vgj,c0,alpg,i,kk,diamjt)
              ireg(2,mz) = 4
c
c transition flow regions in small vertical pipe
c
            else
              call eprij(vgjh,c0h,alpg,alpf,upchan,i,output,kk,velgjt,
     *        velfjt,diamjt)
              call zfslgj(vgjl,c0l,alpg,i,kk,diamjt)
```

```
                 ireg(2,mz) = 5
                 if(gflux.gt.gulow) then
                    xlow = (guhigh-gflux)/(guhigh-gulow)
                 else
                    xlow = (gdhigh-gflux)/(gdhigh-gdlow)
                 endif
                 xhigh = 1.0d0 - xlow
                 vgj = xlow*vgjl + xhigh*vgjh
                 c0 = xlow*c0l + xhigh*c0h
c
c all flow regions in small vertical pipe
c
              endif
c
c very large vertical pipe
c
           elseif(diamjt.ge.dlarge) then
c
c high up or down flow in very large vertical pipe
c
              if(gflux.ge.guhigh.or.gflux.le.gdhigh) then
                 call eprij(vgj,c0,alpg,alpf,upchan,i,output,kk,velgjt,
     *           velfjt,diamjt)
                 ireg(2,mz) = 6
c
c low up, down or counter-current flow in very large vertical pipe
c
              elseif(gflux.le.gulow.and.gflux.ge.gdlow) then
                 call grdnrj(vgj,c0,alpg,alpf,i,kk)
                 ireg(2,mz) = 7
c
c transition flow regions in very large vertical pipe
c
              else
                 call eprij(vgjh,c0h,alpg,alpf,upchan,i,output,kk,velgjt,
     *           velfjt,diamjt)
                 call grdnrj(vgjl,c0l,alpg,alpf,i,kk)
                 ireg(2,mz) = 8
                 if(gflux.gt.gulow) then
                    xlow = (guhigh-gflux)/(guhigh-gulow)
                 else
                    xlow = (gdhigh-gflux)/(gdhigh-gdlow)
                 endif
                 xhigh = 1.0d0 - xlow
                 vgj = xlow*vgjl + xhigh*vgjh
                 c0 = xlow*c0l + xhigh*c0h
c
c all flow regions in very large vertical pipe
c
              endif
c
c intermediate vertical pipe
c
```

```
          else
c
            if( diamjt.le.dlim ) then
c
c high up or down flow in intermediate vertical pipe
c
            if(gflux.ge.guhigh.or.gflux.le.gdhigh) then
              call eprij(vgj,c0,alpg,alpf,upchan,i,output,kk,velgjt,
     *        velfjt,diamjt)
              ireg(2,mz) = 9
c
c low up, down or counter-current flow in intermediate vert pipe
c
            elseif(gflux.le.gulow.and.gflux.ge.gdlow) then
              call katokj(vgj,c0,alpg,i,kk,velgjt,velfjt,diamjt,iflag)
              if (iflag .eq. 1) ireg(2,mz) = 10
              if (iflag .eq. 2) ireg(2,mz) = 11
              if (iflag .eq. 3) ireg(2,mz) = 12
c
c transition flow regions in intermediate vertical pipe
c
            else
              call eprij(vgjh,c0h,alpg,alpf,upchan,i,output,kk,velgjt,
     *        velfjt,diamjt)
              call katokj(vgjl,c0l,alpg,i,kk,velgjt,velfjt,diamjt,iflag)
              ireg(2,mz) = 13
              if(gflux.gt.gulow) then
                xlow = (guhigh-gflux)/(guhigh-gulow)
              else
                xlow = (gdhigh-gflux)/(gdhigh-gdlow)
              endif
              xhigh = 1.0d0 - xlow
              vgj = xlow*vgjl + xhigh*vgjh
              c0 = xlow*c0l + xhigh*c0h
c
c all flow regions in intermediate vertical pipe
c
            endif
c
c large vertical pipe
c
            else
              call katokj(vgj,c0,alpg,i,kk,velgjt,velfjt,diamjt,iflag)
              if (iflag .eq. 1) ireg(2,mz) = 14
              if (iflag .eq. 2) ireg(2,mz) = 15
              if (iflag .eq. 3) ireg(2,mz) = 16
            endif
c
c all vertical pipes
c
          endif
c
c all geometries
```

```
c
      endif
c
c=========================================================================
c limit c0 to the range 0 to 1/alpg (may not be necessary).           =
c if vertical counter-current flow, impose a ccfl on vgj.             =
c=========================================================================
c
c limits on c0
c
      c0 = max(0.0d0,c0)
c   if not in subcooled boiling, c0 greater than 1.0
      if( gammaw(kk).le.0.0d0) c0 = max( 1.0d0, c0 )
c   if not a bundle, c0 less than 1.33
      if( .not.bundle ) c0 = min( 1.33d0, c0 )
      c0 = min(1.0d0/alpg,c0)
c
c conditions for no ccfl
c
      if(hzpipe.or.velfjt*velgjt.ge.0.0d0.or.alpg.le.alp1.or.
     &    abs(gflux).le.gulow) goto 150
c
c critical katateladze number
c
      dstar = diamjt *   sqrt(grav*rfg/sigma(kk))
      if(dstar.le.dst(1)) then
        kucrit = kuc(1)
      elseif(dstar.ge.dst(7)) then
        kucrit = kuc(7)
      else
        do 100, id = 2,7
        if(dstar.lt.dst(id)) then
          kucrit = kuc(id-1) + (dstar-dst(id-1))*(kuc(id)-kuc(id-1))/
     &                                 (dst(id)-dst(id-1))
          goto 110
        endif
  100   continue
  110   continue
      endif
c
c ccfl (note alpg > alp1, abs(gflux) > gulow)
c
      vc = ( grav*rfg*sigma(kk)/(rhofj(i)*rhofj(i)) )**0.25d0
      vgjfld = ( (1.0d0-alpg*c0)*c0*kucrit*vc ) /
     &          (   sqrt(rhogj(i)/rhofj(i))*alpg*c0 + 1.0d0 - alpg*c0 )
      vgjfld = min(vgj,vgjfld)
      if(abs(gflux).lt.guhigh) then
        vgjfld = vgj + (abs(gflux)-gulow)*(vgjfld-vgj)/(guhigh-gulow)
      endif
      if(alpg.lt.alp2) then
        vgj = vgj + (alpg-alp1)*(vgjfld-vgj)/(alp2-alp1)
      else
        vgj = vgjfld
```

```
      endif
      vgj = max(alpf*1.0d-2,vgj)
c
  150 continue
      vgjj(i) = vgj
c
c=====================================================================
c calculate effective interphase drag                              =
c=====================================================================
c
c interphase drag coefficient
c
      if (.not.upchan .and. .not.hzpipe) vgj = - vgj
      if(.not.hzpipe) then
        if (vgj .eq. 0.0d0) then
          fic = 100.0d0
        else
          fic = alpg*alpf*alpf*alpf*rfg*grav*sinbt(mz) / (vgj*abs(vgj))
        endif
      else
        fic = 0.0d0
      endif
      if (chngno(19) .and. bundle) then
        fic = 65.0d0*alpg*alpf*alpf*alpf*rhogj(i)/diamjt
        c0 = 1.2d0
      endif
c=====================================================================
c check for negative coefficients (should never occur)             =
c=====================================================================
      if (fic.lt.0.0d0.or.c0.lt.0.0d0) then
        write(output,1000) junno(2,i),dz(kk),dl(kk),sinbt(mz),ireg(2,mz)
     #,
     &   voidj(i),gflux,velgjt,velfjt,vgj,fic,c0,timehy
 1000 format('0******** Negative interphase friction coefficient in ',
     &         'fidisj - junction ',i10/' dz = ',1p,g13.5,' dl = ',g13.5,
     &         ' sinbt = ',g13.5/' ireg = ',i8,' voidj = ',g13.5,
     &         ' gflux = ',g13.5/' velgjt = ',g13.5,' velfjt = ',g13.5,
     &         ' vgj = ',g13.5/' fic = ',g13.5,
     &         ' c0 = ',g13.5,' time = ',g13.5)
      endif
cmodify begin
       fic = fic*0.5
cmodify end
      return
      end
```

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10. SUPPLEMENTARY NOTES

S. Smith, NRC Project Manager

11. ABSTRACT *(200 words or less)*

This report presents the results of the RELAP5/MOD3 Version 7j assessment on BETHSY 6.2 TC test corresponding to a six inch cold leg break LOCA of the Pressurizer Water Reactor (PWR). The primary objective of the test was to provide reference data of two facilities of different scales (BETHSY and LSTF facilities). The present calculation aims at analysis of RELAP5/MOD3 capability on the small break LOCA simulation. The results of calculation have shown that the RELAP5/MOD3 reasonably predicts occurrences as well as trends of the major phenomena such as primary pressure, timing of loop seal clearing, liquid hold up, etc. However, some differences also have been found in the predictions of loop seal clearing, collapsed core water level after loop seal clearing, and accumulator injection behaviors. For understanding of discrepancies in the same predictions, several sensitivity calculations have been performed as well. These include the changes of two-phase discharge coefficients at the break junction and some corrections of the interphase drag term. As a result, change of a single parameter has not improved the overall predictions and it has been found that the interphase drag model still has large uncertainties.

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