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Assessment of RELAP5/MOD3 With the SNUF Test Simulating Hot Leg Break LOCA in the View of Mass and Energy Release Analysis

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Abstract

SNUF experiment on hot leg break large break loss of coolant accident during post-blowdown was analyzed by RELAP5. As same with the procedure of SNUF experiment, normal operation and blowdown phase were simulated in order, and the initial condition was obtained and compared with the experimental initial condition. The analysis of post-blowdown phase showed that the behavior of primary pressure can be properly simulated by RELAP5 when sufficient heat source is modeled. Resultantly, the release from reactor side broken section and steam generator side broken section were properly predicted. The pressure rise in the second step of pressure behavior was partially well predicted, where the pressure increased by the steam generation in core. The release from the steam generator side broken section was predicted to be little except when there exits large pressure difference between primary system and break boundary. Break size did not affect much on the overall behavior to some degree.

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Executive Summary

This document describes an assessment of beta version of RELAP5/MOD3.2.2 code with Seoul National University Facility (SNUF) test. The SNUF is scaled down model of Young Kwang Nuclear Power Plant Units 3&4 (YGN Units 3&4) with volume ratio 1/1140. And the design was based on the Ishii's three level scaling law. The experiment simulated a hot leg break large break loss-of-coolant accident (LBLOCA) during post-blowdown.

To evaluate the code predictability for specific thermal hydraulic phenomena of hot leg break LBLOCA during post-blowdown, the major thermal hydraulic phenomena observed in the experiment were investigated. Those phenomena include the cold leg refill, steam generation in core and resultant repressurization, and negligible coolant release through the SG side broken section.

The SNUF was modeled as suitable for simulating the experiment, based on the available information on the design and test procedures such as normal operation, drain-down, and post-blowdown. Prior to the preparation of base case input deck, pressure drop test in SNUF was conducted, and the experimental result was reflected in loss coefficient in input deck. The normal operation, the drain-down, and post-blowdown were assessed in order, according to the procedure of experiment.

The base case calculation was executed, the result was compared with the experiment data, and the code predictability on the important thermal hydraulic phenomena was discussed. Sensitivity calculations were attempted to evaluated the effect of modeling of heat structure (Run02), break boundary pressure (Run03), and break size (Run04, Run05). The main parameters for comparison with experiment were system pressure, discharged amount in each broken section, water level in U-tube, and temperature in reactor lower plenum. The analysis results are summarized as follows;

1) System pressure was properly predicted, showing the three distinguished steps; first step in which the pressure decreases rapidly, second step in which the pressure slightly increases due to the steam generation in core, and the third step in which the pressure goes stable. The predicted decrease rate of pressure in first step was similar with experiment. In the second step, the predicted pressure increased slightly due to the two

phase pressure drop in break junction, and the pressure increased a little more than experiment. In third step, no more complicated phenomena were shown even though the pressure showed small instability.

2) The discharged mass through the reactor side broken section showed good agreement with experiment. In first step, pure steam release was predicted. The timing when the main release began because of two-phase release was predicted to be similar with experiment.
3) The discharged mass through the SG side broken section showed roughly similar trend with experiment. In first step, small mass release was predicted because of large pressure difference between system and break boundary. In second step, small mass release was also revealed in calculation because the pressure in second step was predicted to be higher than experiment.
4) The water level in U-tube in second step was predicted to be higher than the experiment since the pressure in second step was higher than experiment.
5) The cold leg was refilled earlier than reactor vessel as experiment, which was checked by the water level in cold leg and U-tube.
6) The temperature in reactor vessel lower plenum showed slightly higher than experiment. However, the temperature near the lower plenum was similar with experiment.
7) Sensitivity study indicated that the modeling of heat structure is very important and that the break size is not so decisive to some degree.

I. Introduction

In postulated LBLOCA (Large Break Loss-of-Coolant-Accident), coolant release continues over several phases like as blowdown and post-blowdown phase (refill, reflood and post-reflood phase). During blowdown phase, most of the initial primary coolant is released to containment. However, during post-blowdown, the evaporation of Safety Injection (SI) water in the reactor core can contribute to the containment pressure rise and thus generate the second peak pressure, which will be the criteria of containment design pressure in most nuclear power plants. During that phase, the Steam Generators (SG's) heat removal has different characteristics depending on break locations.

For cold leg break, the steam and entrained water carried out of the core pass through the SG, where the entrained water is evaporated or can be superheated to nearly the temperature of the SG secondary system temperature by reverse heat transfer. Therefore, in conservative licensing analysis, containment can be repressurized during the post-blowdown phase under the assumption of this reverse heat transfer mechanism. However, for hot leg break, majority of coolant from the core is expected to be directly discharged to the containment without passing the SG, since the broken hot leg provides a direct release path [1]. Thus, in the case of hot leg breaks, quantitative analysis for the post-blowdown phase has not been performed usually in the safety analysis report. And it was a general trend that the containment peak pressure occurred during post-blowdown phase for the cold leg break, and the peak pressure was higher than the blowdown peak pressure of the hot leg break. Therefore, the cold leg break case was recognized as a limiting design basis event in the determination for containment design pressure [2].

However, the maximum containment pressure accident was inconsistently reported in preliminary safety analysis report (PSAR) and final safety analysis report (FSAR) of Young Kwang Nuclear Power Plant Units 3&4 (YGN Units 3&4), which is the base of Korean Standard Nuclear Power Plant. Double Ended Discharge Leg Slot Break (DEDLSB) was reported to be such an accident in PSAR, while Double Ended Hot Leg Slot Break (DEHLSB) in FSAR [3]. This is contradictory from previous trends. Therefore, it became very important to investigate the realistic behavior of hot leg break LBLOCA during post-blowdown.

Korea Atomic Energy Research Institute (KAERI) implemented RELAP5 analysis for LBLOCA of YGN Units 3&4 to investigate the realistic behavior of LBLOCA in YGN Units

3&4[4]. However, the predictability of RELAP5 for hot leg break accident has not been sufficiently discussed yet. In Seoul National University, an experimental study for hot leg break LBLOCA during the post-blowdown was carried out to support the regulatory evaluation of this issue with the facility, Seoul National University Facility (SNUF), which simulates YGN Units 3&4 with volume ratio 1/1140 [5]. The objective of SNUF test was to investigate a characteristic feature of hot leg break LBLOCA during post-blowdown phase. The experiment indicated that the SI water refilled the suction part of cold leg first and refilled the core later. Steam generation in core gave rise to the pressure of reactor coolant system and the repressurization forced the coolant in cold leg to flow up to some height of U-tube of SG. However, the time duration that the coolant stayed in U-tube was short, and the resultant coolant release from SG side broken section was negligible such that the SG could be regarded as a minor heat source of coolant release [5].

The objective of this study is to evaluate the predictability of RELAP5/MOD3 on major thermal hydraulic behaviors during the post-blowdown of hot leg break LBLOCA of YGN Units 3&4. Such transient hydraulic behaviors include the cold leg refill, steam generation in core and resultant repressurization, and negligible coolant release through the SG side broken section.

The code used in this study was the standard version of RELAP5/MOD3.2.2 beta, which was known to have the improved features from the previous version of RELAP5/MOD3 [6].

The Chapter II includes a brief description of SNUF, the experimental condition and procedure. The Chapter III describes the modeling of SNUF nodalization. The Chapter IV discusses in detail the calculation results with experimental results. In particular, the discussion involves an assessment of the major phenomena of hot leg break LBLOCA during post blowdown. The code predictability and run statistics are also described in this chapter. The conclusions are derived through present study and summarized in the Chapter V. Finally, input deck for steady state run, drain-down run, and post-blowdown run are attached in Appendices A, B, and C, respectively.

II. Facility and Test Descriptions

II.1 Facility Description

The Seoul National University Facility (SNUF) is a scaled integral experimental test facility of the YGN Units 3&4, one of the Combustion Engineering type Pressurized Water Reactor in Korea. The facility was constructed in the Seoul National University (SNU). Its length scale ratio is 1/6.4, area scale ratio $(1/13.4)^2$, and resultantly, the volume scale ratio 1/1144. Figure 1 shows the configuration of SNUF, and Figure 2 shows its schematic diagram. The design and the scaling were based on the Ishii's three level scaling [5,7]. The important geometric design parameters are presented in Table 1.

The SNUF has appropriate components of primary system and secondary system for mass and energy release experiment. The facility consists of a reactor vessel, two SG's, an intact loop with one cold leg and one hot leg, a broken loop with one hot leg and two cold legs, two discharge tanks, and SI system.

The reactor vessel contains 60 kW electrical heaters to simulate the scaled 2.2% core decay heat power, which is corresponding to the decay heat at 15 seconds after reactor trip plus the heat of inner metal structures. At the lower part of reactor vessel, the drain valve is piped outwardly for primary coolant drain during the drain-down phase.

A SG is equipped in each loop, and each SG contains four U-tubes with the height of 1725 mm, six U-tubes with the height of 1643 mm and six U-tubes with the height of 1562 mm. Inner and outer diameters of U tubes are 19 mm and 21 mm, respectively. The secondary system is composed of SG shell, steam line and feedwater line.

The intact loop has a hot leg and a cold leg. The two cold legs are scaled into a lumped single cold leg to have the similar volume. At the hot leg, a window glass is also installed to observe the behavior of fluid.

The broken loop is composed of one broken hot leg and two cold legs. The broken hot leg is designed to simulate double ended guillotine break, and thus comprises of two broken sections, i.e. the reactor side broken section and the SG side broken section. The broken sections are

simulated using ball valves, and an isolation valve is installed between the two broken sections. Since the isolation valve is instantly closed at the beginning of the experiment, the mass releases from each broken section can be measured independently. Two window glasses are installed in hot leg for the direct visual observation of fluid behavior. A window glass is also installed in cold leg suction part for the sake of direct visual observation of fluid behaviors in the early stage of ECCS injection.

Discharge tanks connected to each broken section simulate the containment. Thus, the size of each discharge tank was determined to be sufficient for the expected discharge amount. The capacity of the reactor vessel side discharge tank is about 150 liter with diameter of 600 mm and height of 700 mm, while that of the SG side discharge tank is 30 liter with diameter of 300 mm and height of 700 mm. Those two discharge tanks were interconnected with each other with 1/2 inch pipes in order to maintain the same pressure. Each discharge tank contains a cooling system to condense the steam immediately, and then the discharge amount can be measured by a level meter.

The SI system is composed of a storage tank, a SI pump and a flow controller. The storage tank is equipped with electrical pre-heaters of 20 kW in order to control the temperature of SI water. The SI line is connected to cold leg.

II.2 Measurement Instruments

The measurement instruments are listed in Table 2 with the uncertainties. Ten thermocouples, one pressure transducer, two level meter and one flow meter were used.

The steam and water which are released through each broken section are condensed or cooled down in each discharge tank and then the water level is measured. The discharged amount is calculated by multiplying the level by the cross sectional area of each tank. The temperatures were measured, as shown in Figure 2. The fluid temperatures in upper and lower parts of each broken section are measured to investigate the stratification, and the temperature at the half height of U tube is to catch up the flowing up of cold SI water into the half height of U tube. The T type thermocouples were used, which is known to have excellent performance in the range of -200℃~400℃. The absolute pressure is measured at the reactor top head with PDCR922 and DPI 260 model made in Druck Co.. The flow rate is measured at the SI system

with DP103 wet-wet type. The volumetric flowrate is correlated with the pressure drop across the orifice.

II.3 Experimental Conditions and Procedures

The SNUF experiment simulated the post-blowdown transient of hot leg break LBLOCA. Thus, the initial condition is End-Of-Blowdown (EOB). Initial condition of experiment was carefully established. The result of RELAP5 analysis for YGN Units 3&4 was used as reference initial condition [2,4]. The RELAP5 analysis did not show such an EOB point where the primary pressure became same with the containment pressure. Thus, in this experiment the EOB was assumed to be about 15 seconds elapsed from the initiation of accident. The RELAP5 analysis at this time showed that the primary pressure was decreased close to containment pressure, and that the core was fully voided. Resultantly, the collapsed liquid level of the reactor fell to minimum [2,4].

The experiment was conducted in following procedures as shown in Figure 3; pressure drop test, normal operation, drain-down, and post-blowdown. The result of pressure drop test was to check the characteristics of loop, and it was reflected in the determination of loss coefficients. The results of pressure drop test is listed in Table 3.

In normal operation, the primary system and the secondary system were maintained nearly saturated at 0.8MPa and at 0.5MPa, respectively. The core power was 60kW. Important operation conditions are presented in Table 4. From this condition, the primary water inventory was drained until the water remained only at the lower plenum. This procedure is the drain-down phase. In the drain-down phase, the coolant in the cold leg suction part did not flash up but remained as saturated or subcooled water. Thus, in experiments the coolant was artificially drained. The temperature of secondary system was higher than that of primary system, and the secondary system could play a role of heat source if the injected SI water passed through U tubes. From this drain-down process, the initial condition of experiment was obtained, and it is compared with EOB condition of YGN Units 3&4 in Table 5.

At the commencement of experiment, the SI pump operated, each discharge valve opened to simulate the break, and the isolation valve was closed at the same time. The main power was turned on earlier by 30～40 seconds for preheating than the start of the experiment. The SI

temperature was maintained as 60℃, which was a little higher than that of real plant in order to compensate for the lack of the heat capacity of the RCS metal, and the SI flow rate was maintained constant at the rate of 2.2lit/sec. The core power was set as 60kW.

III. Code and Modeling

III.1 Code Description

The RELAP5 code has been developed as one of the best estimate-codes. The code is based on a non-homogeneous and non-equilibrium two-fluid model and constitutive equations for one dimensional two-phase system. In this study, unmodified released version, RELAP5/MOD3.2.2 beta version, was used, and input decks are prepared based upon the RELAP5/MOD3 [7]. RELAP5/MOD3.2.2 beta version was installed in personal computer of Pentium-III 500 MHz.

III.2 Modeling Description

In the analysis of SNUF experiment, the calculation procedure traced the procedure of experiment; calculation of pressure drop, calculation of normal operation (steady state run), calculation of drain-down (drain-down run) and finally calculation of post-blowdown (post-blowdown run), as shown in Figure 3.

1. Preparation of Input Deck and Steady State Calculation

The base case nodalization for SNUF experiment is shown in Figure 4. This base nodalization is composed of 147 volumes, 151 junctions, and 101 heat structures. All important components like as a reactor vessel, a downcomer, two SG's, an intact loop, a broken loop, and secondary system were modeled. Downcomer and suction leg where rapid transient is expected are nodded finely. The downcomer was modeled with separated channel in order to reflect the asymmetric behavior of two loops. All the heat structures of primary system are modeled including electrical heaters. Each leg is connected to reactor vessel or downcomer with cross flow junction.

For the exact simulation of pressure drop over the loop, the results of pressure drop test of Table 3 were reflected through the loss coefficients. The pressure drop experiment was carried out under the condition of atmospheric pressure with 25℃ water. The pressure drop was significant at the inlet and the outlet of the reactor vessel and the SG. Loss coefficients at the other parts were determined referring the fluid handbook [8], since the pressure drops at the other parts were comparatively small.

Reflecting such pressure drops, a steady state was obtained from the calculation of normal operation. The results are presented in Table 4, and compared with the experimental condition. The primary system was 0.8MPa, and nearly saturated. The secondary system was 0.5MPa, and saturated. The core power was 60kW.

2. Simulation of Drain-down and Initial Condition

In the beginning of SNUF experiment, all coolant in primary system was drained except in reactor lower plenum, and the primary pressure was 0.35MPa. To obtain these conditions, drain-down nodalization is used in the Figure 4. Valve junctions J991, J993, J995 and J999 are opened and time dependent volumes C992, C994, C996 and C998 are used. The primary coolant is drained from reactor lower plenum (through J999) and each bottom of cold leg (through J991, J993, J995) as the SNUF experiment. The drain is stopped when the liquid levels of reactor and each cold leg are below 65mm and 20mm, respectively. Even after the drain was complete, dummy calculation was continued for a few ten seconds in order to obtain the stable state of the system. In the calculation, the liquid level is defined as collapsed water level determined from the void fraction in the volumes of reactor vessel and suction legs.

$$L = \sum_i (1-\alpha_i) \cdot H_i \qquad (1)$$

,where L is collapsed water level,

α is void fraction,

H is height of volume.

As a result, initial conditions obtained from this calculation are shown in Table 5, and the results are consistent with initial condition of experiment.

3. Simulation of Post-blowdown

For the simulation of post-blowdown, the drain-down nodalizations (J991, J993, J995, J999, C992, C994, C996, and C998) was removed. The nodalizations for the SI line (C900, C902, C910, C920, C930, J901, J911, J921, and J931) and the breaks were added. The SI water of 60℃ is provided from time dependent volume C900, and is branched to each cold leg. The SI flowrate was set constant as 2.2kg/s, and modeled using time dependent junction, J901. The break is modeled as double ended break, and from two broken sections the coolant is released.

The two break boundaries, C954 and C964, are modeled using time dependent volume filled with saturated steam. The isolation valve J411 was also closed. The important conditions are listed in Table 6, compared with experimental conditions.

IV. Results and Discussions

The considered calculation cases are listed in Table 7. Run01 is base case. In the base case, all the heat structures in primary system are modeled including electrical heaters, and the break boundaries filled with saturated steam are maintained as atmospheric pressure. Run02 is same with base case except that only electrical heater and U-tubes are modeled in heat structure in order to evaluate the effect of heat structure modeling. Run03 assumes the pressurization of break boundary according to primary pressure transient. The condition of pressurized break boundary is more faithful to the definition of EOB, since EOB is generally the time when the primary pressure decreases to the containment pressure. Run04 and Run05 are for the evaluation of break size. In Run04, the break size is same with the cross-sectional area of hot leg, and in Run05, it is half of the cross-sectional area of hot leg. The break size of base case is smaller than that of Run04, and larger that that of Run05.

IV.1 Results of Base Case (Run01)

1. Pressure of primary system

Figure 8 shows comparison of the pressure of reactor vessel top head between the calculation and the experiment. In the experiment, the pressure behavior can be classified into three distinguished steps; first step in which the primary system pressure decreases rapidly, second step in which the pressure increases slightly and last third step in which the pressure decreases slowly toward steady state. The first step extends from 0 to 40 seconds, the second step from 40 to 80 seconds, and the thirds step from 80 seconds to the last [5].

The first step is characterized by rapid decrease of pressure due to the steam release. For this step, the RELAP5 shows the good agreement with experiment, and the rate of pressure decrease is also similar with experiment. However, the timing that the pressure reaches the minimum is earlier than experiment by a few seconds.

Second step is characterized by slight increase of pressure due to the steam generation in core. Run01 could not perfectly predict such a behavior. At about 60 seconds, the pressure in experiment reaches the peak, and the Run01 also shows such a pressure rise. The predicted pressure rise in Run01 is higher than that in experiment. In experiment, since much steam was

generated when the SI water reached the bottom of core, and little steam was generated after the core was fully refilled, the mild increase and decrease of pressure behavior were observed. Whereas, the pressure rise before core refilling was not predicted, however after the mixture level of core increased to the hot leg level and the two-phase mixture began to be released, the pressure rise was induced by the loss coefficient at reactor out let. The starting point of two-phase mixture release is very close to the time when the discharge amount (integrated break flow) begins to increase drastically, which will be discussed in next section. Consequently, in the second step, RELAP5 seems to predict at least the characteristic feature of pressure behavior.

In third step, no more transient is expected thereafter in experiment. The Run01 shows intermittent increase and decrease of pressure, which is thought to be caused by the unstable direct contact condensation of steam and subcooled water in reactor upper plenum. Figure 6 shows that the void fraction in upper plenum (C21001) is decreased by condensation after 90 seconds, and that the void fraction is decreased rapidly after 105 seconds when the rapid change of pressure appears. Consequently, RELAP5 well predict the overall pressure behavior in third step with intermittent instabilities.

2. Mass and Energy Release

Discharged masses (integrated break flow) through reactor vessel side broken section and SG side broken section are presented in Figures 7 and 8, respectively. The figure for the discharged mass of reactor vessel side broken section shows that there is only steam release during first step of pressure behavior, however, it seems that the steam release in experiment was not sufficiently measured since the release was measured by condensing the steam. The result of RELAP5 analysis revealed that a little steam is released before 10 seconds when the pressure decreases rapidly. However, after 15 seconds, little steam is released, and no increase in discharged mass is revealed.

In experiment, from about 60 seconds, two-phase mixture was initiated to be released. RELAP5 analysis of Figure 7 shows that the release rate is increased slightly before 60 seconds, and that main release is initiated slightly after 60 seconds. The initiation of two-phase release causes the larger pressure drop in reactor vessel outlet, and the pressure of reactor vessel is increased.

After 60 seconds, the experiment shows the stable release, however the RELAP5 shows the

unstable one. It seems caused by the unstable direct contact condensation in reactor vessel upper plenum, as shown in Figure 9. As the Figure 9 shows, it can be seen that the void fraction in C20001 was more unstable than the void fractions in the other volumes.

In Figure 8, the experiment shows nearly zero discharge through the SG side broken section, however the RELAP5 shows some discharge in 15 seconds and 65 seconds. This phenomenon is related with the water level in U-tube, which will be discussed in the next section on water level.

3. Water Level

As discussed in experimental result, the SI water refills the cold leg first. The SI water flows up to the U-tubes by the repressurization of reactor vessel in the second step of pressure behavior as shown in Figure 10. Figure 11 shows the collapsed water level in U-tubes from the RELAP5 calculation. High water level was predicted at about 10 and 60 seconds. In experiment, the water level was detected by measuring the fluid temperature at middle height of U-tubes as shown in Figure 12. The water level reaches the location of thermocouple from the fact that the fluid temperature drops rapidly twice by cold water. The first level rise at 10 seconds in Figure 11 was caused by the large pressure difference between the reactor vessel and break boundary. As the water level increases up to such a height, some of the water is released through the SG side broken section. Resultantly, there was a little coolant release through the SG side broken section, as shown in Figure 8. Consequently, the RELAP5 well predicted the fact that water lever in U-tube rose twice at about 10 and 60 seconds, but the predicted water levels were higher than experimental ones. Such a behavior in early transient is largely affected by the boundary pressure, and it will be discussed once more in the analysis of Run03.

In the third step of pressure behavior, the experiment revealed that there was no more water level rise up to the middle height of U-tube. And, the REPAL5 analysis also showed the same result with experiment.

The Figure 13 shows the water level of suction leg in broken loop. In the experiment, the level was identified by the direct observation or taking pictures through the transparent window glass. The experiment revealed that the suction leg was refilled most early and there was slight oscillation only while the leg was being refilled. And, after the suction leg got refilled, the fluid

in the suction leg was stabilized. But, the RELAP5 analysis shows the continuous oscillation in water level as shown in Figure 13. This is caused by the unstable condensation in suction leg, which can be seen in Figure 14.

4. Temperatures

The temperature measured in experiment is local time averaged temperature, and the temperature of RELAP5 is volume averaged and time averaged temperature. In Figure 15, the temperatures of RELAP5 are the liquid temperatures (tempf). The Figure 15 compares the experimental temperature and RELAP5 temperatures near the measured point. The temperature of C13205 is similar with the experimental result, however the temperatures of C16001 and C14205 are higher than experiment's.

The fact that the temperature of C14205 is higher than that of experiment is caused by the distribution of SI water in downcomer as shown in Figure 16. The total SI flow rate was constant as 2.2kg/s. However, the larger SI pipe size of the intact loop than that of broken loop leads to the more injection to the intact loop than broken loop as shown in Figure 17, which induces the more condensation of steam, and the lower pressure in intact side downcomer. Therefore, because of such a pressure gradient between the intact side and broken side in downcomer, the SI water in intact side flow to the broken side along the downcomer wall. Resultantly, most of the SI water is injected through the intact side downcomer as shown in Figure 16, and the temperature of C14205 is predicted higher than that of C13205.

The volume of lower plenum, C16001, contains a little saturated water at the beginning, and as the transient goes on, the water swells to flow up to the core, which heated the water more. Such a swelling can be seen from the behavior of void fraction in Figure 18. The void fraction in C16001 is small at first, and undergoes the increase and decrease in order. Thus, the predicted temperature is revealed higher than the experiment.

Such a temperature difference can be explained related with thermal mixing in reactor lower plenum. According to the study about thermal mixing in reactor lower plenum with SNUF, even in higher mass flow rate the thermal mixing was not prominent [9].

IV.2 Sensitivity Studies

1. Run02 – Effect of Heat Structure

The Figure 19 compares the pressure of reactor top head in Run02 with that in experiment and base case. The pressure in Run02 shows more rapid decrease of pressure than that in experiment and base case in first step. The pressure rise in second step was not well predicted. This fact means that the heat of metal structure is important in the analysis of mass and energy release, as mentioned in FSAR of YGN Units 3&4. Therefore, the modeling of heat structure in the analysis of mass and energy release is very important

Discharge amounts (integrated break flow) through reactor side broken section and SG side broken section in Run02 are presented in Figures 20 and 21, respectively. The Figure 20 shows that the discharge amount in Run02 is similar with that of Run01, however, the Figure 21 shows that Run02 does not predict the second release through SG side broken section because there is no pressure rise in second step. Resultantly, as Figure 22 shows, the water level in U tube in second step does not increase.

2. Run03 – Effect of Boundary Pressure

In Run03, the break boundary is pressurized like as Figure 23, where the boundary pressure is slightly lower than the reactor vessel pressure in first step of experiment. The predicted pressure of reactor top head is shown in Figure 24 comparing with experiment and base case. The pressurization of break boundary led smaller rate of pressure decrease. The release through the reactor side broken section in Figure 25 shows earlier two-phase release than Run01. It is because in the earlier transient, the release through the SG side broken section in Figure 26 is very small compared with Run01, because of the smaller pressure difference between system and boundary. The water level in U tube in first step is also lower than that of Run01 as shown in Figure 27. Consequently, the result of Run03 implies that the effect of boundary pressure does not affect much on the overall behaviors.

3. Run04 and Run05 – Effect of Break Size

Run04 and Run05 are to evaluate the effect of break size. The break area in Run04 is same with the cross-sectional area of hot leg, and that in Run05 is half of the cross-sectional area of hot leg. The pressure in reactor vessel top head shows similar trend with base case in spite of the difference of break area as shown in Figure 28. Discharge amount from each broken section and water level in U-tube are also similar with base case as shown in Figures 29, 30 and 31. From this fact, it can be concluded that the break size in post-blowdown is not so important to some degree.

IV.3 Run Statistics

IBM compatible personal computer of Pentium-III 500 MHz was used in calculation with Microsoft Windows NT 4.0 version. The personal computer has 256 MB main memory.

Calculation in drain-down was attempted to 1200 seconds and, calculation in post-blowdown was attempted from 1200 seconds to 1320 seconds. The base case run was successfully terminated at 1320 seconds. The calculation time is shown in Figure 32, setting 1200 seconds as 0 second, and 1320 seconds as 120 seconds. For 5 seconds from 1200 seconds to 1205 seconds, fine time step was used, and the required calculation time was more than in the other calculation.

The base case run was terminated at 1320 seconds, and the required CPU time in personal computer was 1767.33 seconds including 0.468750 second for input processing. The attempted advancement was 67572 time steps. Therefore, the grind time for the base case can be calculated as follows;

CPU Time,	CP	= 1767.33 – 0.468750 = 1767.33 seconds
Number of Time Step,	DT	= 94766 – 27194 = 67572
Number of Volume,	C	= 134
Transient Real Time,	RT	=120 seconds
Grind Time,	GT	= (CP*1000)/(C*DT)
		= (1767.33*1000)/(134*67572)
		= 0.1952 m CPU sec/(vol-step)

V. Summary and Conclusion

The RELAP5/MOD3 was assessed using SNUF experiment simulating hot leg break LBLOCA in the view of mass and energy release analysis. In order to evaluate the code predictability on major thermal hydraulic behavior, the calculation results were assessed and compared with the experimental data.

SNUF is scaled down model with volume scale ratio 1/1144 simulating YGN Units 3&4. The SNUF experiment showed that most of injected SI water was released through the core side broken section and thus the release through the SG side broken section was negligible. The remarkable feature is that the SI water refilled the cold leg first, and resultantly the steam generated in core could not be heated directly by SG. Although this experiment showed that the water in cold leg could flow up to a half height of U tubes, the duration time was not sufficiently long for the SG to be taken as a major heat source.

RELAP5 analysis for the SNUF experiment showed that this code can properly predict the important features of hot leg break LBLOCA during post-blowdown, when all the heat structures are modeled. And the releases from reactor side broken section and SG side broken section were also predicted satisfyingly. Especially, the pressure rise in second step of pressure behaviors were predicted partially, and the release from SG side broken section was little except when the pressure difference between the primary system and break boundary is not large in early stage of transient. However, since the unstable direct contact condensation in suction legs resulted in the unstable behavior of water level, they were different from experimental results. Break size did not affect much on the overall behavior to some degree.

References

[1] KEPCO, YGN3&4 FSAR, Chap. 6.

[2] Young Min Kwon, Chan Eok Park and Jin Ho Song, "Comparative Mass and Energy Releases and Containment Analysis for a Large-Break Loss-of-Coolant-Accident Using RELAP5/CONTEMPT4 and Design Computer Codes", Nuclear Technology Vol. 122, pp.295-305, 1998

[3] G.C. Park, et al., "Review on the Mass and Energy Release Analysis", KINS/HR-093, 1993

[4] Jin Ho Song, et al., An Analysis Methodology for Hot Leg Break Mass and Energy Release, KAERI/TR-746/96, 1996

[5] S.J. Hong J.H. Kim and G.C. Park, "An Experimental Study on the Mass and Energy Release for a Hot Leg Break LBLOCA during Post Blowdown", J. of the Korean Nuclear Society Vol. 32, pp108-127, 2000

[6] "RELAP5 Code Manual", Vol. 1-5, NUREG/CR-5535, INEL-95/0174, 1995

[7] M. Ishii, et al, "Scientific Design of Purdue University Multi-Dimensional Integral Test Assembly (PUMA) for GE SBWR", NUREG/CR-6309, 1996

[8] Robert D. Blevins, "Applied Fluid Dynamics Handbook", Van Nostrand Reinhold Company, 1984

[9] Kil-Sup Um, Seok-Hee Ryu, Yong Seok Choi and Good-Cherl Park, "Experimental and Computational Study of the Core Inlet Temperature Pattern under Asymmetric Loop Conditions", Nuclear Technology Vol.125, 1999

Table 1 Geometric design parameters for SNUF and YGN3&4

	UNIT	SNUF	YGN3&4[1]
Vessel			
Height	[mm]	1975	12.7×10^3
Flow area	[mm^2]	74748	13.3×10^6
Hot leg			
Flow length	[mm]	683	4.83×10^3
Flow area	[mm^2]	4990	0.89×10^6
Suction leg			
Flow length	[mm]	1172	7.52×10^3
Flow area	[mm^2]	2579	0.46×10^6
Discharge leg			
Flow length	[mm]	916	5.88×10^3
Flow area	[mm^2]	2579	0.46×10^6
Fuel hydraulic diameter	[mm]	14	3
Fuel conduction depth	[mm]	2.5	2.4

Table 2 Measurement instruments

Sensor ID	Measurement	Uncertainty
TC01	Outer wall of reactor vessel lower plenum	2•
TC02	Fluid temperature of intact hot leg	2•
TC03	Fluid temperature of reactor vessel lower plenum	2•
TC04	Fluid temperature of broken hot leg upper part in reactor side	2•
TC05	Fluid temperature of broken hot leg lower part in reactor side	2•
TC06	Fluid temperature of broken hot leg upper part in SG side	2•
TC07	Fluid temperature of broken hot leg lower part in SG side	2•
TC08	Fluid temperature of secondary system	2•
TC09	Fluid temperature of U-tube entrance	2•
TC10	Fluid temperature of U-tube middle height	2•
PT01	Pressure at reactor vessel top head	0.001MPa
LT01	Discharge amount in reactor side broken section	3.8liter
LT02	Discharge amount in SG side broken section	0.7liter
FT01	Total SI flowrate	0.09kg/sec

Table 3 Experiment for the measurement of pressure drop
(Pressure : 0.1013MPa , Temperature 25℃, Water)

	Flowrate [kg/sec]	Pressure drop [Pa]
Reactor In/Outlet (C33001~C36001)	1.9112	513
	1.6370	410
	1.2730	317
SG In/Outlet (C37401~C31001)	0.6099	528
	0.5235	407
	0.3955	256

Table 4 Normal operation condition

Parameters	SNUF	RELAP5
Pressure of reactor top head	0.8MPa	0.826MPa
Temperature of primary system	~ Saturated	~ Saturated
Core power	60kW	60kW
Pressure of secondary system	0.5MPa (Sat.)	0.5MPa (Sat.)

Table 5 Initial condition in model and prototype

	SNUF	YGN3&4[4]
Core pressure [MPa]	0.35	0.5
Core temperature	Sat.	Sat.
Mean power [kW]	60.0	60.0×10^3
Core exit void fraction	100%	100%
Liquid rise velocity [m/sec]	0.0111	0.276

Table 6 Initial conditions of experiment and RELAP5

Parameters	SNUF	RELAP5
Pressure of reactor top head	0.35MPa	0.36MPa
Pressure of secondary system	0.5MPa (Sat.)	0.499MPa(Sat.)
Temperature of reactor lower plenum	142 ℃	140 ℃
Temperature of U tube entrance	139 ℃	137 ℃
Temperature of secondary system	154 ℃	153 ℃
Core power	60 kW	60 kW
Total SI flowrate	2.2 kg/sec	2.2 kg/sec
Temperature of SI	60 ℃	60 ℃

Table 7 Calculation cases

	Break boundary (C954, C964)	Break area (J951, J961)	Heat structure
Run01	Constant as atmospheric pressure, filled with saturated steam	Break valve area	All Structures of primary systems are modeled
Run02	Constant as atmospheric pressure, filled with saturated steam	Break valve area	*Only heaters and U Tubes are modeled*
Run03	*Pressurized according to primary pressure, filled with saturated steam*	Break valve area	All Structures of primary systems are modeled
Run04	Constant as atmospheric pressure, filled with saturated steam	*Hot leg cross-sectional area*	All Structures of primary systems are modeled
Run05	Constant as atmospheric pressure, filled with saturated steam	*1/2 of Hot leg cross-sectional area*	All Structures of primary systems are modeled

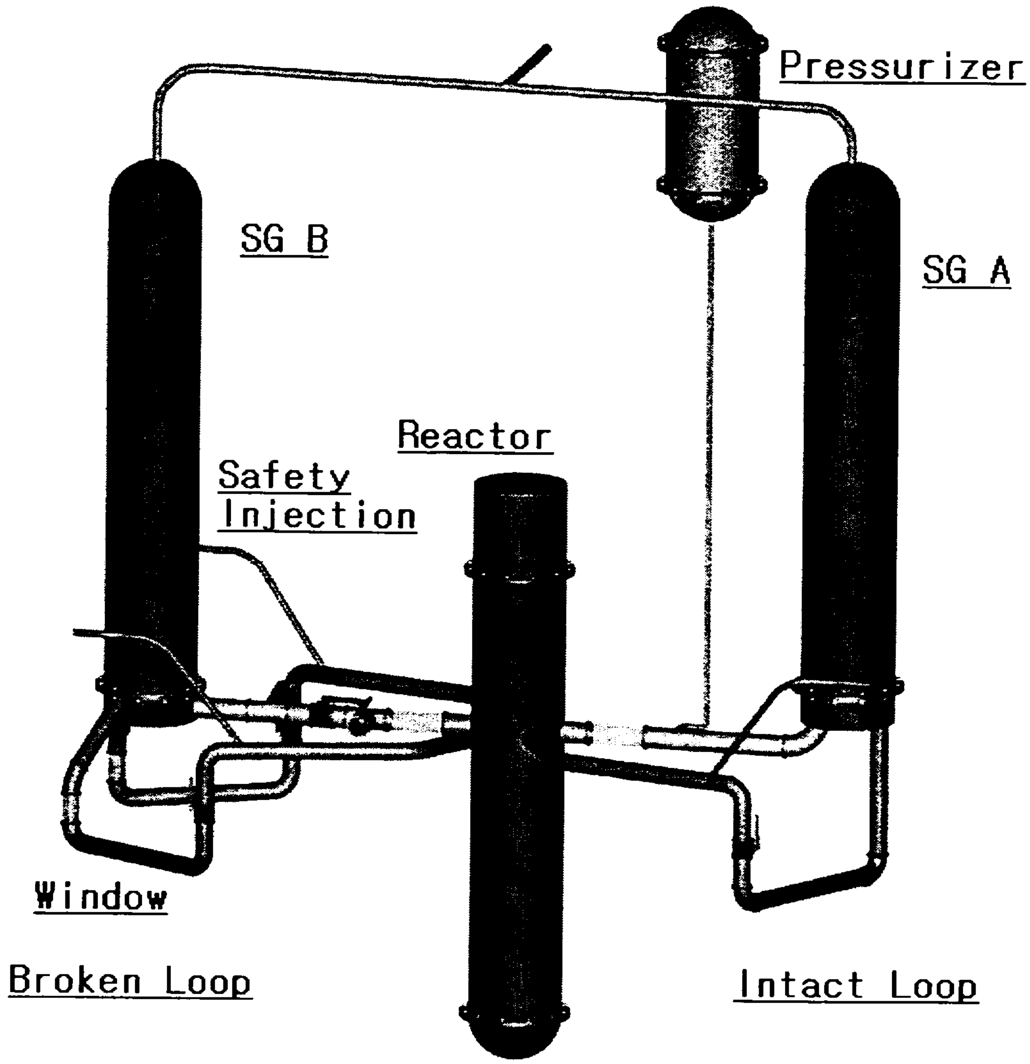

Figure 1 Overview of SNUF

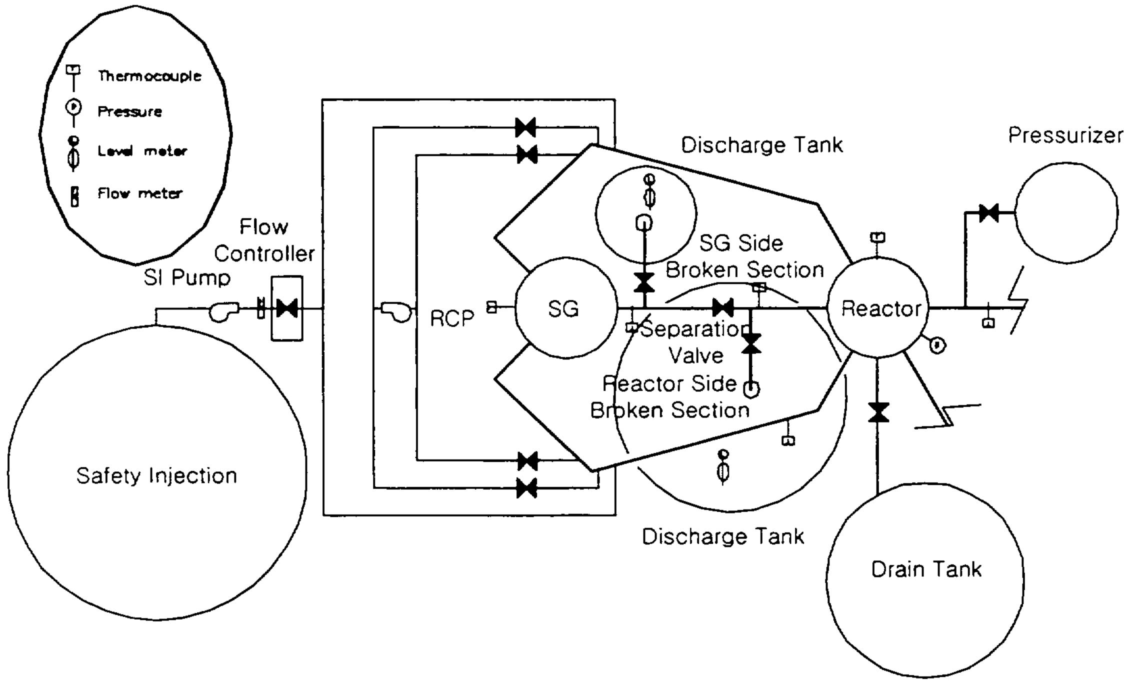

Figure 2 Schematic diagram of SNUF

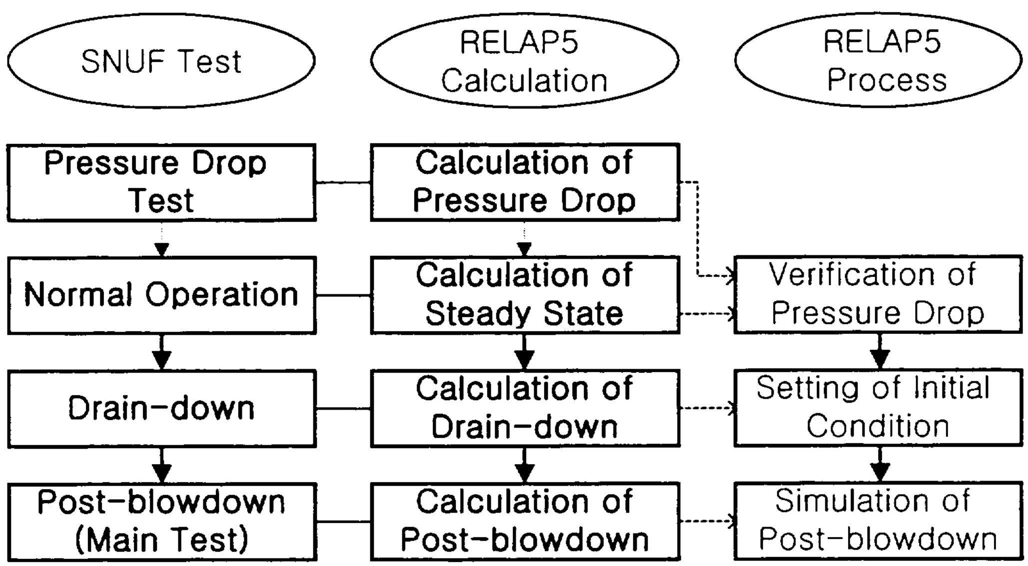

Figure 3 Procedure of SNUF experiment and RELAP5 calculation

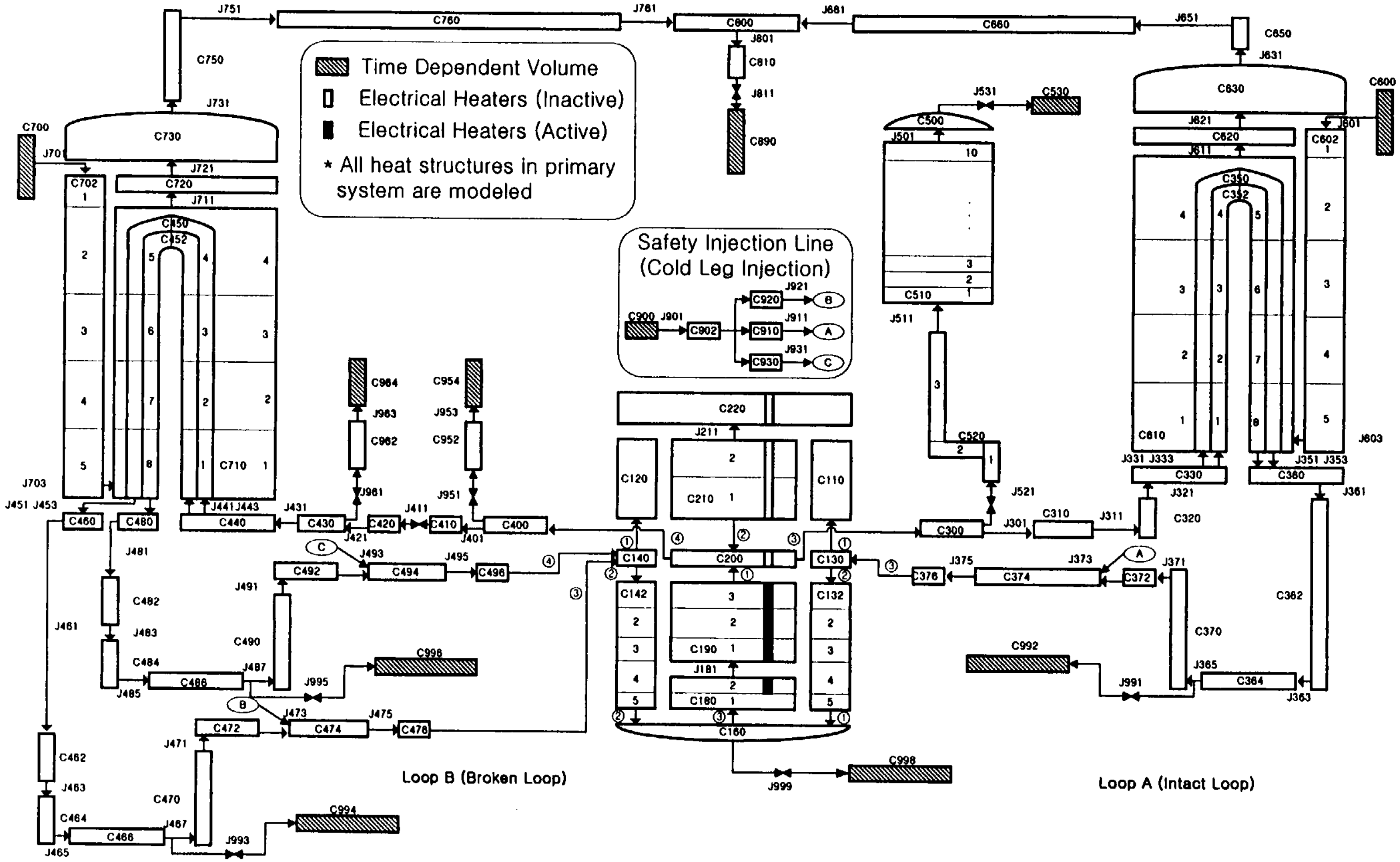

Figure 4 Base nodalization of SNUF for RELAP5 analysis

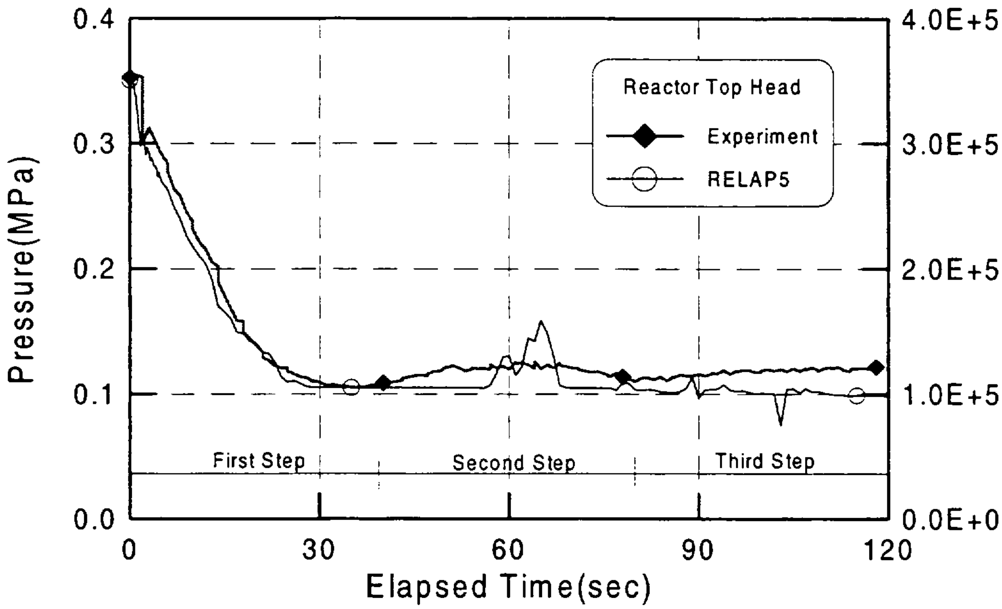

Figure 5 Pressure of reactor vessel top head (Run01)

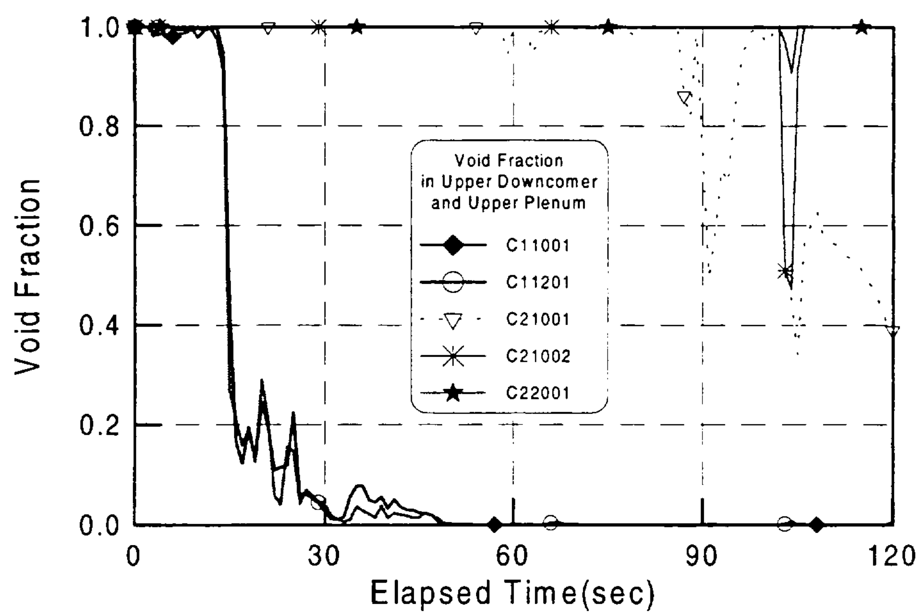

Figure 6 Void fractions in upper downcomer and upper plenum of reactor vessel (Run01)

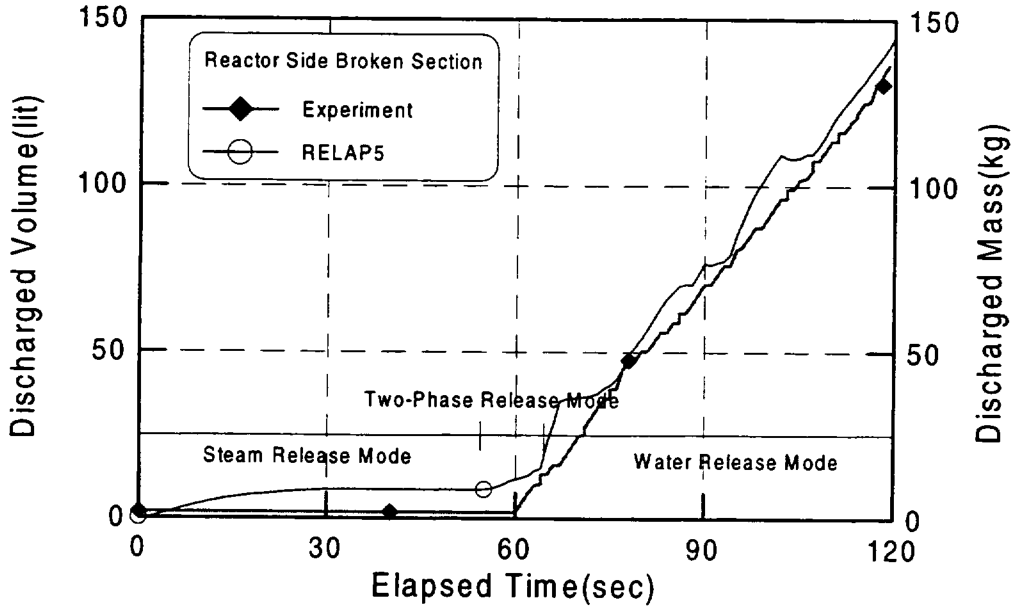

Figure 7 Discharge amount in reactor side broken section (Run01)

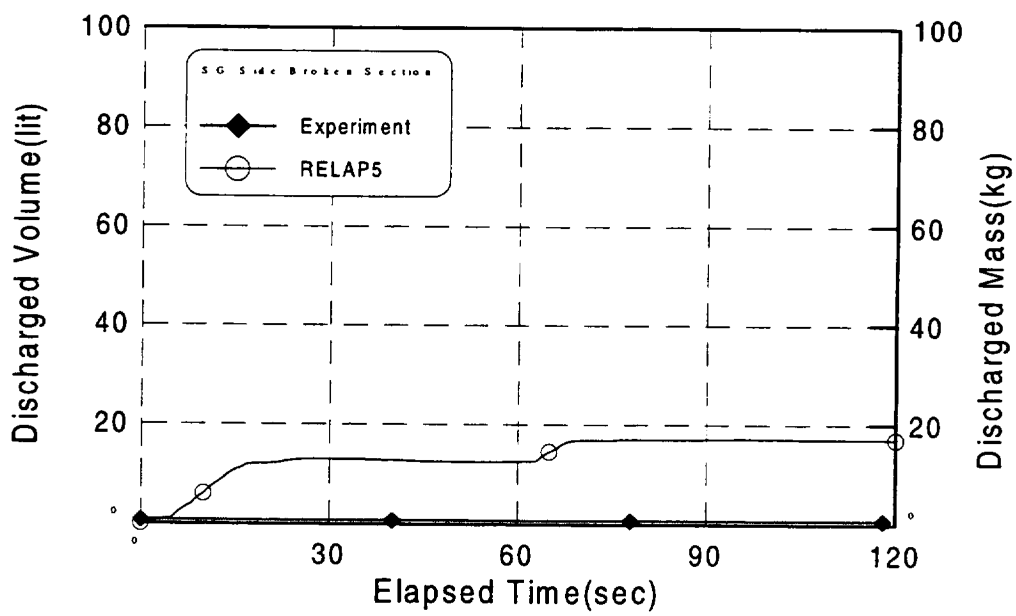

Figure 8 Discharge amount in SG side broken section (Run01)

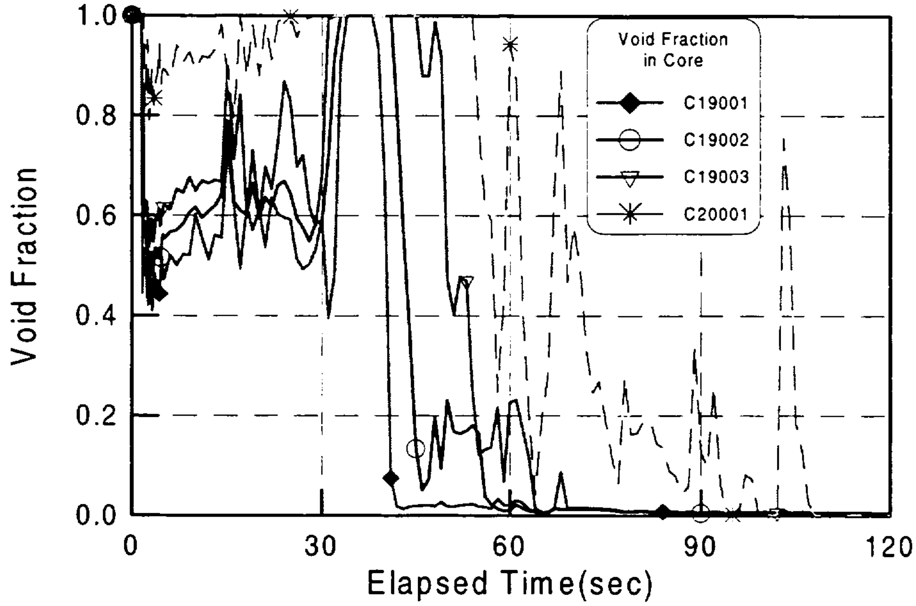

Figure 9 Void fractions in the reactor (Run01)

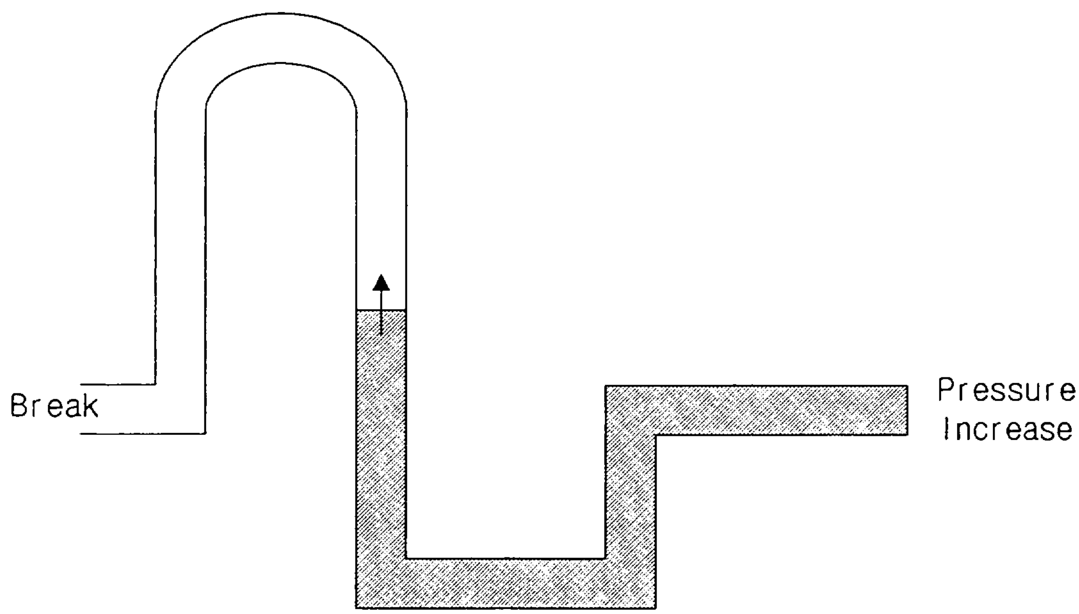

Figure 10 Coolant behavior in cold leg

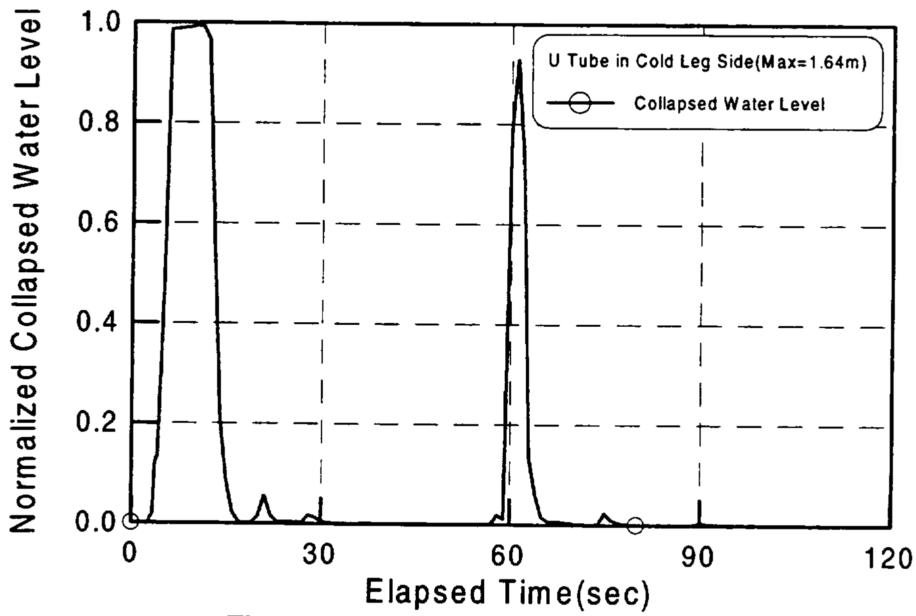

Figure 11 Water level in U Tube (Run01)

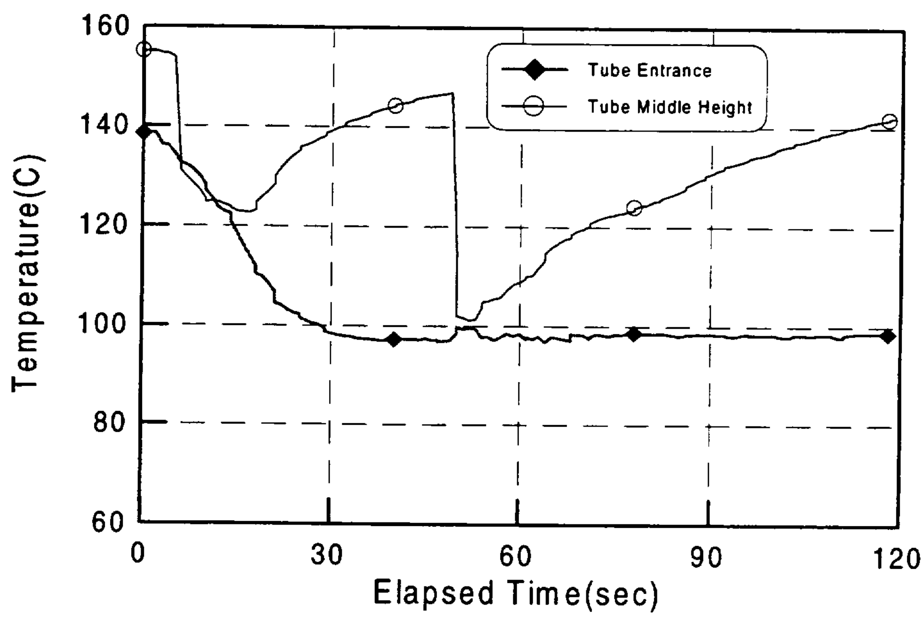

Figure 12 Coolant temperature of U tubes (SNUF experiment)

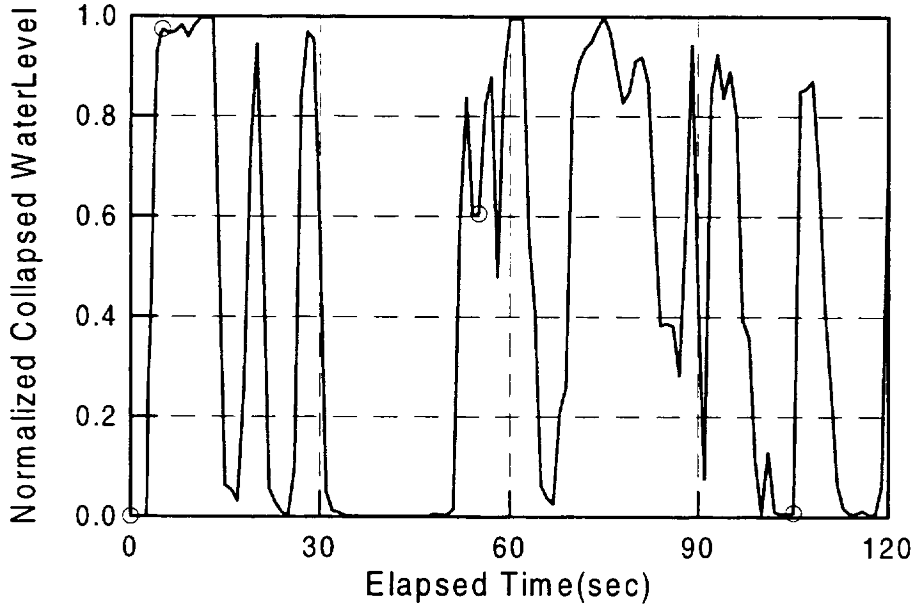

Figure 13 Water level in suction leg of cold leg in broken loop (Run01)

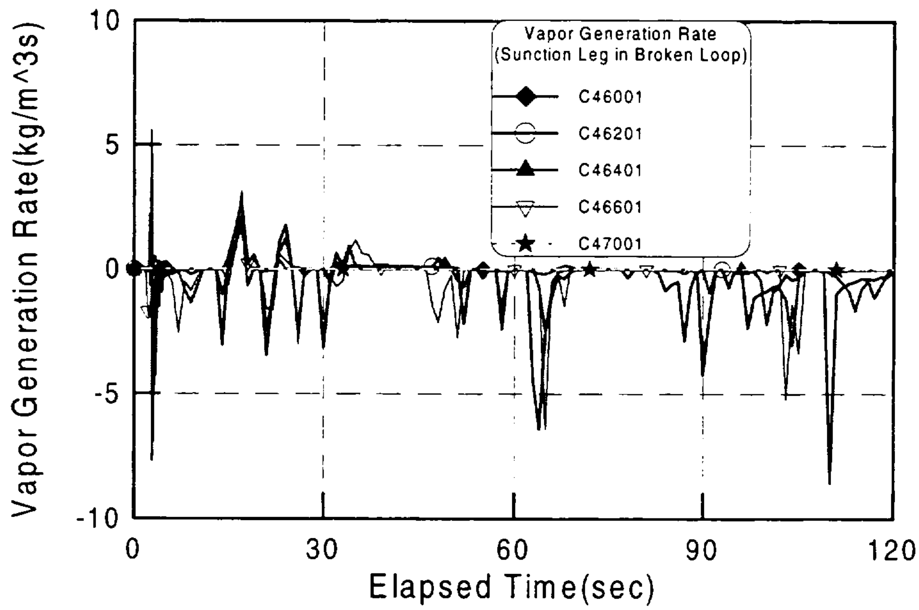

Figure 14 Vapor generation rate at suction leg in broken loop (Run01)

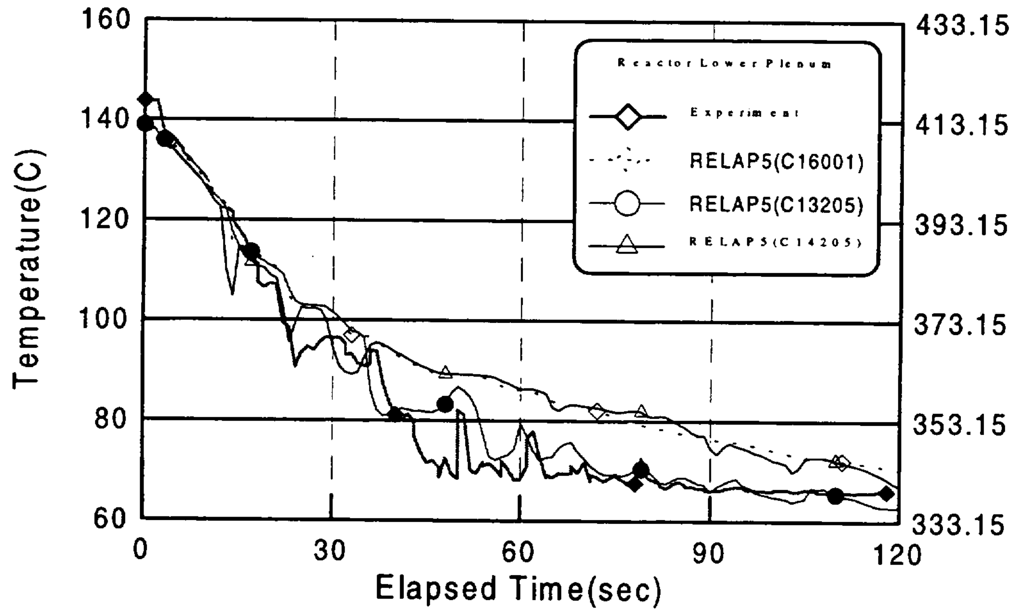

Figure 15 Coolant temperature in reactor lower plenum (Run01)

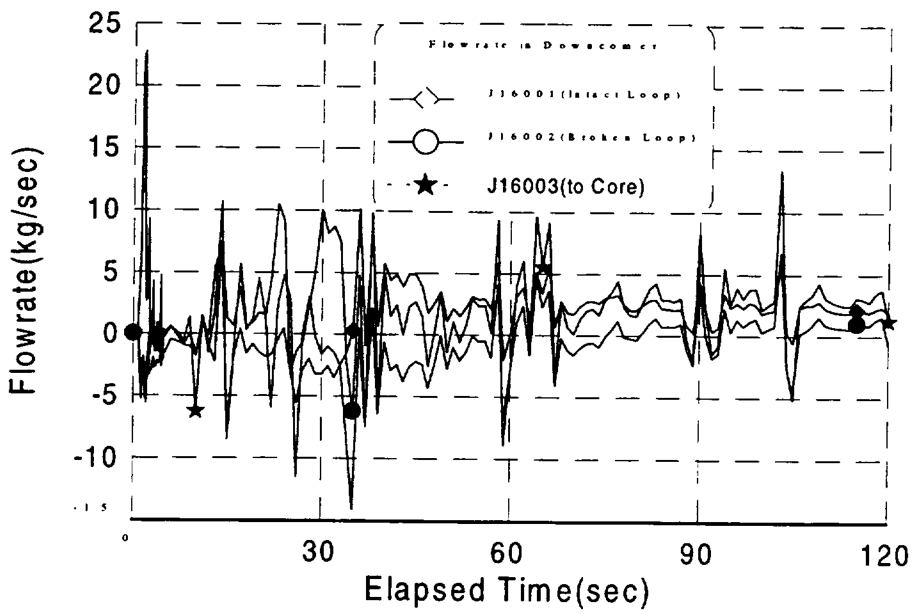

Figure 16 SI flow distribution in downcomer (Run01)

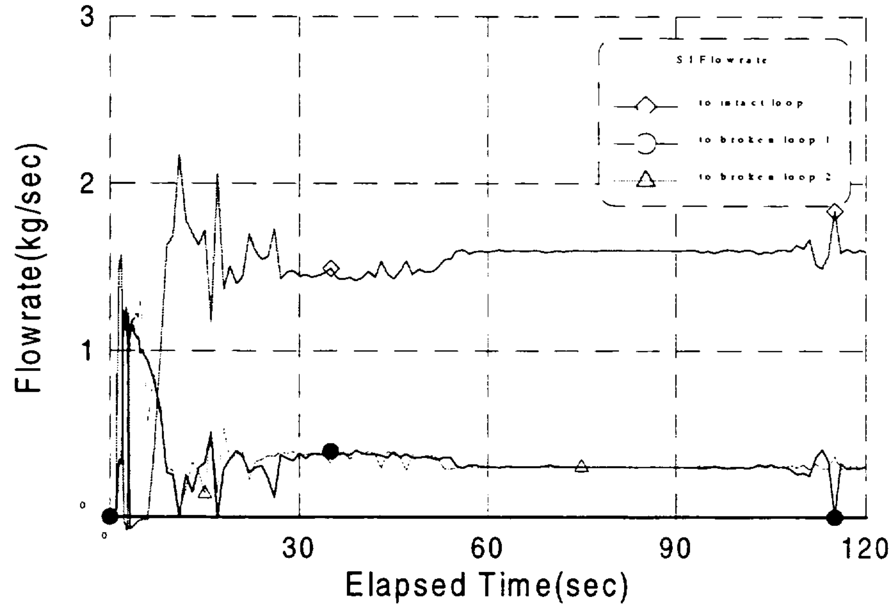

Figure 17 SI flow in SI lines (Run01)

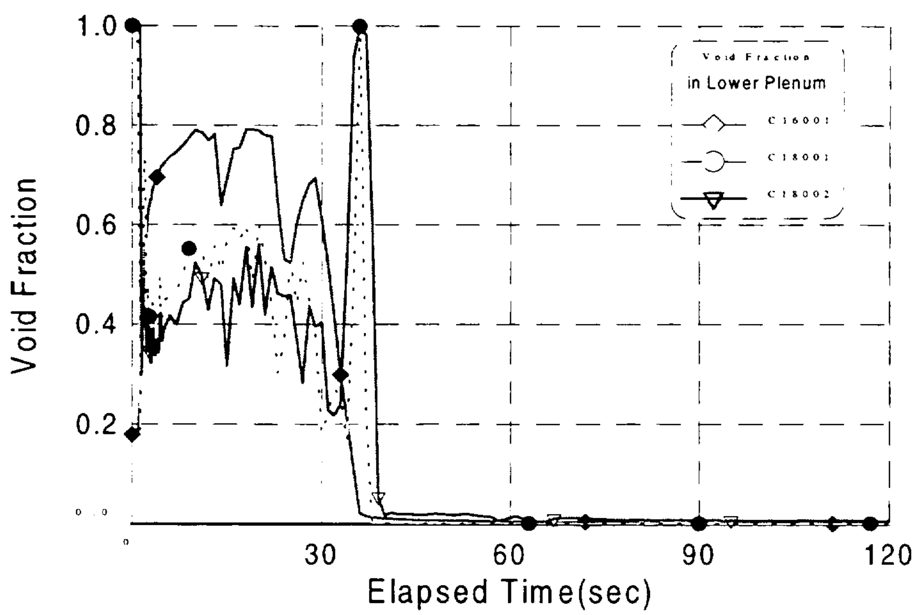

Figure 18 Void fraction in reactor lower part (Run01)

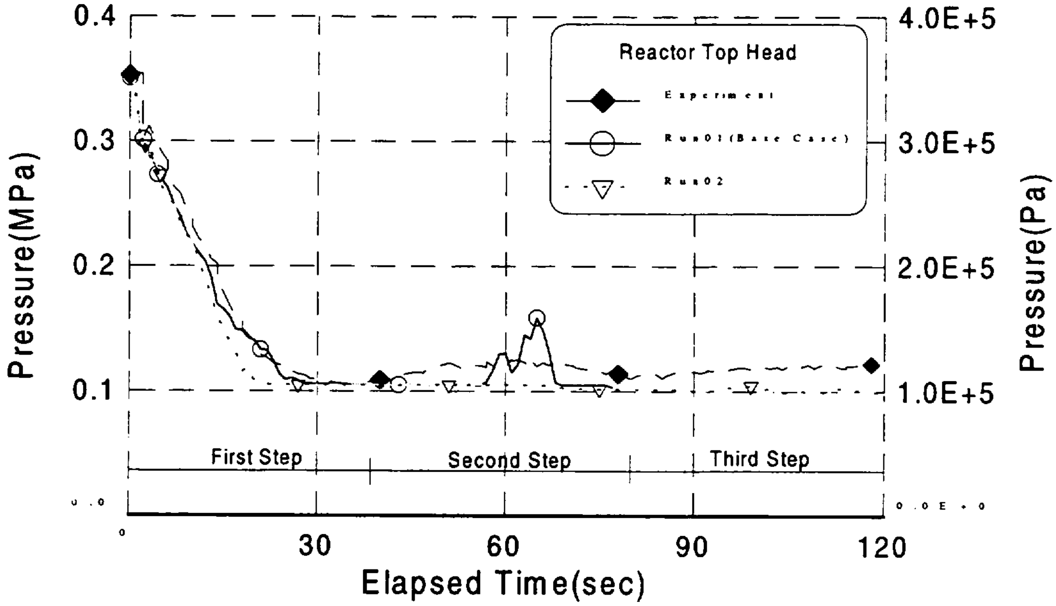

Figure 19 Pressure of reactor top head (Run02)

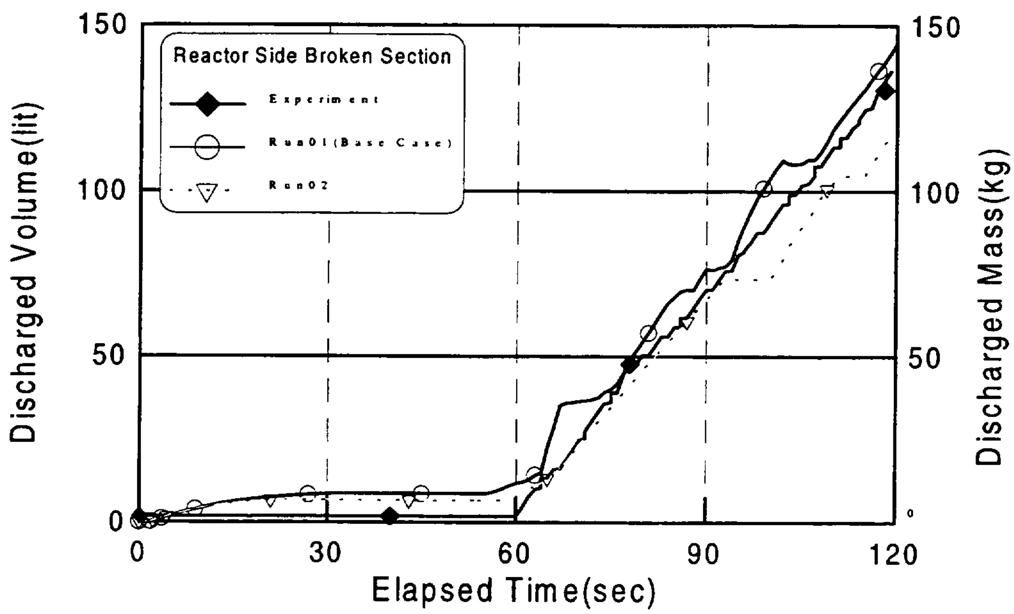

Figure 20 Discharge amount in reactor side broken section (Run02)

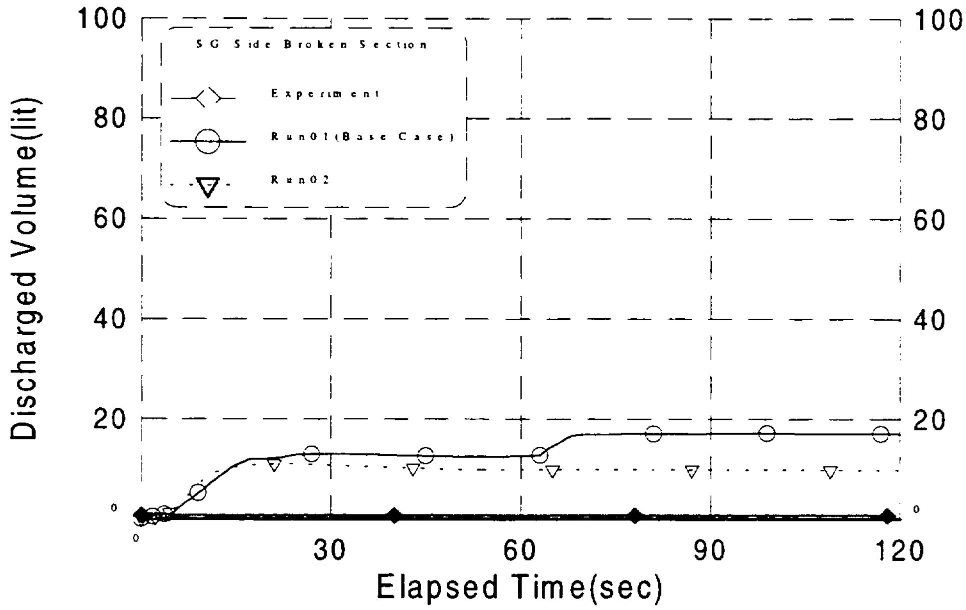

Figure 21 Discharge amount in SG side broken section (Run02)

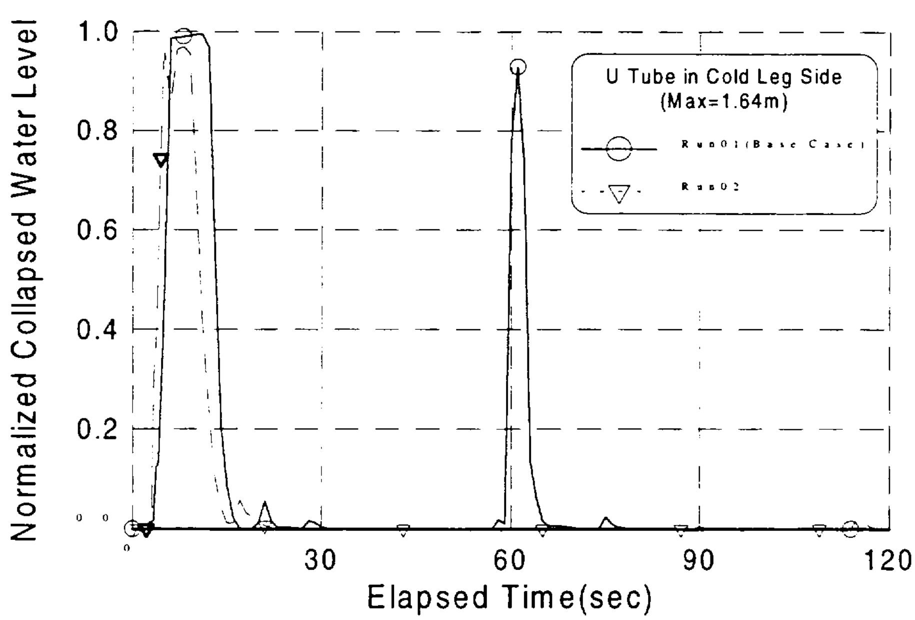

Figure 22 Water level in U Tube (Run02)

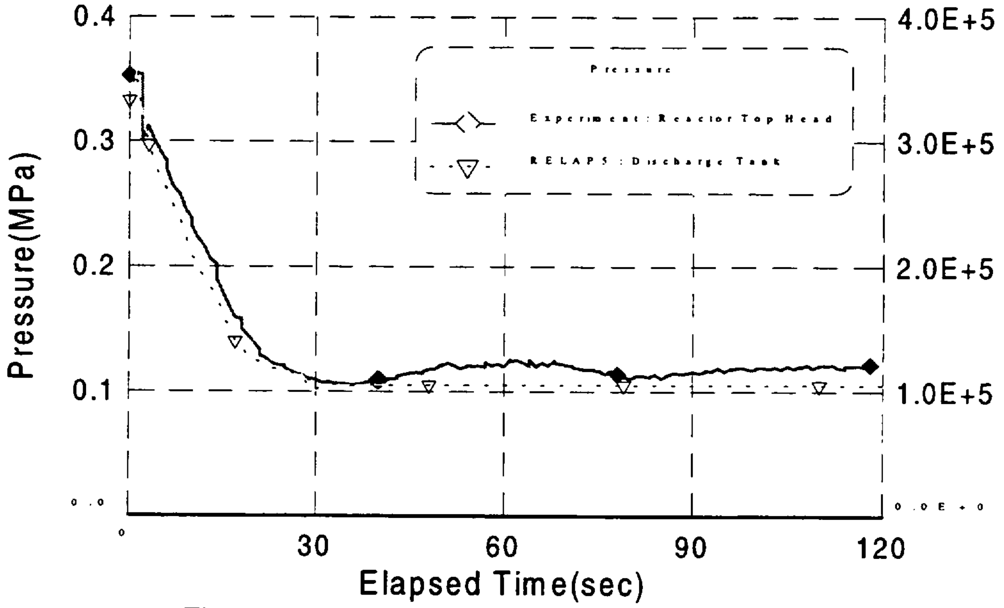

Figure 23 Pressure condition of break boundary in Run03

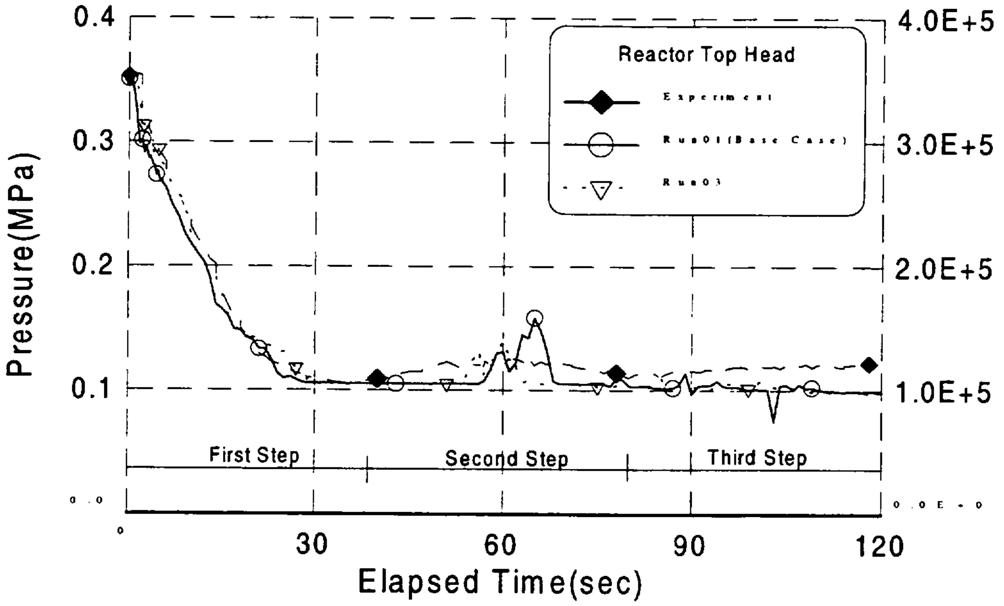

Figure 24 Pressure of reactor top head in Run03

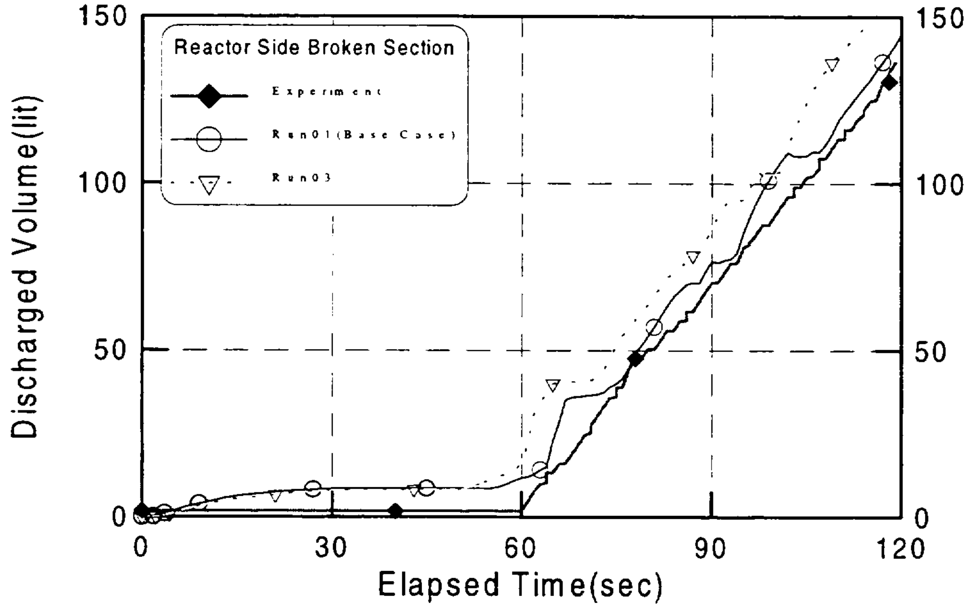

Figure 25 Discharge amount in reactor side broken section (Run03)

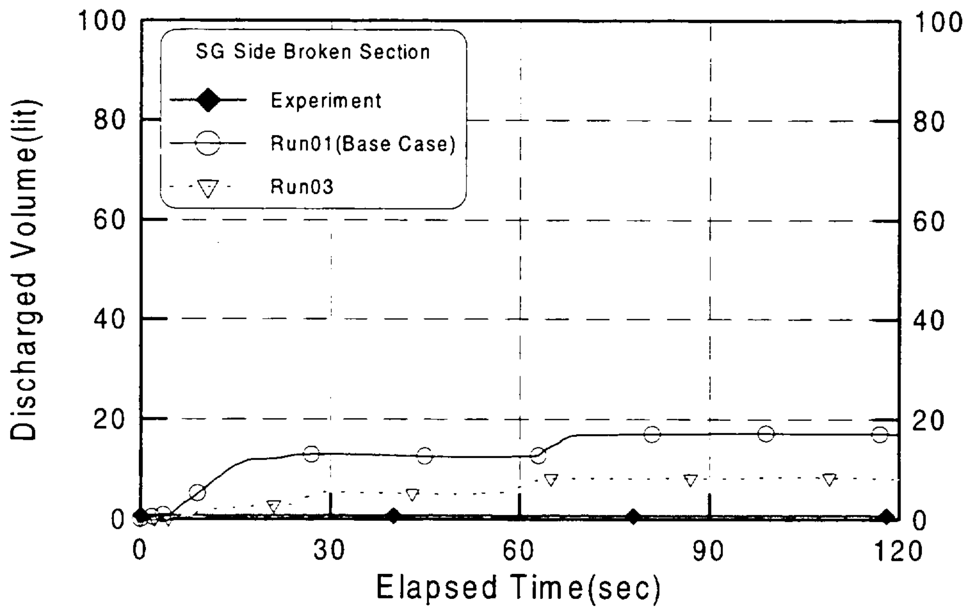

Figure 26 Discharge amount in SG side broken section (Run03)

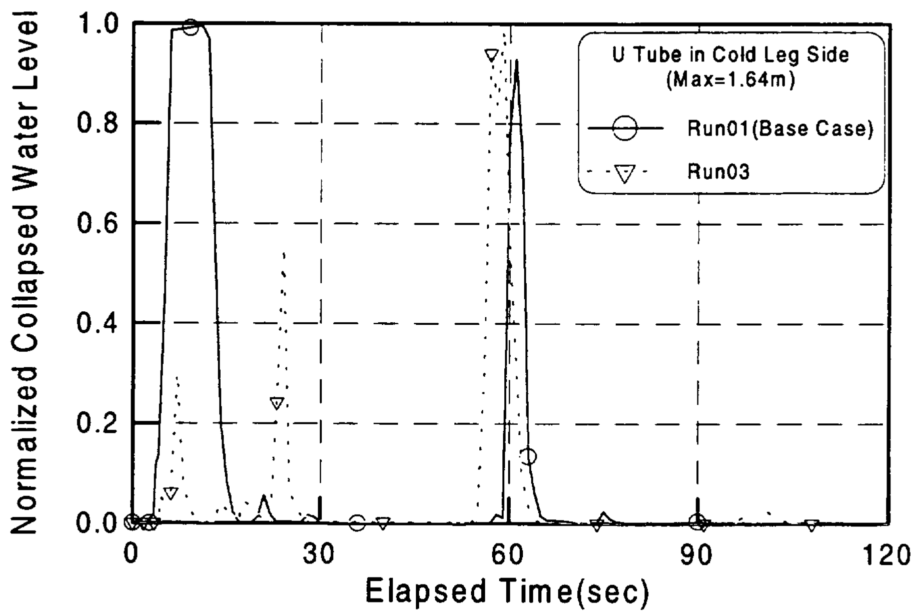

Figure 27 Water level in U Tube (Run03)

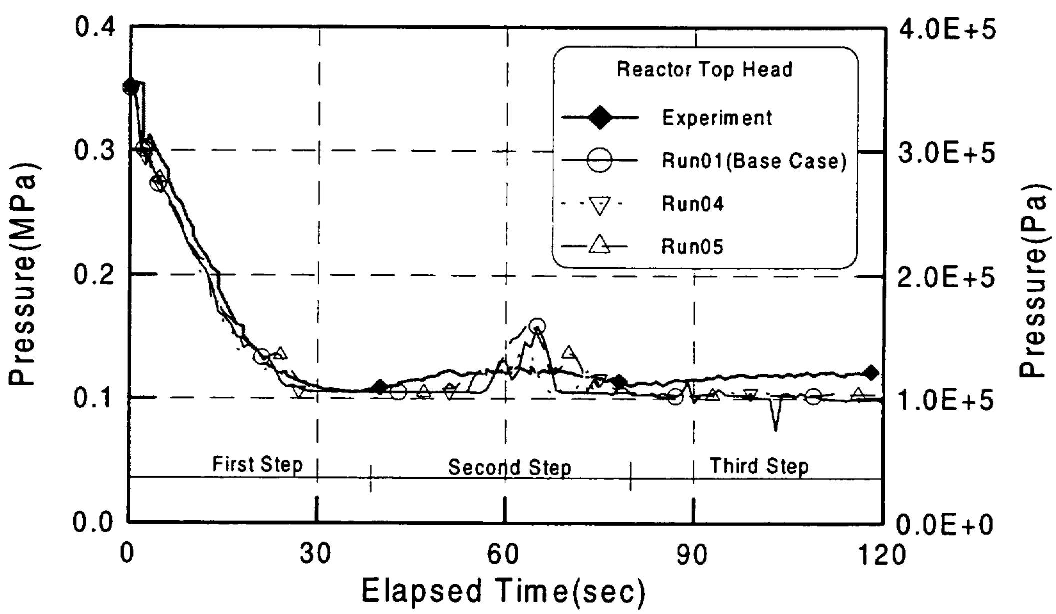

Figure 28 Pressure of reactor top head in Run04 and Run05

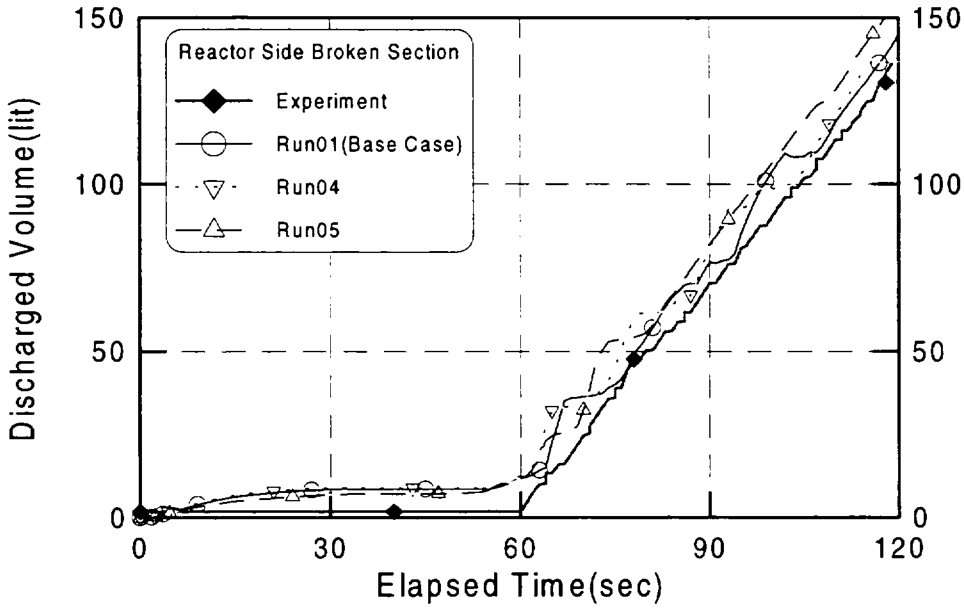

Figure 29 Discharge amount in reactor side broken section (Run04 and Run05)

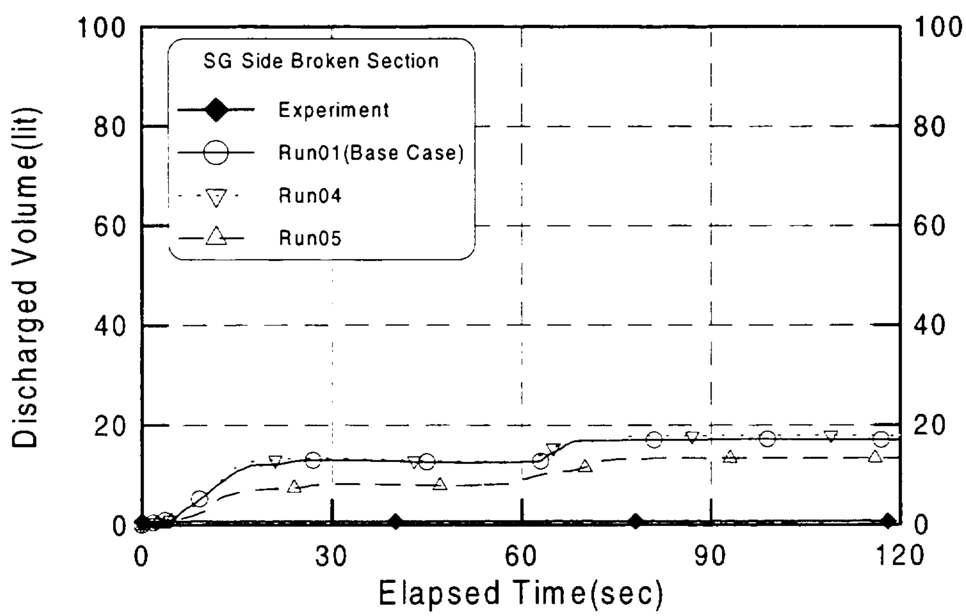

Figure 30 Discharge amount in SG side broken section (Run04 and Run05)

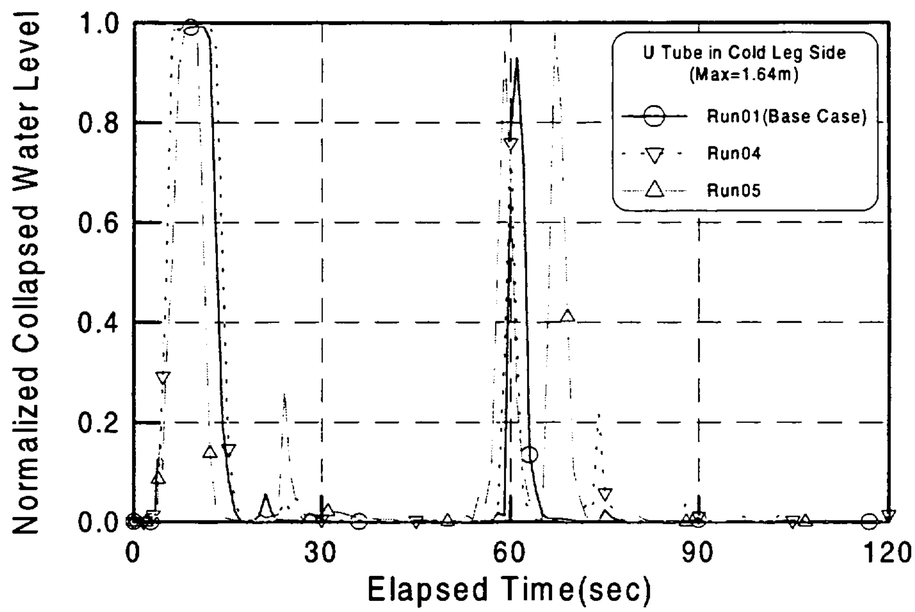

Figure 31 Water level in U Tube (Run04 and Run05)

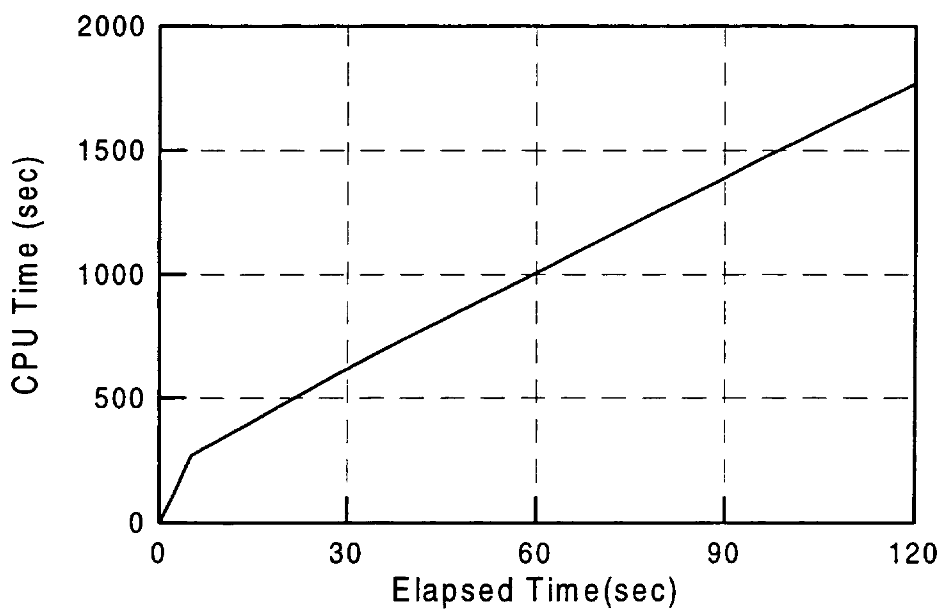

Figure 32 Calculation CPU time in Run01

Appendix A Input Deck for Steady State Calculation (Run01)

```
*==================================================================================
=*
=       SNUF Hot Leg Break LOCA Analysis Input Deck with RELAP5/MOD3.1        =
*==================================================================================
=*
*
* ---------- simple model ---------------------------------------------- *
*
*  form loss verfication input deck
*
0000100  new     stdy-st *transnt *
0000101  run
0000102  si  si
0000105  5.  6.  30000.
0000110  nitrogen
0000115  1.
0000120  400010000  0.0     h2o  primary
0000121  710010000  0.0     h2o  second
*0000201  8.      1.-6  5.0e-2  00003  500     400000     200000000
0000202  20.     1.-6  1.5e-2  00003  500     400000     200000000
0000203  1500.  1.-6  1.0e-3  00003  5000   400000     200000000
*
*-------------------------------------------------------------------------*
*                              minor edits                                  *
*-------------------------------------------------------------------------*
*
0000301  p          220010000
0000302  p          372010000     * p1'
0000303  p          330010000     * p2'
0000304  p          360010000     * p3'
0000305  p          364010000     * p4'
0000306  p          472010000     * p1
0000307  p          440010000     * p2
0000308  p          460010000     * p3
0000309  p          466010000     * p4
0000310  p          610010000     * sg a
0000311  p          710010000     * sg b
*
0000320  tempf     372010000     * intact loop discharge
0000321  tempg     372010000     * intact loop discharge
0000322  tempf     364010000     * intact loop suction
0000323  tempg     364010000     * intact loop suction
0000324  tempf     472010000     * broken loop discharge
0000325  tempg     472010000     * broken loop discharge
0000326  tempf     466010000     * broken loop suction
0000327  tempg     466010000     * broken loop suction
0000328  tempf     492010000     * broken loop discharge
0000329  tempg     492010000     * broken loop discharge
0000330  tempf     486010000     * broken loop suction
0000331  tempg     486010000     * broken loop suction
0000332  tempf     200010000     * core upper
0000333  tempg     200010000     * core upper
*
0000340  mflowj    311000000     * intact loop hot leg flow rate
0000341  mflowj    411000000     * broken loop hot leg flow rate
0000342  mflowj    375000000     * intact loop flow rate
0000343  mflowj    475000000     * broken loop cold leg 1 flow rate
0000344  mflowj    495000000     * broken loop cold leg 1 flow rate
0000345  mflowj    601000000     * to sg a
0000346  mflowj    701000000     * to sg b
0000347  mflowj    811000000     * steam outlet
*
0000360  voidg     364010000
0000361  voidg     466010000
0000362  voidg     486010000
*
*0000370  cntrlvar  001          * pzr normalized water level
0000371  cntrlvar  002          * intact sg normalied water level
0000372  cntrlvar  003          * broken sg normalied water level
*
*-------------------------------------------------------------------------*
*                              trip                                         *
*-------------------------------------------------------------------------*
*
0000501  time   0    ge   null   0   0.        n   -1.0  *
0000502  time   0    le   null   0   60.       n         * pzr press ctrl
0000503  time   0    ge   null   0   1.0e6     n         *
*
*-------------------------------------------------------------------------*
*                              hydraulic input                              *
*-------------------------------------------------------------------------*
*
*------------------------------------*
*                              primary system                               *
*------------------------------------*
*
```

```
*
*******************************************************************************
* component 110 : downcomer upper part at right hand side                *
*******************************************************************************
1100000  dc_up_r   annulus              * name
1100001  1                              * number of volume
1100101  0.         1                   * flow area of volume
*1100201  no junction                   * flow area of junction
1100301  5.8e-1     1                   * flow length
1100401  1.3637e-2  1                   * volume of volume
1100501  0.         1                   * azimuthal angle
1100601  90.0       1                   * inclination angle
*1100701 elevation change
1100801  4.572-4   5.1e-3      1        * roughness, hyd. dia.
*1100901  no junction                   * loss coeff.
1101001  00000      1                   * flag of volume
*1101101  no junction                   * flag of junction
1101201  003    800099.  435.  0.  0.  0.  1   * i.c. of volume
*1101300  no junction                   * i.c. ctrl word of junction
*1101301  no junction                   * i.c. of junction
*
*******************************************************************************
* component 120 : downcomer upper part at left hand side                 *
*******************************************************************************
1200000  dc_up_l   annulus              * name
1200001  1                              * number of volume
1200101  0.         1                   * flow area of volume
*1200201  no junction                   * flow area of junction
1200301  5.8e-1     1                   * flow length
1200401  1.3637e-2  1                   * volume of volume
1200501  0.         1                   * azimuthal angle
1200601  90.0       1                   * inclination angle
*1200701 elevation change
1200801  4.572-4   5.1e-3      1        * roughness, hyd. dia.
*1200901  no junction                   * loss coeff.
1201001  00000      1                   * flag of volume
*1201101  no junction                   * flag of junction
1201201  003    800099.  435.  0.  0.  0.  1   * i.c. of volume
*1201300  no junction                   * i.c. ctrl word of junction
*1201301  no junction                   * i.c. of junction
*
*
*******************************************************************************
```



```
* component 130 : downcomer cold leg connector at right side             *
*******************************************************************************
1300000  dc_cc_r   branch
1300001  3        0
1300101  1.1756e-2  110.0e-3  0.0  0.0  -90.  -110.0-3  4.572-4  25.5e-3  00000
1300200  003  800099.  435.15
1301101  130010001  110010001  0.0  0.0   0.0   000000
1302101  130010002  132010001  0.0  0.0   0.0   000101
1303101  376010002  130010003  0.0  0.45  0.3   000101
1301201  0.0        0.0        0.0
1302201  0.0        0.0        0.0
1303201  0.0        0.0        0.0
*
*******************************************************************************
* component 140 : downcomer cold leg connector at left side              *
*******************************************************************************
1400000  dc_cc_l   branch
1400001  4        0
1400101  1.1756-2  110.0-3  0.0  0.0  -90.  -110.0-3  4.572-4  25.5e-3 00000
1400200  003  800099.  435.15
1401101  140010001  120010001  0.0  0.0   0.0   000000
1402101  140010002  142010001  0.0  0.0   0.0   000000
1403101  476010002  140010003  0.0  0.45  0.3   000101
1404101  496010002  140010003  0.0  0.45  0.3   000101
1401201  0.0        0.0        0.0
1402201  0.0        0.0        0.0
1403201  0.0        0.0        0.0
1404201  0.0        0.0        0.0
*
*******************************************************************************
* component 132 : downcomer at right side                                *
*******************************************************************************
1320000  dc_r       annulus             * name
1320001  5                              * number of volume
1320101  1.1756e-2  5                   * flow area of volume
1320201  0.         4                   * flow area of junction
1320301  200.0e-3   2                   * flow length
1320302  100.0e-3   4
1320303  148.0e-3   5
1320401  0.         5                   * volume of volume
1320501  0.0        5                   * azimuthal angle
1320601  -90.0      5                   * inclination angle
*1320701 elevation change
```

```
1320801  4.572-4   25.5e-3   5          * roughness, hyd. dia.
1320901  0.         0.        4         * loss coeff.
1321001  00000      5                   * flag of volume
1321101  000000     4                   * flag of junction
1321201  003       800099.  435.15   0.  0.  0.  5   * i.c. of volume
1321300  0                              * i.c. ctrl word of junction
1321301  0.         0.        0.   4    * i.c. of junction
*
********************************************************************************
* component 142 : downcomer at left side                                       *
********************************************************************************
1420000  dc_r       annulus             * name
1420001  5
1420101  1.1756e-2  5                   * flow area of volume
1420201  0.         4                   * flow area of junction
1420301  200.0e-3   2                   * flow length
1420302  100.0e-3   4
1420303  148.0e-3   5
1420401  0.         5                   * volume of volume
1420501  0.0        5                   * azimuthal angle
1420601  -90.0      5                   * inclination angle
*1420701 elevation change
1420801  4.572-4   25.5e-3   5          * roughness, hyd. dia.
1420901  0.         0.        4         * loss coeff.
1421001  00000      5                   * flag of volume
1421101  000000     4                   * flag of junction
1421201  003       800099.  435.15   0.  0.  0.  5   * i.c. of volume
1421300  0                              * i.c. ctrl word of junction
1421301  0.         0.        0.   4    * i.c. of junction
*
********************************************************************************
* component 160 : downcomer lower plenum                                       *
********************************************************************************
1600000  lowplenm   branch
1600001  3          0
1600101  0.  80.0e-3  6.7988e-2  0.0  90.  80.0e-3  4.572-4  319.0e-3  00000
1600200  003  800099.  435.15
1601101  132050002  160010002  0.0  0.4   0.2   010100
1602101  142050002  160010002  0.0  0.4   0.2   010100
1603101  160010002  180010001  0.0  0.2   0.4   010100
1601201  0.         0.         0.0
1602201  0.         0.         0.0
1603201  0.         0.         0.0

*
********************************************************************************
* component 180 : core bottom                                                  *
********************************************************************************
1800000  core_bot   pipe                * name
1800001  2                              * number of volume
1800101  2.0204e-2  1                   * flow area of volume
1800102  5.3913e-2  2
1800201  0.0        1                   * flow area of junction
1800301  148.0e-3   1                   * flow length
1800302  100.0e-3   2
1800401  0.         2                   * volume of volume
1800501  0.         2                   * azimuthal angle
1800601  90.0       2                   * inclination angle
*1800701 elevation change
1800801  4.572e-4  35.0e-3    1         * roughness, hyd. dia.
1800802  4.572e-4  262.0e-3   2
1800901  0.04       0.02      1         * loss coeff.
1801001  00000      2                   * flag of volume
1801101  000000     1                   * flag of junction
1801201  003     800099.  440.15  0.0  0.0  0.0  2   * i.c. of volume
1801300  0                              * i.c. ctrl word of junction
1801301  0.0        0.0      0.   1     * i.c. of junction
*
********************************************************************************
* component 181 : core junction                                                *
********************************************************************************
*
1810000  core_jun  sngljun
1810101  180020002  190010001  0.  0.435  0.2  000100
1810201  0  0.  0.  0.
*
********************************************************************************
* component 190 : active core                                                  *
********************************************************************************
*
1900000  act_core  pipe                 * name
1900001  3                              * number of volume
1900101  5.0143e-2  3                   * flow area of volume
1900201  0.         2                   * flow area of junction
1900301  100.0e-3   1                   * flow length
1900302  200.0e-3   3
1900401  0.         3                   * volume of volume
```

```
1900501  0.          3                 * azimuthal angle
1900601  90.0        3                 * inclination angle
*1900701 elevation change
1900801  4.572e-4   86.0e-3    3      * roughness, hyd. dia.
1900901  0.          0.          2     * loss coeff.
1901001  00000       3                 * flag of volume
1901101  000000      2                 * flag of junction
1901201  003    750099.  440.15  0.  0.  0.  3   * i.c. of volume
1901300  0                             * i.c. ctrl word of junction
1901301  0.0      0.0     0.    2      * i.c. ctrl word of junction
*
******************************************************************************
* component 200 : core branch                                                *
******************************************************************************
2000000  core_br   branch
2000001  4         0
2000101  5.0143e-2  110.0e-3  0.0  0.0   90.  110.0e-3  4.572e-4  319.0e-3  00000
2000200  003  800099.  440.15
2001101  190030002  200010001  0.0  0.    0.    000000
2002101  200010002  210010001  0.   0.    0.    000000
2003101  200010004  300010001  0.   0.3   0.45  000102 *to intact hotleg
2004101  200010004  400010001  0.   0.3   0.45  000102 *to broken hotleg
2001201  0.0         0.0         0.0
2002201  0.0         0.0         0.0
2003201  0.0         0.0         0.0
2004201  0.0         0.0         0.0
*
******************************************************************************
* component 210 : core upper                                                 *
******************************************************************************
*
2100000  core_up  pipe                 * name
2100001  2                             * number of volume
2100101  5.0143e-2  2                  * flow area of volume
2100201  0.         1                  * flow area of junction
2100301  2.9e-01    2                  * flow length
2100401  0.         2                  * volume of volume
2100501  0.         2                  * azimuthal angle
2100601  90.        2                  * inclination angle
*2100701 elevation change
2100801  4.572e-4   86.0e-3    2      * roughness, hyd. dia.
2100901  0.         0.         1      * loss coeff.
2101001  00000      2                  * flag of volume
```

```
2101101  000000     1                  * flag of junction
2101201  003    750099.  435.15  0.  0.  0.  2   * i.c. of volume
2101300  0                             * i.c. ctrl word of junction
2101301  0.     0.      0.     1       * i.c. of junction
*
******************************************************************************
* component 211 : upper plenum junction 1                                    *
******************************************************************************
*
2110000  up_jun1  sngljun
2110101  210020002  220010001  0.  0.  0.  000000
2110201  0  0.  0.  0.
*
******************************************************************************
* component 220 : upper plenum                                               *
******************************************************************************
2200000  up_pl  snglvol
2200101  0.  2.51e-1  1.6097e-2  0.  90.  2.51e-1  4.572e-4  121.3529e-3  00000
2200200  003    800099.  435.15  0.   0.   0.
*
******************************************************************************
* component 300 : intact hot leg section 1                                   *
******************************************************************************
*
3000000  ihotl1  pipe                  * name
3000001  1                             * number of volume
3000101  0.         1                  * flow area of volume
*3000201  no junction                  * flow area of junction
3000301  5.27e-1    1                  * flow length
3000401  2.1744e-3  1                  * volume of volume
3000501  0.         1                  * azimuthal angle
3000601  0.         1                  * inclination angle
*3000701 elevation change
3000801  4.572e-4   7.2352e-2   1     * roughness, hyd. dia.
*3000901  no junction                  * loss coeff.
3001001  00000      1                  * flag of volume
*3001101   no junction                 * flag of junction
3001201  003    800099.  440.15  0.  0.  0.  1   * i.c. of volume
*3001300  no junction                  * i.c. ctrl word of junction
*3001301  no junction                  * i.c. of junction
*
******************************************************************************
* component 301 : intact hot leg junction 1                                  *
```

```
******************************************************************************
*
3010000  ihlj1   sngljun
3010101  300010002  310010001  0.  0.003       0.003  000000
3010201  0  0.  0.  0.
*
******************************************************************************
* component 310 : intact hot leg junction 2                                  *
******************************************************************************
*
3100000  ihotl2   pipe                    * name
3100001  1                                * number of volume
3100101  0.          1                    * flow area of volume
*3100201   no junction                      * flow area of junction
3100301  4.38e-1     1                     * flow length
3100401  1.6953e-3   1                      * volume of volume
3100501  0.          1                    * azimuthal angle
3100601  0.          1                    * inclination angle
*3100701 elevation change
3100801  4.572e-4    70.2e-3      1         * roughness, hyd. dia.
*3100901   no junction                      * loss coeff.
3101001  00000       1                      * flag of volume
*3101101   no junction                      * flag of junction
3101201  003     800099.  440.15  0.   0.   0.   1   * i.c. of volume
*3101300   no junction                      * i.c. ctrl word of junction
*3101301   no junction                      * i.c. of junction
*
******************************************************************************
* component 311 : intact hot leg junction 2                                  *
******************************************************************************
*
3110000  ihlj2   sngljun
3110101  310010002  320010001  0.  0.1  0.1  000000  *
3110201  0  0.  0.  0.
*
******************************************************************************
* component 320 : intact hot leg junction 3                                  *
******************************************************************************
3200000  ihotl3   pipe                    * name
3200001  1                                * number of volume
3200101  0.          1                    * flow area of volume
*3200201   no junction                      * flow area of junction
3200301  2.6e-01     1                     * flow length
3200401  1.0063e-3   1                      * volume of volume
3200501  0.          1                    * azimuthal angle
3200601  90.         1                    * inclination angle
*3200701 elevation change
3200801  4.572e-4    70.2e-3      1         * roughness, hyd. dia.
*3200901   no junction                      * loss coeff.
3201001  00000       1                      * flag of volume
*3201101   no junction                      * flag of junction
3201201  003     800099.  440.15  0.   0.   0.   1   * i.c. of volume
*3201300   no junction                      * i.c. ctrl word of junction
*3201301   no junction                      * i.c. of junction
*
******************************************************************************
* component 321 : intact hot leg junction 3                                  *
******************************************************************************
*
3210000  ihlj3   sngljun
3210101  320010002  330010001  0.  0.4  0.2  000100
3210201  0  0.  0.  0.
*
******************************************************************************
* component 330 : intact loop u tube inlet                                   *
******************************************************************************
3300000  iltube-i pipe                    * name
3300001  1                                * number of volume
3300101  0.          1                    * flow area of volume
*330020  no junction                        * flow area of junction
3300301  100.0e-3    1                      * flow length
3300401  3.9961e-3   1                      * volume of volume
3300501  0.          1                    * azimuthal angle
3300601  90.         1                    * inclination angle
*3300701 elevation change
3300801  4.572e-4    194.9139e-3     1  * roughness, hyd. dia.
*3300901   no junction                      * loss coeff.
3301001  00000       1                      * flag of volume
*3301101   no junction                      * flag of junction
3301201  003     750099.  440.15  0.   0.   0.   1   * i.c. of volume
*3301300   no junction                      * i.c. ctrl word of junction
*3301301   no junction                      * i.c. of junction
*
******************************************************************************
* component 331 : intact u tube inlet junction 1                             *
******************************************************************************
```

```
3310000  itub_ij1  sngljun
3310101  330010002  350010001  0.  17.   26.  000100
3310201  0  0.  0.  0.
*
*******************************************************************************
* component 333 : intact u tube inlet junction 2                              *
*******************************************************************************
3330000  itub_ij2  sngljun
3330101  330010002  352010001  0.  17.   26.  000100
3330201  0  0.  0.  0.
*
*******************************************************************************
* component 350 : intact u tube 1                                             *
*******************************************************************************
3500000  itub1  pipe                * name
3500001  8                          * number of volume
3500101  2.2682e-3  8                 * flow area of volume
3500201  0.        7                * flow area of junction
3500301  4.1e-1      8               * flow length
3500401  0.          8              * volume of volume
3500501  0.          8              * azimuthal angle
3500601  90.         4              * inclination angle
3500602  -90.        8
*3500701 elevation change
3500801  4.572e-4   19.0e-3      8 * roughness, hyd. dia.
3500901  0.          0.        3 * loss coeff.
3500902  0.42        0.42       4
3500903  0.          0.         7
3501001  00000       8              * flag of volume
3501101  000000      7              * flag of junction
3501201  003     800099.  438.15  0.   0.   0.   8   * i.c. of volume
3501300  0                                  * i.c. ctrl word of junction
3501301  0.0       0.0      0.     7         * i.c. of junction
*
*******************************************************************************
* component 352 : intact u tube 2                                             *
*******************************************************************************
*
3520000  itub2  pipe
3520001  8                          * number of volume
3520101  2.2682e-3  8                 * flow area of volume
3520201  0.        7                * flow area of junction
3520301  4.1e-1      8               * flow length
3520401  0.          8              * volume of volume
3520501  0.          8              * azimuthal angle
3520601  90.         4              * inclination angle
3520602  -90.        8
*3520701 elevation change
3520801  4.572e-4   19.0e-3      8 * roughness, hyd. dia.
3520901  0.          0.        3 * loss coeff.
3520902  0.42        0.42       4
3520903  0.          0.         7
3521001  00000       8              * flag of volume
3521101  000000      7              * flag of junction
3521201  003     800099.  438.15  0.   0.   0.   8   * i.c. of volume
3521300  0                                  * i.c. ctrl word of junction
3521301  0.0       0.0      0.     7         * i.c. of junction
*
*******************************************************************************
* component 351 : intact u tube outlet junction 1                             *
*******************************************************************************
*
3510000  itub_oj1  sngljun
3510101  350080002  360010001  0.  26.  17.  000100
3510201  0  0.  0.  0.
*
*******************************************************************************
* component 353 : intact u tube outlet junction 2                             *
*******************************************************************************
*
3530000  itub_oj2  sngljun
3530101  352080002  360010001  0.  26.  17.  000100
3530201  0  0.  0.  0.
*
*******************************************************************************
* component 360 : intact loop u tube outlet                                   *
*******************************************************************************
*
3600000  up_pl1  pipe               * name
3600001  1                          * number of volume
3600101  3.9961e-2  1                 * flow area of volume
*3600201  no junction                 * flow area of junction
3600301  100.0e-3   1               * flow length
3600401  0.          1              * volume of volume
3600501  0.          1              * azimuthal angle
3600601  -90.        1              * inclination angle
```

```
*3600701 elevation change
3600801  4.572e-4   194.9139e-3     1     * roughness, hyd. dia.
*3600901  no junction                * loss coeff.
3601001  00000       1               * flag of volume
*3601101  no junction                * flag of junction
3601201  003    800099.  435.15  0.   0.   0.   1   * i.c. of volume
*3601300  no junction                * i.c. ctrl word of junction
*3601301  no junction                * i.c. of junction
*
***************************************************************************
* component 361 : intact suction leg junction 1                           *
***************************************************************************
3610000  slj1  sngljun
3610101  360010002  362010001  0.  0.2  0.4  000100
3610201  0  0.  0.  0.
*
***************************************************************************
* component 362 : intact suction leg 1                                    *
***************************************************************************
3620000  sl1  pipe                   * name
3620001  1                           * number of volume
3620101  0.          1               * flow area of volume
*3620201  no junction                  * flow area of junction
3620301  9.1e-1      1               * flow length
3620401  3.5222e-3   1                 * volume of volume
3620501  0.          1               * azimuthal angle
3620601  -90.        1               * inclination angle
*3620701 elevation change
3620801  4.572e-4   70.2e-3     1      * roughness, hyd. dia.
*3620901  no junction                 * loss coeff.
3621001  00000       1                * flag of volume
*3621101  no junction                 * flag of junction
3621201  003    800099.  435.15  0.   0.   0.   1   * i.c. of volume
*3621300  no junction                 * i.c. ctrl word of junction
*3621301  no junction                 * i.c. of junction
*
***************************************************************************
* component 363 : intact suction leg junction 2                           *
***************************************************************************
3630000  slj2  sngljun
3630101  362010002  364010001  0.  0.05  0.05  000000
3630201  0   0.  0.  0.
*
***************************************************************************
* component 364 : intact suction leg 2                                    *
***************************************************************************
3640000  sl2  pipe                   * name
3640001  1                           * number of volume
3640101  0.          1               * flow area of volume
*3640201  no junction                  * flow area of junction
3640301  7.0e-1      1                * flow length
3640401  2.7094e-3   1                 * volume of volume
3640501  -135.       1                * azimuthal angle
3640601  0.          1               * inclination angle
*3640701 elevation change
3640801  4.572e-4   70.2e-3     1     * roughness, hyd. dia.
*3640901  no junction                 * loss coeff.
3641001  00000       1                * flag of volume
*3641101  no junction                 * flag of junction
3641201  003    800099.  435.15  0.   0.   0.   1   * i.c. of volume
*3641300  no junction                 * i.c. ctrl word of junction
*3641301  no junction                 * i.c. of junction
*
***************************************************************************
* component 365 : intact suction leg junction 3                           *
***************************************************************************
3650000  slj3  sngljun
3650101  364010002  370010001  1.2110e-3  3.05  3.05  000100
3650201  0  0.  0.  0.
*
***************************************************************************
* component 370 : intact discharge leg 1                                  *
***************************************************************************
3700000  dl1  pipe                   * name
3700001  1                           * number of volume
3700101  0.          1                * flow area of volume
*3700201  no junction                   * flow area of junction
3700301  6.5e-1      1                 * flow length
3700401  2.5158e-3   1                   * volume of volume
3700501  0.          1                 * azimuthal angle
3700601  90.         1                 * inclination angle
*3700701 elevation change
3700801  4.572e-4   70.2e-3     1        * roughness, hyd. dia.
*3700901  no junction                   * loss coeff.
3701001  00000       1                  * flag of volume
*3701101  no junction                   * flag of junction
```

```
3701201  003    830099.  435.15  0.   0.   0.   1   * i.c. of volume
*3701300  no junction                  * i.c. ctrl word of junction
*3701301  no junction                  * i.c. of junction
*
********************************************************************************
* component 370 : intact loop - pump                                    *
********************************************************************************
**3700000   ipump   pump
**3700101   0.   6.5e-1  2.5158e-3   0.   90.   6.5e-1   00000
**3700108   364010002   0.        0.      0.   000000
**3700109   372010001   1.9e-5  100.  10000.  000100
**3700200   003    800099.  415.15 0.0
**3700201   1   3.   0.0   0.0
**3700202   1   3.   0.0   0.0
**3700301   -1   -1  -2  -1   -1  503  0
**3700302   50.     1.0057  1.     20.    1.1498e3   1.0284e4  990.
*typpwr   124.51  1.0057  16.761  84.43  1.1498e5   1.0284e4  990.
**3700303   0.   0.   3.2541e3   0.0   0.0
*
********************************************************************************
* component 371 : intact discharge leg junction 1                        *
********************************************************************************
**3710000  dlj1  sngljun
**3710101  370010002  372010001  0.  0.05  0.05  000000
**3710201  0  0.  0.  0.
*
********************************************************************************
* component 372 : intact discharge leg 2                                 *
********************************************************************************
3720000  dl2  pipe                    * name
3720001  1                            * number of volume
3720101  0.          1                 * flow area of volume
*3720201  no junction                    * flow area of junction
3720301  2.9e-1      1                  * flow length
3720401  1.1224e-3  1                   * volume of volume
3720501  175.        1                  * azimuthal angle
3720601  0.          1                  * inclination angle
*3720701 elevation change
3720801  4.572e-4   70.2e-3    1        * roughness, hyd. dia.
*3720901  no junction                   * loss coeff.
3721001  00000        1                 * flag of volume
*3721101  no junction                   * flag of junction
3721201  003    830099.  435.15  0.   0.   0.   1   * i.c. of volume
*3721300  no junction                  * i.c. ctrl word of junction
*3721301  no junction                  * i.c. of junction
*
********************************************************************************
* component 373 : intact discharge leg junction 2                        *
********************************************************************************
3730000  dlj2  sngljun
3730101  372010002  374010001  0.  0.  0.  000000
3730201  0  0.  0.  0.
*
********************************************************************************
* component 374 : intact discharge leg 3                                 *
********************************************************************************
3740000  dl3  pipe                    * name
3740001  1                            * number of volume
3740101  0.          1                 * flow area of volume
*3740201  no junction                    * flow area of junction
3740301  6.85e-1      1                 * flow length
3740401  2.6513e-3   1                  * volume of volume
3740501  175.        1                  * azimuthal angle
3740601  0.          1                  * inclination angle
*3740701 elevation change
3740801  4.572e-4    70.2e-3    1   * roughness, hyd. dia.
*3740901  no junction                   * loss coeff.
3741001  00000        1                 * flag of volume
*3741101  no junction                   * flag of junction
3741201  003    830099.  435.15  0.   0.   0.   1   * i.c. of volume
*3741300  no junction                  * i.c. ctrl word of junction
*3741301  no junction                  * i.c. of junction
*
********************************************************************************
* component 375 : intact discharge leg junction 3                        *
********************************************************************************
3750000  dlj3  sngljun
3750101  374010002  376010001  0.  0.01  0.01  000000
3750201  0  0.  0.  0.
*
********************************************************************************
* component 376 : intact discharge leg 4                                 *
********************************************************************************
3760000  dl4  pipe                    * name
3760001  1                            * number of volume
3760101  0.          1                 * flow area of volume
```

```
*3760201  no junction                 * flow area of junction
3760301  2.7e-1      1                * flow length
3760401  1.0450e-3  1                 * volume of volume
3760501  -60.        1                * azimuthal angle
3760601  0.          1                * inclination angle
*3760701 elevation change
3760801  4.572e-4   70.2e-3    1      * roughness, hyd. dia.
*3760901  no junction                 * loss coeff.
3761001  00000       1                * flag of volume
*3761101  no junction                 * flag of junction
3761201  003    830099.  435.15  0.   0.   0.   1   * i.c. of volume
*3761300  no junction                 * i.c. ctrl word of junction
*3761301  no junction                 * i.c. of junction
*
******************************************************************************
* component 400 : broken hot leg section 1                                    *
******************************************************************************
*
4000000  bhotl1  pipe                 * name
4000001  1                            * number of volume
4000101  0.          1                * flow area of volume
*4000201  no junction                 * flow area of junction
4000301  2.0e-1      1                * flow length
4000401  8.6901e-4  1                 * volume of volume
4000501  180.        1                * azimuthal angle
4000601  0.          1                * inclination angle
4000701  0.          1                * elevation change
4000801  4.572e-4   7.4196e-2   1     * roughness, hyd. dia.
*4000901  no junction                 * loss coeff.
4001001  00000       1                * flag of volume
*4001101  no junction                 * flag of junction
4001201  003    800099.  440.15  0.   0.   0.   1   * i.c. of volume
*4001300  no junction                 * i.c. ctrl word of junction
*4001301  no junction                 * i.c. ctrl word of junction
*
******************************************************************************
* component 401 : broken hot leg junction 1                                   *
******************************************************************************
*
4010000  bhj1   sngljun
4010101  400010002  410010001  0.  0.003  0.003  000100
4010201  0  0.  0.  0.
*
******************************************************************************
* component 410 : broken hot leg section 2                                    *
******************************************************************************
*
4100000  bhotl2  pipe                 * name
4100001  1                            * number of volume
4100101  0.          1                * flow area of volume
*4100201  no junction                 * flow area of junction
4100301  9.8e-2      1                * flow length
4100401  3.4638e-4  1                 * volume of volume
4100501  180.        1                * azimuthal angle
4100601  0.          1                * inclination angle
*4100701 elevation change
4100801  4.572e-4   6.703e-2    1     * roughness, hyd. dia.
*4100901  no junction                 * loss coeff.
4101001  00000       1                * flag of volume
*4101101  no junction                 * flow area of junction
4101201  003    800099.  440.15  0.   0.   0.   1   * i.c. of volume
*4101300  no junction                 * i.c. ctrl word of junction
*4101301  no junction                 * i.c. ctrl word of junction
*
******************************************************************************
* component 411 : broken hot leg separation valve                             *
******************************************************************************
4110000  spavlv     sngljun
4110101  410010001  420010000  0.    0.01    0.01    000100
4110201  0     0.0        0.0        0.0
*4110300  trpvlv
*4110301  1
*
******************************************************************************
* component 420 : broken hot leg section 3                                    *
******************************************************************************
*
4200000  bhotl3  pipe                 * name
4200001  1                            * number of volume
4200101  0.          1                * flow area of volume
*4200201  no junction                 * flow area of junction
4200301  9.7e-2      1                * flow length
4200401  3.1940e-4  1                 * volume of volume
4200501  180.        1                * azimuthal angle
4200601  0.          1                * inclination angle
*4200701 elevation change
```

```
4200801  4.572e-4   6.6997e-2    1     * roughness, hyd. dia.
*4200901  no junction               * loss coeff.
4201001  00000       1              * flag of volume
*4201101  no junction               * flow area of junction
4201201  003    800099.  440.15  0.   0.   0.   1  * i.c. of volume
*4201300  no junction               * i.c. ctrl word of junction
*4201301  no junction               * i.c. ctrl word of junction
*
*******************************************************************************
* component 421 : broken hot leg junction 2                                   *
*******************************************************************************
*
4210000  bhj2  sngljun
4210101  420010002  430010001  0.  0.  0.  000000
4210201  0  0.  0.  0.
*
*
*******************************************************************************
* component 430 : broken hot leg section 4                                    *
*******************************************************************************
*
4300000  bhotl4  pipe                 * name
4300001  1                          * number of volume
4300101  0.         1               * flow area of volume
*4300201  no junction                 * flow area of junction
4300301  1.3e-1     1               * flow length
4300401  5.0317e-4  1                 * volume of volume
4300501  180.       1               * azimuthal angle
4300601  0.         1               * inclination angle
*4300701 elevation change
4300801  4.572e-4   70.2e-3     1     * roughness, hyd. dia.
*4300901  no junction                 * loss coeff.
4301001  00000       1                * flag of volume
*4301101  no junction               * flow area of junction
4301201  003    800099.  440.15  0.   0.   0.   1  * i.c. of volume
*4301300  no junction                 * i.c. ctrl word of junction
*4301301  no junction                 * i.c. of junction
*
*******************************************************************************
* component 431 : broken hot leg junction 3                                   *
*******************************************************************************
*
4310000  bhj3  sngljun
4310101  430010002  440010003  0.  0.4   0.25  000102
4310201  0  0.  0.  0.
*
*******************************************************************************
* component 440 : broken loop u tube inlet                                    *
*******************************************************************************
*
4400000  bltube-i  pipe               * name
4400001  1                          * number of volume
4400101  3.9961e-2  1                 * flow area of volume
*4400201  no junction                 * flow area of junction
4400301  100.0e-3   1                * flow length
4400401  0.         1               * volume of volume
4400501  0.         1               * azimuthal angle
4400601  0.         1               * inclination angle
4400701  0.0e-3     1
4400801  4.572e-4   194.9139e-3     1  * roughness, hyd. dia.
*4400901  no junction                 * loss coeff.
4401001  00000      1                 * flag of volume
*4401101  no junction                * flag of junction
4401201  003    800099.  440.15  0.   0.   0.   1  * i.c. of volume
*4401300  no junction                 * i.c. ctrl word of junction
*4401301  no junction                 * i.c. of junction
*
*******************************************************************************
* component 441 : broken u tube inlet junction 1                              *
*******************************************************************************
*
4410000  btub_ij1  sngljun
4410101  440010002  450010001  0.  17.  26.   000100
4410201  0  0.  0.  0.
*
*******************************************************************************
* component 443 : broken u tube inlet junction 2                              *
*******************************************************************************
*
4430000  btub_ij2  sngljun
4430101  440010002  452010001  0.  17.  26.   000100
4430201  0  0.  0.  0.
*
*******************************************************************************
* component 450 : broken u tube 1                                             *
*******************************************************************************
```

```
*
4500000  btub1   pipe                    * name
4500001  8                              * number of volume
4500101  2.2682e-3  8                     * flow area of volume
4500201  0.          7                  * flow area of junction
4500301  4.1e-1      8                   * flow length
4500401  0.          8                  * volume of volume
4500501  0.          8                  * azimuthal angle
4500601  90.         4                   * inclination angle
4500602  -90.        8
*4500701 elevation change
4500801  4.572e-4   19.0e-3    8 * roughness, hyd. dia.
4500901  0.           0.        3 * loss coeff.
4500902  0.42         0.42       4
4500903  0.           0.         7
4501001  00000       8               * flag of volume
4501101  000000      7               * flag of junction
4501201  003    800099.  438.15  0.   0.   0.   8   * i.c. of volume
4501300  0                                   * i.c. ctrl word of junction
4501301  0.0      0.0      0.     7                 * i.c. of junction
*
********************************************************************************
* component 452 : broken u tube 2                                  *
********************************************************************************
*
4520000  btub2   pipe
4520001  8                              * number of volume
4520101  2.2682e-3  8                     * flow area of volume
4520201  0.          7                  * flow area of junction
4520301  4.1e-1      8                   * flow length
4520401  0.          8                  * volume of volume
4520501  0.          8                  * azimuthal angle
4520601  90.         4                   * inclination angle
4520602  -90.        8
*4520701 elevation change
4520801  4.572e-4   19.0e-3    8 * roughness, hyd. dia.
4520901  0.           0.        3 * loss coeff.
4520902  0.42         0.42       4
4520903  0.           0.         7
4521001  00000       8               * flag of volume
4521101  000000      7               * flag of junction
4521201  003    800099.  438.15  0.   0.   0.   8   * i.c. of volume
4521300  0                                   * i.c. ctrl word of junction
4521301  0.0      0.0      0.     7                 * i.c. of junction
*
********************************************************************************
* component 451 : broken u tube outlet junction 1                  *
********************************************************************************
*
4510000  btub_oj1  sngljun
4510101  450080002  460010001  0.  26.  17.  000100
4510201  0  0.  0.  0.
*
********************************************************************************
* component 453 : broken u tube outlet junction 2                  *
********************************************************************************
*
4530000  btub_oj2  sngljun
4530101  452080002  480010001  0.  26.  17.  000100
4530201  0  0.  0.  0.
*
********************************************************************************
* component 460 : broken loop u tube outlet 1                      *
********************************************************************************
*
4600000  bltub-o1  pipe                 * name
4600001  1                             * number of volume
4600101  1.9830e-2  1                    * flow area of volume
*4600201  no junction                   * flow area of junction
4600301  100.0e-3   1                   * flow length
4600401  0.          1                 * volume of volume
4600501  180.        1                  * azimuthal angle
4600601  0.          1                 * inclination angle
*4600701 elevation change
4600801  4.572e-4   194.9139e-3     1   * roughness, hyd. dia.
*4600901  no junction                   * loss coeff.
4601001  00000       1                  * flag of volume
*4601101  no junction                   * flag of junction
4601201  003    800099.  435.15  0.   0.   0.   1   * i.c. of volume
*4601300  no junction                   * i.c. ctrl word of junction
*4601301  no junction                   * i.c. of junction
*
********************************************************************************
* component 461 : broken suction leg junction 1-1                  *
********************************************************************************
*
```

```
4610000  slj1-1  sngljun
4610101  460010004  462010001  0.  0.25  0.40  000102
4610201  0  0.  0.  0.
*
********************************************************************************
* component 480 : broken loop u tube outlet 2                                  *
********************************************************************************
*
4800000  bltub-o2  pipe              * name
4800001  1                           * number of volume
4800101  1.9830e-2  1                * flow area of volume
*4800201  no junction                * flow area of junction
4800301  100.0e-3   1                * flow length
4800401  0.         1                * volume of volume
4800501  180.       1                * azimuthal angle
4800601  0.         1                * inclination angle
4800701  0.0e-3     1
4800801  4.572e-4   194.9139e-3    1  * roughness, hyd. dia.
*4800901  no junction                * loss coeff.
4801001  00000      1                * flag of volume
*4801101  no junction                * flow area of junction
4801201  003   800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4801300  no junction                * i.c. ctrl word of junction
*4801301  no junction                * i.c. of junction
*
********************************************************************************
* component 481 : broken suction leg junction 2-1                              *
********************************************************************************
*
4810000  slj1-1  sngljun
4810101  480010004  482010001  0.  0.25  0.4  000102
4810201  0  0.  0.  0.
*
********************************************************************************
* component 462 : broken loop suction leg 1-1                                  *
********************************************************************************
*
4620000  bsuc1-1  pipe               * name
4620001  1                           * number of volume
4620101  0.         1                * flow area of volume
*4620201  no junction                * flow area of junction
4620301  2.5456e-1  1                * flow length
4620401  6.0259e-4  1                * volume of volume
4620501  -135.      1                * azimuthal angle
4620601  -45.       1                * inclination angle
*4620701 elevation change
4620801  4.572e-4   54.9e-3     1    * roughness, hyd. dia.
*4620901  no junction                * loss coeff.
4621001  00000      1                * flag of volume
*4621101  no junction                * flow area of junction
4621201  003   800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4621300  no junction                * i.c. ctrl word of junction
*4621301  no junction                * i.c. of junction
*
********************************************************************************
* component 463 : broken suction leg junction 1-2                              *
********************************************************************************
*
4630000  slj1-2  sngljun
4630101  462010002  464010001  0.  0.001  0.001  000000
4630201  0  0.  0.  0.
*
********************************************************************************
* component 464 : broken loop section leg 1-2                                  *
********************************************************************************
*
4640000  bsuc11-2  pipe              * name
4640001  1                           * number of volume
4640101  0.         1                * flow area of volume
*4640201  no junction                * flow area of junction
4640301  2.45e-1    1                * flow length
4640401  6.3996e-4  1                * volume of volume
4640501  0.         1                * azimuthal angle
4640601  -90.       1                * inclination angle
*4640701 elevation change
4640801  4.572e-4   5.7545e-2   1    * roughness, hyd. dia.
*4640901  no junction                * loss coeff.
4641001  00000      1                * flag of volume
*4641101  no junction                * flow area of junction
4641201  003   800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4641300  no junction                * i.c. ctrl word of junction
*4641301  no junction                * i.c. ctrl of junction
*
********************************************************************************
* component 465 : broken suction leg junction 1-3                              *
********************************************************************************
```

```
*
4650000  slj1-3  sngljun
4650101  464010002  466010001  0.  0.05  0.05  000000
4650201  0    0.    0.  0.
*
***************************************************************************
* component 466 : broken loop suction leg 1-3                            *
***************************************************************************
*
4660000  bsuc11-3  pipe                 * name
4660001  1                            * number of volume
4660101  0.           1               * flow area of volume
*4660201  no junction                  * flow area of junction
4660301  5.1e-1       1                * flow length
4660401  1.2073e-3  1                  * volume of volume
4660501  -45.         1               * azimuthal angle
4660601  -3.3723      1                * inclination angle
*4660701 elevation change
4660801  4.572e-4    54.9e-3      1      * roughness, hyd. dia.
*4660901  no junction                  * loss coeff.
4661001  00000        1                * flag of volume
*4661101  no junction                  * flow area of junction
4661201  003    800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4661300  no junction                  * i.c. ctrl word of junction
*4661301  no junction                  * i.c. of junction
*
***************************************************************************
* component 467 : broken suction leg junction 1-4                        *
***************************************************************************
*
4670000  slj1-4  sngljun
4670101  466010002  470010001  0.  0.05  0.05  000000
4670201  0  0.  0.  0.
*
***************************************************************************
* component 470 : broken loop pump volume 1                              *
***************************************************************************
*
4700000  pumpv1     pipe                 * name
4700001  1                             * number of volume
4700101  0.           1                * flow area of volume
*4700201  no junction                   * flow area of junction
4700301  4.55e-1      1                 * flow length
4700401  9.3958e-4  1                   * volume of volume
4700501  0.           1                * azimuthal angle
4700601  90.          1                * inclination angle
*4700701 elevation change
4700801  4.572e-4    5.2974e-2   1      * roughness, hyd. dia.
*4700901  no junction                   * loss coeff.
4701001  00000        1                 * flag of volume
*4701101  no junction                   * flag of junction
4701201  003    800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4701300  no junction                   * i.c. ctrl word of junction
*4701301  no junction                   * i.c. of junction
*
***************************************************************************
* component 470 : broken loop - pump 1                                   *
***************************************************************************
**4700000   ipump   pump
**4700101   0.   4.55e-1   9.3958e-4   -45.  90.  4.55e-1   00000
**4700108   466010002   0.        0.    0.    000000
**4700109   472010001   1.3e-5   100.  710000.   000100
**4700200   003   800099.  415.15  0.0
**4700201   1   3.   0.0   0.0
**4700202   1   3.   0.0   0.0
**4700301   -1   -1   -2   -1   -1   503   0
**4700302   50.     1.0057   1.     20.     1.1498e3    1.0284e4   990.
*typpwr   124.51   1.0057   16.761   84.43   1.1498e5    1.0284e4   990.
**4700303   0.   0.   3.2541e3    0.0   0.0
*
***************************************************************************
* component 471 : broken discharge leg junction 1-1                      *
***************************************************************************
*
**4710000  dlj1-1  sngljun
**4710101  470010002  472010001  0.  0.1  0.1  000000
**4710201  0  0.  0.  0.
*
***************************************************************************
* component 472 : broken loop discharge leg 1-1                          *
***************************************************************************
*
4720000  disl1-1     pipe                 * name
4720001  1                             * number of volume
4720101  0.          1                 * flow area of volume
*4720201  no junction                   * flow area of junction
```

```
4720301  2.95e-1    1                 * flow length
4720401  6.9832e-4  1                 * volume of volume
4720501  15.        1                 * azimuthal angle
4720601  0.         1                 * inclination angle
*4720701 elevation change
4720801  4.572e-4   54.9e-3    1      * roughness, hyd. dia.
*4720901  no junction                 * loss coeff.
4721001  00000      1                 * flag of volume
*4721101  no junction                 * flow area of junction
4721201  003   830099.  435.15  0.   0.   0.   1  * i.c. of volume
*4721300  no junction                 * i.c. ctrl word of junction
*4721301  no junction                 * i.c. of junction
*
********************************************************************************
* component 473 : broken discharge leg junction 1-2                            *
********************************************************************************
*
4730000  dlj1-2  sngljun
4730101  472010002  474010001  0.  0.  0.  000000
4730201  0  0.  0.  0.
*
********************************************************************************
* component 474 : broken loop discharge leg 1-2                                *
********************************************************************************
*
4740000  disl1-2    pipe              * name
4740001  1                            * number of volume
4740101  0.         1                 * flow area of volume
*4740201  no junction                 * flow area of junction
4740301  4.15e-1    1                 * flow length
4740401  9.8239e-4  1                 * volume of volume
4740501  15.        1                 * azimuthal angle
4740601  0.         1                 * inclination angle
4740701  0.         1                 * elevation change
4740801  4.572e-4   54.9e-3    1      * roughness, hyd. dia.
*4740901  no junction                 * loss coeff.
4741001  00000      1                 * flag of volume
*4741101  no junction                 * flow area of junction
4741201  003   830099.  435.15  0.   0.   0.   1  * i.c. of volume
*4741300  no junction                 * i.c. ctrl word of junction
*4741301  no junction                 * i.c. of junction
*
********************************************************************************

* component 475 : broken discharge leg junction 1-3                            *
********************************************************************************
*
4750000  dlj1-3  sngljun
4750101  474010002  476010001  0.  0.005  0.005  000000
4750201  0  0.  0.  0.
*
********************************************************************************
* component 476 : broken loop discharge leg 1-3                                *
********************************************************************************
*
4760000  disl1-3    pipe              * name
4760001  1                            * number of volume
4760101  0.         1                 * flow area of volume
*4760201  no junction                 * flow area of junction
4760301  2.0e-1     1                 * flow length
4760401  4.7344e-4  1                 * volume of volume
4760501  60.        1                 * azimuthal angle
4760601  0.         1                 * inclination angle
*4760701  elevation change
4760801  4.572e-4   54.9e-3    1      * roughness, hyd. dia.
*4760901  no junction                 * loss coeff.
4761001  00000      1                 * flag of volume
*4761101  no junction                 * flow area of junction
4761201  003   830099.  435.15  0.   0.   0.   1  * i.c. of volume
*4761300  no junction                 * i.c. ctrl word of junction
*4761301  no junction                 * i.c. of junction
*
********************************************************************************
* component 482 : broken loop suction leg 2-1                                  *
********************************************************************************
*
4820000  bsuc2-1  pipe                * name
4820001  1                            * number of volume
4820101  0.         1                 * flow area of volume
*4820201  no junction                 * flow area of junction
4820301  2.5456e-1  1                 * flow length
4820401  6.0259e-4  1                 * volume of volume
4820501  135.       1                 * azimuthal angle
4820601  -45.       1                 * inclination angle
*4820701 elevation change
4820801  4.572e-4   54.9e-3    1      * roughness, hyd. dia.
*4820901  no junction                 * loss coeff.
```

```
4821001  00000       1                    * flag of volume
*4821101  no junction                     * flow area of junction
4821201  003    800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4821300  no junction                     * i.c. ctrl word of junction
*4821301  no junction                     * i.c. of junction
*
******************************************************************************
* component 483 : broken suction leg junction 2-2                           *
******************************************************************************
*
4830000  slj2-2  sngljun
4830101  482010002  484010001  0.  0.001  0.001  000000
4830201  0  0.  0.  0.
*
******************************************************************************
* component 484 : broken loop section leg 2-2                               *
******************************************************************************
*
4840000  bsucl2-2  pipe                  * name
4840001  1                              * number of volume
4840101  0.          1                  * flow area of volume
*4840201  no junction                     * flow area of junction
4840301  2.45e-1     1                    * flow length
4840401  6.3996e-4   1                     * volume of volume
4840501  0.          1                  * azimuthal angle
4840601  -90.        1                  * inclination angle
*4840701 elevation change
4840801  4.572e-4   5.7545e-2     1       * roughness, hyd. dia.
*4840901  no junction                     * loss coeff.
4841001  00000       1                    * flag of volume
*4841101  no junction                     * flow area of junction
4841201  003    800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4841300  no junction                     * i.c. ctrl word of junction
*4841301  no junction                     * i.c. ctrl of junction
*
******************************************************************************
* component 485 : broken suction leg junction 2-3                           *
******************************************************************************
*
4850000  slj2-3  sngljun
4850101  484010002  486010001  0.  0.05  0.05  000000
4850201  0    0.    0.  0.
*
```

```
******************************************************************************
* component 486 : broken loop suction leg 2-3                               *
******************************************************************************
*
4860000  bsucl2-3  pipe                  * name
4860001  1                              * number of volume
4860101  0.          1                  * flow area of volume
*860201  no junction                    * flow area of junction
4860301  5.1e-01     1                   * flow length
4860401  1.2073e-3   1                    * volume of volume
4860501  -45.        1                  * azimuthal angle
4860601  -3.3723     1                   * inclination angle
*4860701 elevation change
4860801  4.572e-4   54.9e-3      1        * roughness, hyd. dia.
*4860901  no junction                    * loss coeff.
4861001  00000       1                   * flag of volume
*4861101  no junction                    * flow area of junction
4861201  003    800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4861300  no junction                    * i.c. ctrl word of junction
*4861301  no junction                    * i.c. of junction
*
******************************************************************************
* component 487 : broken suction leg junction 2-4                           *
******************************************************************************
*
4870000  slj2-4  sngljun
4870101  486010002  490010001  0.  0.05  0.05  000000
4870201  0  0.  0.  0.
*
******************************************************************************
* component 490 : broken loop pump volume 2                                 *
******************************************************************************
*
4900000  pumpv1      pipe                * name
4900001  1                              * number of volume
4900101  0.          1                  * flow area of volume
*4900201  no junction                      * flow area of junction
4900301  4.55e-1     1                   * flow length
4900401  9.3958e-4   1                    * volume of volume
4900501  0.          1                  * azimuthal angle
4900601  90.         1                  * inclination angle
*4900701 elevation change
4900801  4.572e-4   5.2974e-2     1       * roughness, hyd. dia.
```

```
*4900901  no junction                * loss coeff.
4901001  00000      1                * flag of volume
*4901101  no junction                * flag of junction
4901201  003   800099.  435.15  0.   0.   0.   1  * i.c. of volume
*4901300  no junction                * i.c. ctrl word of junction
*4901301  no junction                * i.c. of junction
*
*******************************************************************************
* component 490 : broken loop - pump 2                                        *
*******************************************************************************
**4900000   ipump   pump
**4900101   0.   4.55e-1   9.3958e-4   -45.   90.   4.55e-1   00000
**4900108   486010002   0.        0.       0.   000000
**4900109   492010001   1.3e-5   100.   10000.   000100
**4900200   003   800099.  415.15 0.0
**4900201   1   3.   0.0   0.0
**4900202   1   3.   0.0   0.0
**4900301   -1   -1  -2  -1   -1  503  0
**4900302   50.     1.0057  1.     20.     1.1498e3    1.0284e4   990.
**4900303   0.   0.   3.2541e3   0.0   0.0
*
*******************************************************************************
* component 491 : broken discharge leg junction 2-1                           *
*******************************************************************************
*
**4910000  dlj2-1  sngljun
**4910101  490010002  492010001  0.  0.05  0.05  000000
**4910201  0  0.  0.  0.
*
*******************************************************************************
* component 492 : broken loop discharge leg 2-1                               *
*******************************************************************************
*
4920000  disl2-1     pipe              * name
4920001  1                             * number of volume
4920101  0.          1                 * flow area of volume
*4920201  no junction                   * flow area of junction
4920301  2.95e-1     1                  * flow length
4920401  6.9832e-4  1                    * volume of volume
4920501  -15.        1                 * azimuthal angle
4920601  0.          1                 * inclination angle
*4920701 elevation change
4920801  4.572e-4    54.9e-3       1        * roughness, hyd. dia.
```

```
*4920901  no junction                * loss coeff.
4921001  00000      1                * flag of volume
*4921101  no junction                * flow area of junction
4921201  003    830099.  435.15  0.   0.   0.   1  * i.c. of volume
*4921300  no junction                * i.c. ctrl word of junction
*4921301  no junction                * i.c. of junction
*
*******************************************************************************
* component 493 : broken discharge leg junction 2-2                           *
*******************************************************************************
*
4930000  dlj2-2  sngljun
4930101  492010002  494010001  0.  0.  0.  000000
4930201  0  0.  0.  0.
*
*******************************************************************************
* component 494 : broken loop discharge leg 2-2                               *
*******************************************************************************
*
4940000  disl2-2     pipe              * name
4940001  1                             * number of volume
4940101  0.          1                 * flow area of volume
*4940201  no junction                   * flow area of junction
4940301  4.15e-1     1                 * flow length
4940401  9.8239e-4  1                   * volume of volume
4940501  -15.        1                 * azimuthal angle
4940601  0.          1                 * inclination angle
4940701  0.          1                 * elevation change
4940801  4.572e-4    54.9e-3      1       * roughness, hyd. dia.
*4940901  no junction                   * loss coeff.
4941001  00000       1                 * flag of volume
*4941101  no junction                   * flow area of junction
4941201  003    830099.  435.15  0.   0.   0.   1  * i.c. of volume
*4941300  no junction                   * i.c. ctrl word of junction
*4941301  no junction                   * i.c. of junction
*
*******************************************************************************
* component 495 : broken discharge leg junction 2-3                           *
*******************************************************************************
*
4950000  dlj2-3  sngljun
4950101  494010002  496010001  0.  0.005  0.005  000000
4950201  0  0.  0.  0.
```

```
*
********************************************************************************
* component 496 : broken loop discharge leg 2-3                        *
********************************************************************************
*
4960000  disl1-3     pipe                    * name
4960001  1                                   * number of volume
4960101  0.           1                      * flow area of volume
*4960201   no junction                       * flow area of junction
4960301  2.0e-1       1                      * flow length
4960401  4.7344e-4  1                        * volume of volume
4960501  -60.         1                      * azimuthal angle
4960601  0.         · 1                      * inclination angle
*4960701   elevation change
4960801  4.572e-4    54.9e-3      1          * roughness, hyd. dia.
*4960901   no junction                       * loss coeff.
4961001  00000        1                      * flag of volume
*4961101   no junction                       * flow area of junction
4961201  003    830099.  435.15  0.   0.   0.   1   * i.c. of volume
*4961300   no junction                       * i.c. ctrl word of junction
*4961301   no junction                       * i.c. of junction
*
*-------------------------------------*
*                    secondary system                  *
*-------------------------------------*
*
********************************************************************************
* component 600 : virtual feedwater volume a                           *
********************************************************************************
6000000  feed_a       tmdpvol
6000101  0.0  100.0  1.0e6   0.0   0.  0.   4.572e-4  0.0  00000
6000200  003
6000201  0.0  550500.  420.
*
********************************************************************************
* component 601 : feed water pump junction a 1                         *
********************************************************************************
*
6010000  feed_ja1  tmdpjun
6010101  600010002  602010001  0.
6010200  1   501  cntrlvar   006        * mass flow rate
6010201  0.         0.          0.   0.
6010202  1.0e6      1.0e6       0.   0.
```

```
*
********************************************************************************
* component 602 : sg downcomer a                                       *
********************************************************************************
*
6020000  sg_dc_a      annulus              * name
6020001  5                                 * number of volume
6020101  4.7024e-2  5                      * flow area of volume
6020201  4.7024e-2  4                      * flow area of junction
6020301  95.0e-3      1                    * flow length
6020302  410.0e-3    5
6020401  0.           5                    * volume of volume
6020501  0.           5                    * azimuthal angle
6020601  -90.         5                    * inclination angle
*6020701 elevation change
6020801  4.572e-4    51.0e-3      5        * roughness, hyd. dia.
6020901  0.            0.          4       * loss coeff.
6021001  00000         5                   * flag of volume    : pvbfe
6021101  000000        4                   * flag of junction : fvcahs
6021201  003      530500.  420.  0.   0.   0.   5   * i.c. of volume
6021300  0                                 * i.c. ctrl word of junction
6021301  0.0       0.0      0.    4        * i.c. of junction
*
********************************************************************************
* component 603 : feed water pump junction a 2                         *
********************************************************************************
*
6030000  sg_dc_ja  sngljun
6030101  602050002  610010001  0.  0.5  0.5  000100
6030201  0  5.0e-3  5.0e-3  0.
*
********************************************************************************
* component 610 : steam generator a shell                              *
********************************************************************************
*
6100000  sg-a-sh  pipe                     * name
6100001  4                                 * number of volume
6100101  4.9376e-2  4                      * flow area of volume
6100201  0.           3                    * flow area of junction
6100301  4.1e-1       4                    * flow length
6100401  0.           4                    * volume of volume
6100501  0.           4                    * azimuthal angle
6100601  90.          4                    * inclination angle
```

```
*6100701 elevation change
6100801  4.572e-4   105.133e-3  4      * roughness, hyd. dia.
6100901  0.5        0.5         3      * loss coeff.
6101001  00000      4                  * flag of volume    : pvbfe
6101101  000000     3                  * flag of junction : fvcahs
6101201  003   530500.  420.  0.   0.   0.   3  * i.c. of volume
6101202  002   530500.  0.    0.   0.   0.   4
6101300  0                                      * i.c. ctrl word of junction
6101301  0.0      0.0      0.    3              * i.c. of junction
*
*******************************************************************************
* component 611 : steam generator a junction 1                               *
*******************************************************************************
*
6110000  sg_a_j1  sngljun
6110101  610040002  620010001  0.  0.1  0.1  000100
6110201  0  5.0e-3  5.0e-3  0.
*
*******************************************************************************
* component 620 : steam generator a top shell                                *
*******************************************************************************
*
6200000  sg-a-tsh    pipe               * name
6200001  1                              * number of volume
6200101  5.3913e-2  1                    * flow area of volume
*6200201  no junction                    * flow area of junction
6200301  95.0e-3    1                    * flow length
6200401  0.         1                   * volume of volume
6200501  0.         1                   * azimuthal angle
6200601  90.        1                   * inclination angle
*6200701  elevation change
6200801  4.572e-4   262.0e-3     1      * roughness, hyd. dia.
*6200901  no junction      * loss coeff.
6201001  00000      1                    * flag of volume
*6201101  no junction                    * flag of junction
6201201  002    530500.  0.  0.   0.   0.   1  * i.c. of volume
*6201300  no junction                            * i.c. ctrl word of junction
*6201301  no junction                            * i.c. of junction
*
*******************************************************************************
* component 621 : steam generator a junction 2                               *
*******************************************************************************
*
6210000  sg_a_j2  sngljun
6210101  620010002  630010001  0.  0.1  0.1  000100
6210201  0  0.  0.  0.
*
*******************************************************************************
* component 630 : steam generator a upper plenum 1                           *
*******************************************************************************
*
6300000  sg-a-up1    pipe               * name
6300001  1                              * number of volume
6300101  7.9923e-2  1                    * flow area of volume
*6300201  no junction                    * flow area of junction
6300301  215.0e-3   1                    * flow length
6300401  0.         1                   * volume of volume
6300501  0.         1                   * azimuthal angle
6300601  90.        1                   * inclination angle
*6300701  elevation change
6300801  4.572e-4   319.0e-3     1      * roughness, hyd. dia.
*6300901  no junction      * loss coeff.
6301001  00000      1                    * flag of volume
*6301101  no junction                    * flag of junction
6301201  002    550500.  0.  0.   0.   0.   1  * i.c. of volume
*6301300  no junction                            * i.c. ctrl word of junction
*6301301  no junction                            * i.c. of junction
*
*******************************************************************************
* component 631 : steam generator a exit                                     *
*******************************************************************************
*
6310000  sg_a_ext  sngljun
6310101  630010002  650010001  0.  0.2  0.4  000100
6310201  0  0.  0.  0.
*
*******************************************************************************
* component 650 : steam line a 1                                             *
*******************************************************************************
*
6500000  sline-a1    pipe               * name
6500001  1                              * number of volume
6500101  6.1575e-4  1                    * flow area of volume
*6500201  no junction                    * flow area of junction
6500301  640.0e-3   1                    * flow length
6500401  0.         1                   * volume of volume
```

```
6500501  0.          1                    * azimuthal angle
6500601  90.         1                    * inclination angle
*6500701  elevation change
6500801  4.572e-4   28.0e-3    1      * roughness, hyd. dia.
*6500901  no junction      * loss coeff.
6501001  00000      1                   * flag of volume
*6501101  no junction                   * flag of junction
6501201  002     550500.   1.0  0.  0.  0.  1    * i.c. of volume
*6501300  no junction                         * i.c. ctrl word of junction
*6501301  no junction                         * i.c. of junction
*
********************************************************************************
* component 651 : steam line a junction 1                                       *
********************************************************************************
*
6510000  sl-a-j1   sngljun
6510101  650010002  660010001  0.  0.05  0.05  000000
6510201  0  0.  0.  0.
*
********************************************************************************
* component 660 : steam line a 2                                                *
********************************************************************************
*
6600000  sline-a2    pipe                 * name
6600001  1                                * number of volume
6600101  6.1575e-4  1                     * flow area of volume
*6600201  no junction                     * flow area of junction
6600301  1.269      1                     * flow length
6600401  0.         1                     * volume of volume
6600501  180.       1                     * azimuthal angle
6600601  0.         1                     * inclination angle
*6600701  elevation change
6600801  4.572e-4   28.0e-3    1       * roughness, hyd. dia.
*6600901  no junction      * loss coeff.
6601001  00000      1                   * flag of volume
*6601101  no junction                   * flag of junction
6601201  002     550500.  1.  0.  0.  0.  1         * i.c. of volume
*6601300  no junction                         * i.c. ctrl word of junction
*6601301  no junction                         * i.c. of junction
*
********************************************************************************
* component 661 : steam line a junction 2                                       *
********************************************************************************
*
6610000  sl-a-j2  sngljun
6610101  660010002  800010002  0.  0.  0.  000000
6610201  0  0.  0.  0.
*
********************************************************************************
* component 700 : virtual feedwater volume b                                    *
********************************************************************************
7000000  feed_b      tmdpvol
7000101  0.0  100.0  1.0e6   0.0   0.  0.   4.572e-4  0.0  00000
7000200  003
7000201  0.0  550500.  420.
*
********************************************************************************
* component 701 : feed water pump junction b 1                                  *
********************************************************************************
*
7010000  feed_jb1  tmdpjun
7010101  700010002  702010001  0.
7010200  1   501  cntrlvar   009         * mass flow rate
7010201  0.        0.          0.   0.
7010202  1.0e6     1.0e6       0.   0.

*
********************************************************************************
* component 702 : sg downcomer b                                                *
********************************************************************************
7020000  sg_dc_b     annulus              * name
7020001  5                              * number of volume
7020101  4.7024e-2  5                     * flow area of volume
7020201  4.7024e-2  4                     * flow area of junction
7020301  95.0e-3    1                     * flow length
7020302  410.0e-3   5
7020401  0.          5                  * volume of volume
7020501  0.          5                  * azimuthal angle
7020601  -90.        5                  * inclination angle
*7020701 elevation change
7020801  4.572e-4   51.0e-3     5       * roughness, hyd. dia.
7020901  0.          0.          4      * loss coeff.
7021001  00000       5                    * flag of volume    : pvbfe
7021101  000000      4                    * flag of junction : fvcahs
7021201  003     530500.  420.  0.   0.   0.   5   * i.c. of volume
7021300  0                                         * i.c. ctrl word of junction
```

```
7021301  0.0      0.0     0.    4                  * i.c. of junction
*
********************************************************************************
* component 703 : steam generator downcomer junction                          *
********************************************************************************
7030000  sg_dc_jb  sngljun
7030101  702050002  710010001  0.  0.5  0.5  000100
7030201  0  5.0e-3  5.0e-3  0.
*
********************************************************************************
* component 710 : steam generator b shell                                     *
********************************************************************************
7100000  sg-b-sh  pipe              * name
7100001  4                          * number of volume
7100101  4.9376e-2  4                 * flow area of volume
7100201  0.          3              * flow area of junction
7100301  4.1e-1       4              * flow length
7100401  0.           4             * volume of volume
7100501  0.           4             * azimuthal angle
7100601  90.          4             * inclination angle
*7100701 elevation change
7100801  4.572e-4   105.133e-3  4     * roughness, hyd. dia.
7100901  0.5         0.5         3    * loss coeff.
7101001  00000        4               * flag of volume    : pvbfe
7101101  000000       3               * flag of junction : fvcahs
7101201  003      530500.  420.  0.   0.   0.   3  * i.c. of volume
7101202  002      530500.  0.    0.   0.   0.   4
7101300  0                                     * i.c. ctrl word of junction
7101301  0.0      0.0     0.    3               * i.c. of junction
*
********************************************************************************
* component 711 : steam generator b junction 1                                *
********************************************************************************
7110000  sg_b_j1  sngljun
7110101  710040002  720010001  0.  0.1  0.1  000100
7110201  0  5.0e-3  5.0e-3  0.
*
********************************************************************************
* component 720 : steam generator b top shell                                 *
********************************************************************************
7200000  sg-b-tsh   pipe              * name
7200001  1                          * number of volume
7200101  5.3913e-2  1                 * flow area of volume
*7200201  no junction                 * flow area of junction
7200301  95.0e-3     1                * flow length
7200401  0.          1               * volume of volume
7200501  0.          1               * azimuthal angle
7200601  90.         1               * inclination angle
*7200701  elevation change
7200801  4.572e-4   262.0e-3     1      * roughness, hyd. dia.
*7200901  no junction       * loss coeff.
7201001  00000       1                * flag of volume
*7201101  no junction                 * flag of junction
7201201  002     530500.   0.  0.   0.   0.   1    * i.c. of volume
*7201300  no junction                           * i.c. ctrl word of junction
*7201301  no junction                           * i.c. of junction
*
********************************************************************************
* component 721 : steam generator b junction 2                                *
********************************************************************************
7210000  sg_b_j2  sngljun
7210101  720010002  730010001  0.  0.1  0.1  000100
7210201  0  0.  0.  0.
*
********************************************************************************
* component 730 : steam generator b upper plenum                              *
********************************************************************************
7300000  sg-b-up    pipe              * name
7300001  1                          * number of volume
7300101  7.9923e-2  1                 * flow area of volume
*7300201  no junction                 * flow area of junction
7300301  215.0e-3    1                * flow length
7300401  0.          1               * volume of volume
7300501  0.          1               * azimuthal angle
7300601  90.         1               * inclination angle
*7300701  elevation change
7300801  4.572e-4   319.0e-3     1     * roughness, hyd. dia.
*7300901  no junction       * loss coeff.
7301001  00000       1                * flag of volume
*7301101  no junction                 * flag of junction
7301201  002     550500.   0.  0.   0.   0.   1    * i.c. of volume
*7301300  no junction                           * i.c. ctrl word of junction
*7301301  no junction                           * i.c. of junction
*
********************************************************************************
* component 731 : steam generator b exit                                      *
```

```
********************************************************************************
7310000  sg_a_ext  sngljun
7310101  730010002  750010001  0.  0.2  0.4  000100
7310201  0  0.  0.  0.
*
********************************************************************************
* component 750 : steam line b 1                                               *
********************************************************************************
*
7500000  sline-a1    pipe              * name
7500001  1                             * number of volume
7500101  6.1575e-4  1                   * flow area of volume
*7500201  no junction                   * flow area of junction
7500301  1050.0e-3  1                   * flow length
7500401  0.          1                 * volume of volume
7500501  0.          1                 * azimuthal angle
7500601  90.         1                 * inclination angle
*7500701  elevation change
7500801  4.572e-4   28.0e-3    1        * roughness, hyd. dia.
*7500901  no junction       * loss coeff.
7501001  00000      1                   * flag of volume
*7501101  no junction                   * flag of junction
7501201  002     550500.   1.  0.  0.  0.  1       * i.c. of volume
*7501300  no junction                              * i.c. ctrl word of junction
*7501301  no junction                              * i.c. of junction
*
********************************************************************************
* component 751 : steam line b junction 1                                      *
********************************************************************************
*
7510000  sl-b-j1  sngljun
7510101  750010002  760010001  0.  0.05  0.05  000000
7510201  0  0.  0.  0.
*
********************************************************************************
* component 760 : steam line b 2                                               *
********************************************************************************
*
7600000  sline-b2    pipe              * name
7600001  1                             * number of volume
7600101  6.1575e-4  1                   * flow area of volume
*7600201  no junction                   * flow area of junction
7600301  913.0e-3   1                   * flow length
7600401  0.          1                 * volume of volume
7600501  0.          1                 * azimuthal angle
7600601  0.          1                 * inclination angle
*7600701  elevation change
7600801  4.572e-4   28.0e-3    1        * roughness, hyd. dia.
*7600901  no junction       * loss coeff.
7601001  00000      1                   * flag of volume
*7601101  no junction                   * flag of junction
7601201  002     550500.  1.  0.  0.  0.  1    * i.c. of volume
*7601300  no junction                          * i.c. ctrl word of junction
*7601301  no junction                          * i.c. of junction
*
********************************************************************************
* component 761 : steam line b junction 2                                      *
********************************************************************************
*
7610000  sl-b-j2  sngljun
7610101  760010002  800010001  0.  0.  0.  000000
7610201  0  0.  0.  0.
*
********************************************************************************
* component 800 : steam header                                                 *
********************************************************************************
*
8000000  s-header    pipe              * name
8000001  1                             * number of volume
8000101  6.1575e-4  1                   * flow area of volume
*8000201  no junction                   * flow area of junction
8000301  120.0e-3   1                   * flow length
8000401  0.          1                 * volume of volume
8000501  0.          1                 * azimuthal angle
8000601  0.          1                 * inclination angle
*8000701  elevation change
8000801  4.572e-4   28.0e-3    1        * roughness, hyd. dia.
*8000901  no junction.         1        * loss coeff.
8001001  00000      1                   * flag of volume
*8001101  no junction                   * flag of junction
8001201  002   550500.  1.  0.  0.  0.  1    * i.c. of volume
*8001300  no junction                   * i.c. ctrl word of junction
*8001301    no junction                 * i.c. of junction
*
********************************************************************************
* component 801 : steam header junction 1                                      *
```

```
********************************************************************************
*
8010000  s-hd-j1  sngljun
8010101  800010004  810010001  0.  0.1  0.1  000002     *fvcahs
8010201  0  0.  0.  0.
*
********************************************************************************
* component 810 : steam header line                                            *
********************************************************************************
*
8100000  s-headl    pipe                * name
8100001  1                              * number of volume
8100101  6.1575e-4  1                   * flow area of volume
*8100201  no junction                   * flow area of junction
8100301  5.0        1                   * flow length
8100401  0.         1                   * volume of volume
8100501  -90.       1                   * azimuthal angle
8100601  0.         1                   * inclination angle
*8100701  elevation change
8100801  4.572e-4   28.0e-3    1        * roughness, hyd. dia.
*8100901  no junction      * loss coeff.
8101001  00000      1                   * flag of volume
*8101101  no junction                   * flag of junction
8101201  002    550500.  1.  0.  0.  0.  1    * i.c. of volume
*8101300  no junction                          * i.c. ctrl word of junction
*8101301  no junction                          * i.c. of junction
*
********************************************************************************
* component 811 : steam header junction 2                                      *
********************************************************************************
*
8110000  s-hd-j2  sngljun
8110101  810010002  890010001  0.  0.  0.  000100     *fvcahs
8110201  0  0.  0.  0.
*
********************************************************************************
* component 811 : steam header junction 2                                      *
********************************************************************************
*
**8110000  feed_jb1  tmdpjun
**8110101  810010002  890010001  0.
**8110200  1   501  cntrlvar   010      * mass flow rate
**8110201  -1.0e6   0.       0.   0.
**8110202  0.       0.       0.   0.
**8110203  1.0e6    1.0e6    0.   0.
*
********************************************************************************
* component 890 : steam dump volume                                            *
********************************************************************************
8900000  bdtank     tmdpvol
8900101  0.0  100.0  1.0e6   -90.0   0.  0.   4.572e-4  0.0  00000
8900200  002
8900201  0.0  550000.  1.
*
*------------------------------------------------------------------------------*
*                              structure input                                 *
*------------------------------------------------------------------------------*
*
********************************************************************************
* structure 1100 : downcomer upper part at right hand side                     *
********************************************************************************
11100000  1     3   2   0    159.5e-3
11100100  0     1
11100101  1     162.0e-3
11100102  1     165.0e-3
11100201  001    2
11100301  0.    2
11100400  0
11100401  435.0      3
11100501  110010000  0    1    1  290.0e-3   1  * 580 mm x 1/2
11100601  0          0   0    1  290.0e-3   1
11100701  0          0.  0.   0.          1
11100801  0.1878   100.  100.   0.   0.  0.  0.  1.  1
11100901  0.1821   100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 1200 : downcomer upper part at left hand side                      *
********************************************************************************
11200000  1     3   2   0    159.5e-3
11200100  0     1
11200101  1     162.0e-3
11200102  1     165.0e-3
11200201  001    2
11200301  0.    2
11200400  0
11200401  435.0      3
```

```
11200501  120010000  0    1    1  290.0e-3   1  * 580 mm x 1/2
11200601  0          0    0    1  290.0e-3   1
11200701  0          0.   0.   0.        1
11200801  0.1878   100.  100.   0.   0.  0.  0.  1.  1
11200901  0.1821   100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 1300 : downcomer cold leg connector at right side               *
******************************************************************************
11300000  1      3    2    0     159.5e-3
11300100  0      1
11300101  1      162.0e-3
11300102  1      165.0e-3
11300201  001    2
11300301  0.     2
11300400  0
11300401  435.0      3
11300501  130010000  0    1    1  55.0e-3   1  * 110 mm x 1/2
11300601  0          0    0    1  55.0e-3   1
11300701  0          0.   0.   0.        1
11300801  0.1878   100.  100.   0.   0.  0.  0.  1.  1
11300901  0.1821   100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 1400 : downcomer cold leg connector at left side                *
******************************************************************************
11400000  1      3    2    0     159.5e-3
11400100  0      1
11400101  1      162.0e-3
11400102  1      165.0e-3
11400201  001    2
11400301  0.     2
11400400  0
11400401  435.0      3
11400501  140010000  0    1    1  55.0e-3   1  * 110 mm x 1/2
11400601  0          0    0    1  55.0e-3   1
11400701  0          0.   0.   0.        1
11400801  0.1878   100.  100.   0.   0.  0.  0.  1.  1
11400901  0.1821   100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 1320 : downcomer at right side                                  *
******************************************************************************
11320000  5      3    2    0     159.5e-3
11320100  0      1
11320101  1      162.0e-3
11320102  1      165.0e-3
11320201  001    2
11320301  0.     2
11320400  0
11320401  435.0      3
11320501  132010000  0    1    1  100.0e-3   1  * 200 mm x 1/2
11320502  132020000  0    1    1  100.0e-3   2  * 200 mm x 1/2
11320503  132030000  0    1    1   50.0e-3   3  * 100 mm x 1/2
11320504  132040000  0    1    1   50.0e-3   4  * 100 mm x 1/2
11320505  132050000  0    1    1   74.0e-3   5  * 148 mm x 1/2
11320601  0          0    0    1  100.0e-3   1
11320602  0          0    0    1  100.0e-3   2
11320603  0          0    0    1   50.0e-3   3
11320604  0          0    0    1   50.0e-3   4
11320605  0          0    0    1   74.0e-3   5
11320701  0          0.   0.   0.        5
11320801  0.1878   100.  100.   0.   0.  0.  0.  1.  5
11320901  0.1821   100.  100.   0.   0.  0.  0.  1.  5
*
******************************************************************************
* structure 1420 : downcomer at left side                                   *
******************************************************************************
11420000  5      3    2    0     159.5e-3
11420100  0      1
11420101  1      162.0e-3
11420102  1      165.0e-3
11420201  001    2
11420301  0.     2
11420400  0
11420401  435.0      3
11420501  132010000  0    1    1  100.0e-3   1  * 200 mm x 1/2
11420502  132020000  0    1    1  100.0e-3   2  * 200 mm x 1/2
11420503  132030000  0    1    1   50.0e-3   3  * 100 mm x 1/2
11420504  132040000  0    1    1   50.0e-3   4  * 100 mm x 1/2
11420505  132050000  0    1    1   74.0e-3   5  * 148 mm x 1/2
11420601  0          0    0    1  100.0e-3   1
11420602  0          0    0    1  100.0e-3   2
11420603  0          0    0    1   50.0e-3   3
11420604  0          0    0    1   50.0e-3   4
11420605  0          0    0    1   74.0e-3   5
```

```
11420701 0        0.  0.  0.     5
11420801 0.1878   100. 100.  0.  0. 0. 0. 1. 5
11420901 0.1821   100. 100.  0.  0. 0. 0. 1. 5
*
*******************************************************************************
* structure 1600 : downcomer lower plenum                                     *
*******************************************************************************
11600000 1    3  2  0  159.5e-3
11600100 0    1
11600101 1    162.0e-3
11600102 1    165.0e-3
11600201 001  2
11600301 0.   2
11600400 0
11600401 435.0   3
11600501 160010000 0  1  1  80.0e-3  1  * 80 mm
11600601 0        0  0  1  80.0e-3  1
11600701 0        0.  0.  0.     1
11600801 3.3938  100. 100.  0.  0. 0. 0. 1. 1
11600901 3.2906  100. 100.  0.  0. 0. 0. 1. 1
*
*******************************************************************************
* structure 1601 : downcomer lower plenum structure                           *
*******************************************************************************
11601000 1    3  2  0  0.
11601100 0    1
11601101 1    50.0e-3
11601102 1    100.0e-3
11601201 001  2
11601301 0.   2
11601400 0
11601401 435.0   3
11601501 0        0  0  1   1.  1  * 1 m
11601601 160010000 0  1  1   1.  1
11601701 0        0.  0.  0.   1
11601801 0.       100. 100.  0.  0. 0. 0. 1. 1
11601901 5.413    100. 100.  0.  0. 0. 0. 1. 1
*
*******************************************************************************
* structure 1800 : core bottom                                                *
*******************************************************************************
11800000 2    3  2  0  131.0e-3
11800100 0    1
11800101 1    132.5e-3
11800102 1    134.0e-3
11800201 001  2
11800301 0.   2
11800400 0
11800401 435.0   3
11800501 180010000 0  1  1  148.0e-3  1  * 148 mm
11800502 180020000 0  1  1  100.0e-3  2  * 100 mm
11800601 0        0  0  1  148.0e-3  1
11800602 0        0  0  1  100.0e-3  2
11800701 0        0.  0.  0.     2
11800801 98.235e-3 100. 100.0.  0. 0. 0. 1. 1
11800802 262.13e-3 100. 100.0.  0. 0. 0. 1. 2
11800901 96.036e-3 100. 100.0.  0. 0. 0. 1. 1
11800902 256.26e-3 100. 100.0.  0. 0. 0. 1. 2
*
*******************************************************************************
* structure 1801 : core active electric heaters                               *
*******************************************************************************
11801000 1    3  2  0  0.
11801100 0    1
11801101 1    2.5e-3
11801102 1    5.0e-3
11801201 002  1
11801202 001  2
11801301 1.0  2
11801400 0
11801401 440.0   3
11801501 0        0  0  1  2.4  1  * 0.1 m x 12 ea x 2 (u-type)
11801601 180020000 0  1  1  2.4  1
11801701 888  1.  0.  0.  1
11801801 0.0   100.  100.  0.  0.  0.  0.  1. 1
11801901 0.266 100.  100.  0.  0.  0.  0.  1. 1
*
*******************************************************************************
* structure 1802 : core inactive electric heaters                             *
*******************************************************************************
11802000 1    3  2  0  0.
11802100 0    1
11802101 1    2.5e-3
11802102 1    5.0e-3
11802201 002  1
11802201 001  2
```

```
11802301  0.    2
11802400  0
11802401  500.0      3
11802501  0           0    0    1    2.4   1   * 0.1 m x 12 ea x 2(u-type)
11802601  180020000  0    1    1   2.4   1
11802701  0        0.    0.   0.   1
11802801  0.0   100.  100.   0.   0.  0.  0.  1. 1
11802901  0.266 100.  100.   0.   0.  0.  0.  1. 1
*
*******************************************************************************
* structure 1900 : active core                                                 *
*******************************************************************************
11900000  3      3    2    0     131.0e-3
11900100  0      1
11900101  1      132.5e-3
11900102  1      134.0e-3
11900201  001     2
11900301  0.     2
11900400  0
11900401  435.0      3
11900501  190010000  0    1    1  100.0e-3   1   * 100 mm
11900502  190010000  0    1    1  200.0e-3   2   * 200 mm
11900503  190010000  0    1    1  200.0e-3   3   * 200 mm
11900601  0           0    0    1  100.0e-3   1
11900602  0           0    0    1  200.0e-3   2
11900603  0           0    0    1  200.0e-3   3
11900701  0           0.   0.   0.       3
11900801  0.2438   100.  100.   0.   0.  0.  0.  1.  3
11900901  0.2383   100.  100.   0.   0.  0.  0.  1.  3
*
*******************************************************************************
* structure 1901 : core active electric heaters                                *
*******************************************************************************
11901000  3      3    2    0     0.
11901100  0      1
11901101  1      2.5e-3
11901102  1      5.0e-3
11901201  002    1
11901202  001    2
11901301  1.0    2
11901400  0
11901401  500.0      3
11901501  0           0    0    1    2.4   1   * 0.1 m x 12 ea x 2(u-type)
11901502  0           0    0    1    4.8   2   * 0.1 m x 12 ea x 2(u-type)
11901503  0           0    0    1    4.8   3   * 0.1 m x 12 ea x 2(u-type)
11901601  190010000  0    1    1   2.4   1
11901602  190020000  0    1    1   4.8   2
11901603  190030000  0    1    1   4.8   3
11901701  888   1.   0.   0.   1
11901702  889   1.   0.   0.   3
11901801  0.0   100.  100.  0.  0.  0.  0.  1.  3
11901901  0.266 100.  100.  0.  0.  0.  0.  1.  3
*
*******************************************************************************
* structure 1902 : core inactive electric heaters                              *
*******************************************************************************
11902000  3      3    2    0     0.
11902100  0      1
11902101  1      2.5e-3
11902102  1      5.0e-3
11902201  002    1
11902202  001    2
11902301  1.0    2
11902400  0
11902401  440.0      3
11902501  0           0    0    1    2.4   1   * 0.1 m x 12 ea x 2(u-type)
11902502  0           0    0    1    4.8   2   * 0.1 m x 12 ea x 2(u-type)
11902503  0           0    0    1    4.8   3   * 0.1 m x 12 ea x 2(u-type)
11902601  190010000  0    1    1   2.4   1
11902602  190020000  0    1    1   4.8   2
11902603  190030000  0    1    1   4.8   3
11902701  0    1.   0.   0.   1
11902702  0    1.   0.   0.   3
11902801  0.0   100.  100.  0.  0.  0.  0.  1.  3
11902901  0.266 100.  100.  0.  0.  0.  0.  1.  3
*
*******************************************************************************
* structure 2000 : core branch                                                 *
*******************************************************************************
12000000  1      3    2    0     131.0e-3
12000100  0      1
12000101  1      132.5e-3
12000102  1      134.0e-3
12000201  001     2
12000301  0.     2
12000400  0
```

```
12000401  435.0      3
12000501  200010000  0    1    1  110.0e-3   1  * 110 mm
12000601  0          0    0    1  110.0e-3   1
12000701  0          0.   0.   0.      1
12000801  0.2438   100.  100.   0.   0.  0.  0.  1.  1
12000901  0.2383   100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 2001 : core branch inactive electric heaters                      *
********************************************************************************
12001000  1    3    2    0    0.
12001100  0    1
12001101  1    2.5e-3
12001102  1    5.0e-3
12001201  002   1
12001202  001   2
12001301  1.0   2
12001400  0
12001401  440.0      3
12001501  0          0    0    1   5.28   1  * 0.11 m x 24 ea x 2(u-type)
12001601  200010000  0    1    1   5.28   1
12001701  0    1.   0.   0.   1
12001801  0.0   100.  100.  0.  0.  0.  0.  1.  1
12001901  0.266 100.  100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 2100 : core upper                                                 *
********************************************************************************
12100000  2    3    2    0    131.0e-3
12100100  0    1
12100101  1    132.5e-3
12100102  1    134.0e-3
12100201  001    2
12100301  0.     2
12100400  0
12100401  435.0      3
12100501  210010000  0    1    1  290.0e-3   1  * 290 mm
12100502  210020000  0    1    1  290.0e-3   2  * 290 mm
12100601  0          0    0    1  290.0e-3   1
12100602  0          0    0    1  290.0e-3   2
12100701  0          0.   0.   0.      2
12100801  0.2438   100.  100.   0.   0.  0.  0.  1.  2
12100901  0.2383   100.  100.   0.   0.  0.  0.  1.  2
*
********************************************************************************
* structure 2101 : upper core inactive electric heaters                       *
********************************************************************************
12101000  2    3    2    0    0.
12101100  0    1
12101101  1    2.5e-3
12101102  1    5.0e-3
12101201  002   1
12101202  001   2
12101301  1.0   2
12101400  0
12101401  440.0      3
12101501  0          0    0    1   13.92   1  * 0.29 m x 24 ea x 2(u-type)
12101502  0          0    0    1   13.92   2  * 0.29 m x 24 ea x 2(u-type)
12101601  210010000  0    1    1   13.92   1
12101602  210020000  0    1    1   13.92   2
12101701  0    1.   0.   0.   2
12101801  0.0   100.  100.  0.  0.  0.  0.  1.  2
12101901  0.266 100.  100.  0.  0.  0.  0.  1.  2
*
********************************************************************************
* structure 2200 : upper plenum                                               *
********************************************************************************
12200000  1    3    2    0    159.5e-3
12200100  0    1
12200101  1    162.0e-3
12200102  1    168.0e-3
12200201  001    2
12200301  0.     2
12200400  0
12200401  435.0      3
12200501  210010000  0    1    1  251.0e-3   1  * 251 mm
12200601  0          0    0    1  251.0e-3   1
12200701  0          0.   0.   0.      1
12200801  0.2561   100.  100.   0.   0.  0.  0.  1.  1
12200901  0.2483   100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 2201 : upper plenum inactive electric heaters                     *
********************************************************************************
12201000  1    3    2    0    0.
12201100  0    1
```

```
12201101  1      2.5e-3
12201102  1      5.0e-3
12201201  002    1
12201202  001    2
12201301  1.0    2
12201400  0
12201401  440.0       3
12201501  0           0    0    1    12.048    1   * 0.251 m x 24 ea x 2(u-type)
12201601  220010000  0    1    1    12.048    1
12201701  0      1.   0.   0.   1
12201801  0.0    100.  100.  0.  0.  0.  0.  1.  1
12201901  0.266 100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 3000 : intact hot leg section 1                                   *
*******************************************************************************
13000000  1      3    2    0    35.1e-3
13000100  0      1
13000101  1      36.5e-3
13000102  1      46.0e-3
13000201  001    2
13000301  0.     2
13000400  0
13000401  435.0       3
13000501  300010000  0    1    1   527.0e-3    1   * 438 mm
13000601  0           0    0    1   527.0e-3    1
13000701  0           0.   0.   0.        1
13000801  70.2e-3  100.  100.   0.   0.  0.  0.  1.  1
13000901  76.3e-3  100.  100.   0.   0.  0.  0.  1.  1
*
*******************************************************************************
* structure 3100 : intact hot leg section 2                                   *
*******************************************************************************
13100000  1      3    2    0    35.1e-3
13100100  0      1
13100101  1      36.5e-3
13100102  1      39.0e-3
13100201  001    2
13100301  0.     2
13100400  0
13100401  435.0       3
13100501  310010000  0    1    1   438.0e-3    1   * 438 mm
13100601  0           0    0    1   438.0e-3    1
13100701  0           0.   0.   0.        1
13100801  70.2e-3  100.  100.   0.   0.  0.  0.  1.  1
13100901  76.3e-3  100.  100.   0.   0.  0.  0.  1.  1
*
*******************************************************************************
* structure 3200 : intact hot leg section 3                                   *
*******************************************************************************
13200000  1      3    2    0    35.1e-3
13200100  0      1
13200101  1      36.5e-3
13200102  1      39.0e-3
13200201  001    2
13200301  0.     2
13200400  0
13200401  435.0       3
13200501  320010000  0    1    1   260.0e-3    1   * 260 mm
13200601  0           0    0    1   260.0e-3    1
13200701  0           0.   0.   0.        1
13200801  70.2e-3  100.  100.   0.   0.  0.  0.  1.  1
13200901  76.3e-3  100.  100.   0.   0.  0.  0.  1.  1
*
*******************************************************************************
* structure 3300 : intact loop u tube inlet                                   *
*******************************************************************************
13300000  1      3    2    0    159.5e-3
13300100  0      1
13300101  1      162.0e-3
13300102  1      165.0e-3
13300201  001    2
13300301  0.     2
13300400  0
13300401  435.0       3
13300501  330010000  0    1    1   100.0e-3    1   * 100 mm
13300601  0           0    0    1   100.0e-3    1
13300701  0           0.   0.   0.        1
13300801  187.8e-3 100.  100.   0.   0.  0.  0.  1.  1
13300901  182.1e-3 100.  100.   0.   0.  0.  0.  1.  1
*
*******************************************************************************
* structure 3500 : intact loop u tubes 1                                      *
*******************************************************************************
13500000  8      3    2    0    9.5e-3
13500100  0      1
```

```
13500101 1       10.0e-3
13500102 1       10.5e-3
13500201 003     2
13500301 0.      2
13500400 0
13500401 435.0       3
13500501 350010000 0    1    1 3.28 1 * 0.41 m x 8 ea
13500502 350020000 0    1    1 3.28 2
13500503 350030000 0    1    1 3.28 3
13500504 350040000 0    1    1 3.28 4
13500504 350050000 0    1    1 3.28 5
13500504 350060000 0    1    1 3.28 6
13500504 350070000 0    1    1 3.28 7
13500504 350080000 0    1    1 3.28 8
13500601 610010000 0    1    1 3.28 1
13500602 610020000 0    1    1 3.28 2
13500603 610030000 0    1    1 3.28 3
13500604 610040000 0    1    1 3.28 4
13500605 610040000 0    1    1 3.28 5
13500606 610030000 0    1    1 3.28 6
13500607 610020000 0    1    1 3.28 7
13500608 610010000 0    1    1 3.28 8
13500701 0          0.   0.   0.       8
13500801 0.266    100.  100.   0.   0.  0.  0.  1.  8
13500901 0.3742   100.  100.   0.   0.  0.  0.  1.  8
*
******************************************************************************
* structure 3520 : intact loop u tubes 2                              *
******************************************************************************
13520000 8     3    2    0    9.5e-3
13520100 0       1
13520101 1       10.0e-3
13520102 1       10.5e-3
13520201 003     2
13520301 0.      2
13520400 0
13520401 435.0       3
13520501 352010000 0    1    1 3.28 1 * 0.41 m x 8 ea
13520502 352020000 0    1    1 3.28 2
13520503 352030000 0    1    1 3.28 3
13520504 352040000 0    1    1 3.28 4
13520504 352050000 0    1    1 3.28 5
13520504 352060000 0    1    1 3.28 6
13520504 352070000 0    1    1 3.28 7
13520504 352080000 0    1    1 3.28 8
13520601 610010000 0    1    1 3.28 1
13520602 610020000 0    1    1 3.28 2
13520603 610030000 0    1    1 3.28 3
13520604 610040000 0    1    1 3.28 4
13520605 610040000 0    1    1 3.28 5
13520606 610030000 0    1    1 3.28 6
13520607 610020000 0    1    1 3.28 7
13520608 610010000 0    1    1 3.28 8
13520701 0          0.   0.   0.       8
13520801 0.266    100.  100.   0.   0.  0.  0.  1.  8
13520901 0.3742   100.  100.   0.   0.  0.  0.  1.  8
*
******************************************************************************
* structure 3600 : intact loop u tube outlet                          *
******************************************************************************
13600000 1     3    2    0    159.5e-3
13600100 0       1
13600101 1       162.0e-3
13600102 1       165.0e-3
13600201 001     2
13600301 0.      2
13600400 0
13600401 435.0       3
13600501 360010000 0    1    1 100.0e-3   1 * 100 mm
13600601 0          0    0    1 100.0e-3   1
13600701 0          0.   0.   0.       1
13600801 187.8e-3 100.  100.   0.   0.  0.  0.  1.  1
13600901 182.1e-3 100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 3620 : intact suction leg 1                               *
******************************************************************************
13620000 1     3    2    0    35.1e-3
13620100 0       1
13620101 1       36.5e-3
13620102 1       39.0e-3
13620201 001     2
13620301 0.      2
13620400 0
13620401 435.0       3
13620501 362010000 0    1    1 910.0e-3   1 * 910 mm
```

```
13620601 0        0   0   1  910.0e-3   1
13620701 0        0.  0.  0.        1
13620801 70.2e-3 100. 100.  0.  0.  0.  0.  1.  1
13620901 76.3e-3 100. 100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 3640 : intact suction leg 2                                        *
********************************************************************************
13640000 1     3   2   0    35.1e-3
13640100 0     1
13640101 1     36.5e-3
13640102 1     39.0e-3
13640201 001   2
13640301 0.    2
13640400 0
13640401 435.0     3
13640501 364010000 0    1    1  700.0e-3   1  * 700 mm
13640601 0        0   0   1  700.0e-3   1
13640701 0        0.  0.  0.        1
13640801 70.2e-3 100. 100.  0.  0.  0.  0.  1.  1
13640901 76.3e-3 100. 100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 3700 : intact discharge leg 1                                      *
********************************************************************************
13700000 1     3   2   0    35.1e-3
13700100 0     1
13700101 1     36.5e-3
13700102 1     39.0e-3
13700201 001   2
13700301 0.    2
13700400 0
13700401 435.0     3
13700501 370010000 0    1    1  650.0e-3   1  * 650 mm
13700601 0        0   0   1  650.0e-3   1
13700701 0        0.  0.  0.        1
13700801 70.2e-3 100. 100.  0.  0.  0.  0.  1.  1
13700901 76.3e-3 100. 100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 3720 : intact discharge leg 2                                      *
********************************************************************************
13720000 1     3   2   0    35.1e-3
13720100 0     1
13720101 1     36.5e-3
13720102 1     39.0e-3
13720201 001   2
13720301 0.    2
13720400 0
13720401 435.0     3
13720501 372010000 0    1    1  290.0e-3   1  * 290 mm
13720601 0        0   0   1  290.0e-3   1
13720701 0        0.  0.  0.        1
13720801 70.2e-3 100. 100.  0.  0.  0.  0.  1.  1
13720901 76.3e-3 100. 100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 3740 : intact discharge leg 3                                      *
********************************************************************************
13740000 1     3   2   0    35.1e-3
13740100 0     1
13740101 1     36.5e-3
13740102 1     39.0e-3
13740201 001   2
13740301 0.    2
13740400 0
13740401 435.0     3
13740501 374010000 0    1    1  685.0e-3   1  * 685 mm
13740601 0        0   0   1  685.0e-3   1
13740701 0        0.  0.  0.        1
13740801 70.2e-3 100. 100.  0.  0.  0.  0.  1.  1
13740901 76.3e-3 100. 100.  0.  0.  0.  0.  1.  1
*
********************************************************************************
* structure 3760 : intact discharge leg 4                                      *
********************************************************************************
13760000 1     3   2   0    35.1e-3
13760100 0     1
13760101 1     38.5e-3
13760102 1     46.0e-3
13760201 001   2
13760301 0.    2
13760400 0
13760401 435.0     3
13760501 376010000 0    1    1  270.0e-3   1  * 270 mm
13760601 0        0   0   1  270.0e-3   1
```

```
13760701 0          0.  0.  0.        1
13760801 70.2e-3 100. 100.  0.  0. 0. 0. 1. 1
13760901 76.3e-3 100. 100.  0.  0. 0. 0. 1. 1
*
********************************************************************************
* structure 4000 : broken hot leg section 1                                    *
********************************************************************************
14000000 1    3   2   0    35.1e-3
14000100 0    1
14000101 1    42.5e-3
14000102 1    50.0e-3
14000201 001    2
14000301 0.    2
14000400 0
14000401 435.0      3
14000501 400010000 0    1    1  200.0e-3   1  * 200 mm
14000601 0          0    0    1  200.0e-3   1
14000701 0          0.  0.  0.        1
14000801 70.2e-3 100. 100.  0.  0. 0. 0. 1. 1
14000901 76.3e-3 100. 100.  0.  0. 0. 0. 1. 1
*
********************************************************************************
* structure 4100 : broken hot leg section 2                                    *
********************************************************************************
14100000 1    3   2   0    35.1e-3
14100100 0    1
14100101 1    42.5e-3
14100102 1    50.0e-3
14100201 001    2
14100301 0.    2
14100400 0
14100401 435.0      3
14100501 400010000 0    1    1  98.0e-3   1  * 98 mm
14100601 0          0    0    1  98.0e-3   1
14100701 0          0.  0.  0.        1
14100801 70.2e-3 100. 100.  0.  0. 0. 0. 1. 1
14100901 76.3e-3 100. 100.  0.  0. 0. 0. 1. 1
*
********************************************************************************
* structure 4200 : broken hot leg section 3                                    *
********************************************************************************
14200000 1    3   2   0    35.1e-3
14200100 0    1
14200101 1    42.5e-3
14200102 1    50.0e-3
14200201 001    2
14200301 0.    2
14200400 0
14200401 435.0      3
14200501 420010000 0    1    1  98.0e-3   1  * 98 mm
14200601 0          0    0    1  98.0e-3   1
14200701 0          0.  0.  0.        1
14200801 70.2e-3 100. 100.  0.  0. 0. 0. 1. 1
14200901 76.3e-3 100. 100.  0.  0. 0. 0. 1. 1
*
********************************************************************************
* structure 4300 : broken hot leg section 4                                    *
********************************************************************************
14300000 1    3   2   0    35.1e-3
14300100 0    1
14300101 1    42.5e-3
14300102 1    50.0e-3
14300201 001    2
14300301 0.    2
14300400 0
14300401 435.0      3
14300501 430010000 0    1    1  130.0e-3   1  * 130 mm
14300601 0          0    0    1  130.0e-3   1
14300701 0          0.  0.  0.        1
14300801 70.2e-3 100. 100.  0.  0. 0. 0. 1. 1
14300901 76.3e-3 100. 100.  0.  0. 0. 0. 1. 1
*
********************************************************************************
* structure 4400 : broken loop u tube inlet                                    *
********************************************************************************
14400000 1    3   2   0    159.5e-3
14400100 0    1
14400101 1    162.0e-3
14400102 1    165.0e-3
14400201 001    2
14400301 0.    2
14400400 0
14400401 435.0      3
14400501 440010000 0    1    1  100.0e-3   1  * 100 mm
14400601 0          0    0    1  100.0e-3   1
14400701 0          0.  0.  0.        1
```

```
14400801  187.8e-3 100.  100.   0.   0.  0.  0.  1.  1
14400901  182.1e-3 100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 4500 : intact loop u tubes 1                                     *
******************************************************************************
14500000  8     3    2    0    9.5e-3
14500100  0       1
14500101  1       10.0e-3
14500102  1       10.5e-3
14500201  003     2
14500301  0.      2
14500400  0
14500401  435.0       3
14500501  450010000  0    1    1  3.28  1  * 0.41 m x 8 ea
14500502  450020000  0    1    1  3.28  2
14500503  450030000  0    1    1  3.28  3
14500504  450040000  0    1    1  3.28  4
14500504  450050000  0    1    1  3.28  5
14500504  450060000  0    1    1  3.28  6
14500504  450070000  0    1    1  3.28  7
14500504  450080000  0    1    1  3.28  8
14500601  710010000  0    1    1  3.28  1
14500602  710020000  0    1    1  3.28  2
14500603  710030000  0    1    1  3.28  3
14500604  710040000  0    1    1  3.28  4
14500605  710040000  0    1    1  3.28  5
14500606  710030000  0    1    1  3.28  6
14500607  710020000  0    1    1  3.28  7
14500608  710010000  0    1    1  3.28  8
14500701  0           0.   0.   0.       8
14500801  0.266    100.  100.   0.   0.  0.  0.  1.  8
14500901  0.3742   100.  100.   0.   0.  0.  0.  1.  8
*
******************************************************************************
* structure 4520 : intact loop u tubes 2                                     *
******************************************************************************
14520000  8     3    2    0    9.5e-3
14520100  0       1
14520101  1       10.0e-3
14520102  1       10.5e-3
14520201  003     2
14520301  0.      2
14520400  0
14520401  435.0       3
14520501  452010000  0    1    1  3.28  1  * 0.41 m x 8 ea
14520502  452020000  0    1    1  3.28  2
14520503  452030000  0    1    1  3.28  3
14520504  452040000  0    1    1  3.28  4
14520504  452050000  0    1    1  3.28  5
14520504  452060000  0    1    1  3.28  6
14520504  452070000  0    1    1  3.28  7
14520504  452080000  0    1    1  3.28  8
14520601  710010000  0    1    1  3.28  1
14520602  710020000  0    1    1  3.28  2
14520603  710030000  0    1    1  3.28  3
14520604  710040000  0    1    1  3.28  4
14520605  710040000  0    1    1  3.28  5
14520606  710030000  0    1    1  3.28  6
14520607  710020000  0    1    1  3.28  7
14520608  710010000  0    1    1  3.28  8
14520701  0           0.   0.   0.       8
14520801  0.266    100.  100.   0.   0.  0.  0.  1.  8
14520901  0.3742   100.  100.   0.   0.  0.  0.  1.  8
*
******************************************************************************
* structure 4600 : broken loop u tube outlet 1                               *
******************************************************************************
14600000  1       3    2    0    159.5e-3
14600100  0       1
14600101  1       164.0e-3
14600102  1       169.0e-3
14600201  001     2
14600301  0.      2
14600400  0
14600401  435.0       3
14600501  460010000  0    1    1   25.0e-3   1  * 100/4 mm
14600601  0          0    0    1   25.0e-3   1
14600701  0          0.   0.   0.        1
14600801  140.3e-3 100.  100.   0.   0.  0.  0.  1.  1
14600901  145.3e-3 100.  100.   0.   0.  0.  0.  1.  1
*
******************************************************************************
* structure 4800 : broken loop u tube outlet 2                               *
******************************************************************************
14800000  1       3    2    0    159.5e-3
```

```
14800100 0      1
14800101 1      164.0e-3
14800102 1      169.0e-3
14800201 001    2
14800301 0.     2
14800400 0
14800401 435.0      3
14800501 480010000 0    1    1  25.0e-3    1  * 100/4 mm
14800601 0          0    0    1  25.0e-3    1
14800701 0          0.  0.  0.        1
14800801 140.3e-3 100.  100.  0.  0.  0.  0.  1.  1
14800901 145.3e-3 100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 4620 : broken loop suction leg 1-1                                *
*******************************************************************************
14620000 1      3    2    0    27.45e-3
14620100 0      1
14620101 1      31.5e-3
14620102 1      35.0e-3
14620201 001    2
14620301 0.     2
14620400 0
14620401 435.0      3
14620501 462010000 0    1    1  254.6e-3    1  * 254.6 mm
14620601 0          0    0    1  254.6e-3    1
14620701 0          0.  0.  0.        1
14620801 54.9e-3  100.  100.  0.  0.  0.  0.  1.  1
14620901 60.5e-3  100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 4640 : broken loop suction leg 1-2                                *
*******************************************************************************
14640000 1      3    2    0    27.45e-3
14640100 0      1
14640101 1      31.5e-3
14640102 1      35.0e-3
14640201 001    2
14640301 0.     2
14640400 0
14640401 435.0      3
14640501 464010000 0    1    1  245.0e-3    1  * 245 mm
14640601 0          0    0    1  245.0e-3    1
14640701 0          0.  0.  0.        1
14640801 54.9e-3  100.  100.  0.  0.  0.  0.  1.  1
14640901 60.5e-3  100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 4660 : broken loop suction leg 1-2                                *
*******************************************************************************
14660000 1      3    2    0    27.45e-3
14660100 0      1
14660101 1      31.5e-3
14660102 1      35.0e-3
14660201 001    2
14660301 0.     2
14660400 0
14660401 435.0      3
14660501 466010000 0    1    1  510.0e-3    1  * 510 mm
14660601 0          0    0    1  510.0e-3    1
14660701 0          0.  0.  0.        1
14660801 54.9e-3  100.  100.  0.  0.  0.  0.  1.  1
14660901 60.5e-3  100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 4700 : broken loop pump volume 1                                  *
*******************************************************************************
14700000 1      3    2    0    27.45e-3
14700100 0      1
14700101 1      31.5e-3
14700102 1      35.0e-3
14700201 001    2
14700301 0.     2
14700400 0
14700401 435.0      3
14700501 470010000 0    1    1  455.0e-3    1  * 455 mm
14700601 0          0    0    1  455.0e-3    1
14700701 0          0.  0.  0.        1
14700801 54.9e-3  100.  100.  0.  0.  0.  0.  1.  1
14700901 60.5e-3  100.  100.  0.  0.  0.  0.  1.  1
*
*******************************************************************************
* structure 4720 : broken loop discharge leg 1-1                              *
*******************************************************************************
14720000 1      3    2    0    27.45e-3
14720100 0      1
```

```
14720101  1      31.5e-3
14720102  1      35.0e-3
14720201  001    2
14720301  0.     2
14720400  0
14720401  435.0      3
14720501  472010000  0    1    1  295.0e-3    1   * 295 mm
14720601  0          0    0    1  295.0e-3    1
14720701  0          0.   0.   0.         1
14720801  54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14720901  60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4740 : broken loop discharge leg 1-2                              *
********************************************************************************
14740000  1      3    2    0    27.45e-3
14740100  0      1
14740101  1      31.5e-3
14740102  1      35.0e-3
14740201  001    2
14740301  0.     2
14740400  0
14740401  435.0      3
14740501  474010000  0    1    1  415.0e-3    1   * 415 mm
14740601  0          0    0    1  415.0e-3    1
14740701  0          0.   0.   0.         1
14740801  54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14740901  60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4760 : broken loop discharge leg 1-3                              *
********************************************************************************
14760000  1      3    2    0    27.45e-3
14760100  0      1
14760101  1      31.5e-3
14760102  1      35.0e-3
14760201  001    2
14760301  0.     2
14760400  0
14760401  435.0      3
14760501  476010000  0    1    1  200.0e-3    1   * 200 mm
14760601  0          0    0    1  200.0e-3    1
14760701  0          0.   0.   0.         1
14760801  54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14760901  60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4820 : broken loop suction leg 2-1                                *
********************************************************************************
14820000  1      3    2    0    27.45e-3
14820100  0      1
14820101  1      31.5e-3
14820102  1      35.0e-3
14820201  001    2
14820301  0.     2
14820400  0
14820401  435.0      3
14820501  482010000  0    1    1  254.6e-3    1   * 254.6 mm
14820601  0          0    0    1  254.6e-3    1
14820701  0          0.   0.   0.         1
14820801  54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14820901  60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4840 : broken loop suction leg 2-2                                *
********************************************************************************
14840000  1      3    2    0    27.45e-3
14840100  0      1
14840101  1      31.5e-3
14840102  1      35.0e-3
14840201  001    2
14840301  0.     2
14840400  0
14840401  435.0      3
14840501  484010000  0    1    1  245.0e-3    1   * 245 mm
14840601  0          0    0    1  245.0e-3    1
14840701  0          0.   0.   0.         1
14840801  54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14840901  60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4860 : broken loop suction leg 2-2                                *
********************************************************************************
14860000  1      3    2    0    27.45e-3
14860100  0      1
14860101  1      31.5e-3
```

```
14860102 1      35.0e-3
14860201 001    2
14860301 0.     2
14860400 0
14860401 435.0      3
14860501 486010000 0    1    1 510.0e-3   1  * 510 mm
14860601 0          0    0    1 510.0e-3   1
14860701 0          0.   0.   0.       1
14860801 54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14860901 60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4900 : broken loop pump volume 2                                   *
********************************************************************************
14900000 1      3    2    0    27.45e-3
14900100 0      1
14900101 1      31.5e-3
14900102 1      35.0e-3
14900201 001    2
14900301 0.     2
14900400 0
14900401 435.0      3
14900501 490010000 0    1    1 455.0e-3   1  * 455 mm
14900601 0          0    0    1 455.0e-3   1
14900701 0          0.   0.   0.       1
14900801 54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14900901 60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4920 : broken loop discharge leg 2-1                               *
********************************************************************************
14920000 1      3    2    0    27.45e-3
14920100 0      1
14920101 1      31.5e-3
14920102 1      35.0e-3
14920201 001    2
14920301 0.     2
14920400 0
14920401 435.0      3
14920501 492010000 0    1    1 295.0e-3   1  * 295 mm
14920601 0          0    0    1 295.0e-3   1
14920701 0          0.   0.   0.       1
14920801 54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14920901 60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4940 : broken loop discharge leg 2-2                               *
********************************************************************************
14940000 1      3    2    0    27.45e-3
14940100 0      1
14940101 1      31.5e-3
14940102 1      35.0e-3
14940201 001    2
14940301 0.     2
14940400 0
14940401 435.0      3
14940501 494010000 0    1    1 415.0e-3   1  * 415 mm
14940601 0          0    0    1 415.0e-3   1
14940701 0          0.   0.   0.       1
14940801 54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14940901 60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
********************************************************************************
* structure 4960 : broken loop discharge leg 2-3                               *
********************************************************************************
14960000 1      3    2    0    27.45e-3
14960100 0      1
14960101 1      31.5e-3
14960102 1      35.0e-3
14960201 001    2
14960301 0.     2
14960400 0
14960401 435.0      3
14960501 476010000 0    1    1 200.0e-3   1  * 200 mm
14960601 0          0    0    1 200.0e-3   1
14960701 0          0.   0.   0.       1
14960801 54.9e-3  100.  100.   0.   0.  0.  0.  1.  1
14960901 60.5e-3  100.  100.   0.   0.  0.  0.  1.  1
*
*------------------------------------------------------------------------------*
* structure input thermal property                                             *
*------------------------------------------------------------------------------*
*
********************************************************************************
* stainless steel                                                              *
********************************************************************************
```

```
20100100  tbl/fctn        1                   1
*               temperature        thermal conductivity
20100101          294.26             14.8842
20100102          366.48             16.0929
20100103          477.59             17.9993
20100104          588.71             19.5570
20100105          699.82             21.1145
20100106          810.93             22.8466
20100107          922.04             24.2297
20100108          1088.71            26.4788
20100109          100000.0           40.
*
*               temperature        heat capacity
20100151          294.26             3.8195e6
20100152          366.48             3.9979e6
20100153          477.59             4.2270e6
20100154          588.71             4.3552e6
20100155          699.82             4.4465e6
20100156          810.93             4.5630e6
20100157          922.04             4.6250e6
20100158          1088.71            4.7502e6
20100159          100000.0           1.0e7
*
*******************************************************************************
* nicrom heater                                                               *
*******************************************************************************
20100200  tbl/fctn        1                   1
*               temperature        thermal conductivity
20100201          273.15             8.78
20100202          293.15             8.78
20100203          573.15             11.3
20100204          773.15             13.81
20100205          1073.15            18.83
20100206          1273.15            22.18
20100207          1473.15            25.52
20100208          10000.0            25.52
*
*               temperature        heat capacity
20100251          273.15             3.23e6
20100252          373.15             3.23e6
20100253          573.15             3.62e6
20100254          773.15             4.10e6
20100255          1073.15            4.61e6
20100256          1173.15            4.73e6
20100257          1273.15            4.95e6
20100258          1473.15            5.29e6
20100259          10000.0            5.29e6
*
*******************************************************************************
* copper                                                                      *
*******************************************************************************
20100300  tbl/fctn        1                   1
*               temperature        thermal conductivity
20100301          273.15             384.
20100302          373.15             379.
20100303          473.15             374.
20100304          573.15             369.
20100305          673.15             363.
20100306          873.15             353.
*
*               temperature        heat capacity
20100351          273.15             3.4496e6
20100352          293.15             3.4496e6
20100353          373.15             3.5661e6
20100354          573.15             3.7184e6
20100355          1000.0             3.7184e6
20100356          2000.0             3.7184e6
*
*-----------------------------------------------------------------------------*
* general table                                                               *
*-----------------------------------------------------------------------------*
* core heater power at C18002 & c19001
20288800  power
20288801  -10.0     0.0e3
20288802    0.1     0.0e3
20288803    5.0    10.0e3
20288804 1000.0    10.0e3
*
* core heater power at C19002 & c19003
20288900  power
20288901  -10.0     0.0e3
20288902    0.1     0.0e3
20288903    5.0    20.0e3
20288904 1000.0    20.0e3
*
*-----------------------------------------------------------------------------*
```

```
* control variable                                              *
*-----------------------------------------------------------------------*
*
*********************************************************************************
* control variable 001 : pressurizer normalized water level            *
*********************************************************************************
**20500100  pzmlvl  sum     1.11111   0.8  1   3  0.  1. *1.11111=1/total lvl
**20500101  0.        90.0e-3   voidf   510010000
**20500102            90.0e-3   voidf   510020000
**20500103            90.0e-3   voidf   510030000
**20500104            90.0e-3   voidf   510040000
**20500105            90.0e-3   voidf   510050000
**20500106            90.0e-3   voidf   510060000
**20500107            90.0e-3   voidf   510070000
**20500108            90.0e-3   voidf   510080000
**20500109            90.0e-3   voidf   510090000
**20500110            90.0e-3   voidf   510100000
*
*********************************************************************************
* control variable 002 : intact loop sg normalized water level          *
*********************************************************************************
20500200  sganlvl  sum     0.5128205  0.99  1  3  0.  1. *0.5128205=1/total lvl
20500201  0.       4.1e-1     voidf   610010000
20500202           4.1e-1     voidf   610020000
20500203           4.1e-1     voidf   610030000
20500204           4.1e-1     voidf   610040000
20500205           95.0e-3    voidf   620010000
20500206           215.0e-3   voidf   630010000
*
*********************************************************************************
* control variable 003 : broken loop sg normalized water level          *
*********************************************************************************
20500300  sgbnlvl  sum     0.5128205  0.99  1  3  0.  1. *0.5128205=1/total lvl
20500301  0.       4.1e-1     voidf   710010000
20500302           4.1e-1     voidf   710020000
20500303           4.1e-1     voidf   710030000
20500304           4.1e-1     voidf   710040000
20500305           95.0e-3    voidf   720010000
20500306           215.0e-3   voidf   730010000
*
*=======================================================================*
*------------ sg a feed water control ------------------*
*=======================================================================*

*********************************************************************************
* control variable 004 : intact loop sg heat removal amount             *
*********************************************************************************
20500400  sgaheat  sum     1.  0.    1
20500401  0.       1.   q   610010000
20500402           1.   q   610020000
20500403           1.   q   610030000
20500404           1.   q   610040000
*
*********************************************************************************
* control variable 005 : intact loop sg feed water ugj-ufj              *
*********************************************************************************
20500500  augj-ufj  sum    1.  0.    1
20500501  0.      1.   ugj   603000000
20500502         -1.   ufj   603000000
*
*********************************************************************************
* control variable 006 : intact loop sg feed water flow rate            *
*********************************************************************************
20500600  afeed  div     1.  0.    1
20500601  cntrlvar   005
20500602  cntrlvar   004
*
*=======================================================================*
*------------ sg b feed water control ------------------*
*=======================================================================*
*
*********************************************************************************
* control variable 007 : broken loop sg heat removal amount             *
*********************************************************************************
20500700  sgbheat  sum     1.  0.    1
20500701  0.       1.   q   710010000
20500702           1.   q   710020000
20500703           1.   q   710030000
20500704           1.   q   710040000
*
*********************************************************************************
* control variable 008 : broken loop sg feed water ugj-ufj              *
*********************************************************************************
20500800  bugj-ufj  sum    1.  0.    1
20500801  0.      1.   ugj   703000000
20500802         -1.   ufj   703000000
*
```

```
*******************************************************************************
* control variable 009 : broken loop sg feed water flow rate                  *
*******************************************************************************
20500900  bfeed  div     1.   0.     1
20500901  cntrlvar   008
20500902  cntrlvar   007
*
*=====================================================================*
*------------ sg's steam dump control ------------------*
*=====================================================================*
*
*******************************************************************************
* control variable 010 : steam line steam dump                                *
*******************************************************************************
20501000  stmdump  sum     1.   0.     1
20501001  0.       1.   cntrlvar   006
20501002           1.   cntrlvar   009
*
*
*-pump---pump---pump---pump---pump---pump---pump---pump---pump---pump---pump--*
*                         pump simulation                                     *
*--pump---pump---pump---pump---pump---pump---pump---pump---pump---pump---pump-*
*
*-----------------------------------*
************ delete card ***************
*-----------------------------------*
* 3710000   cold leg in intact loop
* 4710000   cold leg in broken loop
* 4910000   cold leg in broken loop
* 5210000   surge line in intact loop hot leg
*
*-----------------------------------*
************ intact loop ***************
*-----------------------------------*
*
*******************************************************************************
* component 001 : pump bypass line junction 1 in intact loop                  *
*******************************************************************************
*
0010000   apumpj1   sngljun
0010101   364010002   002010001   0.   2.5   2.5   000000
0010201   0   0.   0.   0.
*
```

```
*******************************************************************************
* component 002 : pump bypass line 1 in intact loop                           *
*******************************************************************************
*
0020000  apmpb1      pipe                 * name
0020001  4                              * number of volume
0020101  1.3136e-3   4                    * flow area of volume
0020201  0.          3                  * flow area of junction
0020301  650.0e-3    4                    * flow length
0020401  0.          4                  * volume of volume
0020501  0.          1                  * azimuthal angle
0020502  0.          2
0020503  0.          4
0020601  0.          4                  * inclination angle
*0020701 elevation change
0020801  4.572e-4   40.89e-3     4      * roughness, hyd. dia.
0020901  0.2        0.2          1      * loss coeff.
0020902  0.2        0.2          2
0020903  0.2        0.2          3
0021001  00000       4                    * flag of volume
0021101  000000      3                    * flag of junction
0021201  003    850000.  435.  0.   0.   0.   4   * i.c. of volume
0021300  0                                          * i.c. ctrl word of junction
0021301  0.0        0.0      0.    3                 * i.c. of junction
*
*******************************************************************************
* component 003 : pump junction 2 in intact loop                              *
*******************************************************************************
*
0030000  apumpj2   sngljun
0030101  002040002   004010001   0.   1.0e-6   1.0e-6   000000
0030201  0  0.   0.   0.
*
*******************************************************************************
* component 004 : pump line 1 in intact loop                                  *
*******************************************************************************
*
0040000  apmp1       pipe                 * name
0040001  1                              * number of volume
0040101  1.3136e-3   1                    * flow area of volume
*0040201   no junction
0040301  250.0e-3    1                    * flow length
0040401  0.          1                  * volume of volume
```

```
0040501  0.        1              * azimuthal angle
0040601  0.        1              * inclination angle
*0040701  elevation change
0040801  4.572e-4  40.89e-3   1     * roughness, hyd. dia.
*0040901  no junction
0041001  00000     1              * flag of volume
*0041101 no junction
0041201  003   850000.  435.  0.   0.   0.   1  * i.c. of volume
*0041300  no junction
*0041301  no junction
*
*****************************************************************************
* component 007 : pump junction 4 in intact loop                            *
*****************************************************************************
*
0070000  apumpj4  tmdpjun
0070101  004010002  008010001  0. * 1.0e-6  1.0e-6  000000
0070200  1   501    cntrlvar   011
*                 velf    velg
0070201   -1.0e10    -1.0e10   0.0    0.
0070202  -10.        -10.      0.     0.
0070203   0.          0.       0.     0.
0070204   10.         10.      0.     0.
0070205    1.0e10     1.0e10   0.0    0.

*
*****************************************************************************
* component 008 : pump line 3 in intact loop                                *
*****************************************************************************
*
0080000  apmp3     pipe           * name
0080001  1                        * number of volume
0080101  1.3136e-3  1               * flow area of volume
*0080201  no junction
0080301  250.0e-3   1               * flow length
0080401  0.        1              * volume of volume
0080501  0.        1              * azimuthal angle
0080601  0.        1              * inclination angle
*0080701  elevation change
0080801  4.572e-4   40.89e-3   1    * roughness, hyd. dia.
*0080901  no junction
0081001  00000     1              * flag of volume
*0081101 no junction
0081201  003   850000.  435.  0.   0.   0.   1  * i.c. of volume
*0081300  no junction
*0081301  no junction
*
*****************************************************************************
* component 009 : pump junction 5 in intact loop                            *
*****************************************************************************
*
0090000  apumpj5  sngljun
0090101  008010002  010010001  1.3136e-4  1.0  1.0  000100
0090201  0  0.1  0.1  0.
*
*****************************************************************************
* component 010 : pump by pass line 2 in intact loop                        *
*****************************************************************************
*
0100000  apmp2     pipe           * name
0100001  4                        * number of volume
0100101  1.3136e-3  4               * flow area of volume
0100201  0.        3              * flow area of junction
0100301  650.0e-3   1               * flow length
0100302  650.0e-3   2
0100303  650.0e-3   4
0100401  0.        4              * volume of volume
0100501  0.        4              * azimuthal angle
0100601  0.        1              * inclination angle
0100602  90.       2
0100603  0.        4
*0100701  elevation change
0100801  4.572e-4   40.89e-3    4     * roughness, hyd. dia.
0100901  0.2       0.2       1     * loss coeff.
0100902  0.2       0.2       2
0100903  0.2       0.2       3
0101001  00000     4              * flag of volume
0101101  000000    3              * flag of junction
0101201  003    900000.  435.  0.   0.   0.   4  * i.c. of volume
0101300  0                              * i.c. ctrl word of junction
0101301  0.0      0.0     0.    3           * i.c. of junction
*
*****************************************************************************
* component 011 : pump junction 6 in intact loop                            *
*****************************************************************************
*
```

```
0110000  apumpj6   sngljun
0110101  010040002  372010001  0.  5.  5.  000100  * K=10.
0110201  0  0.  0.  0.
*
*-------------- pump --------------
*
*******************************************************************************
* component 020 : pump pressure <<SINKER>> in intact loop                    *
*******************************************************************************
0200000  aoutlet     tmdpvol
0200101  2.3672e-3  0.  1.0e6   180.0   0.  0.   4.572e-4  0.0  00000
0200200  003     0    tempf 004010000
0200201  0.       830000.       0.
0200202  1000.  830000.  1000.
*
*******************************************************************************
* component 021 : pump pressure sinker junction in intact loop               *
*******************************************************************************
*
0210000  aoutletj    sngljun
0210101  004010002  020010001  0.  1.0e-5  1.0e-5  000000
0210201  0  0.  0.  0.
*
*******************************************************************************
* component 022 : pump pressure <<SOURCE>> in intact loop                    *
*******************************************************************************
0220000  ainlet     tmdpvol
0220101  2.3672e-3  0.  1.0e6   180.0   0.  0.   4.572e-4  0.0  00000
0220200  003    0     tempf 008010000
0220201  0.      900000.       .0
0220202  1000. 900000.   1000.0
*
*******************************************************************************
* component 023 : pump pressure source junction in intact loop               *
*******************************************************************************
*
0230000  ainletj    sngljun
0230101  022010002  008010001  0.  1.0e-5  1.0e-5  000000
0230201  0  0.  0.  0.
*
*
*-------------------------------------*
************ broken loop ***************
*-------------------------------------*
*
*  cold leg 1 in broken loop ---------------------------------------------*
*
*******************************************************************************
* component 031 : pump bypass line junction 1 in broken loop                 *
*******************************************************************************
*
0310000  bpumpj1   sngljun
0310101  466010002  032010001  0.  2.5  2.5  000000
0310201  0  0.  0.  0.
*
*******************************************************************************
* component 032 : pump bypass line 1 in broken loop                          *
*******************************************************************************
*
0320000  bpmpb1      pipe                 * name
0320001  4                              * number of volume
0320101  1.3136e-3  4                     * flow area of volume
0320201  0.          3                  * flow area of junction
0320301  650.0e-3    1                    * flow length
0320302  195.0e-3    2
0320303  650.0e-3    4
0320401  0.          4                  * volume of volume
0320501  0.          4                  * azimuthal angle
0320601  0.          1                  * inclination angle
0320602  -90.        2
0320603  0.          4
*0320701 elevation change
0320801  4.572e-4   40.89e-3      4      * roughness, hyd. dia.
0320901  0.2          0.2           1      * loss coeff.
0320902  0.2          0.2           2
0320903  0.2          0.2           3
0321001  00000       4                  * flag of volume
0321101  000000      3                  * flag of junction
0321201  003      850000.  435.  0.   0.   0.   4   * i.c. of volume
0321300  0                                * i.c. ctrl word of junction
0321301  0.0      0.0      0.     3                 * i.c. of junction
*
*******************************************************************************
* component 033 : pump junction 2 in broken loop                             *
*******************************************************************************
*
```

```
0330000  bpumpj2  sngljun
0330101  032040002  004010001  0.  1.0e-6  1.0e-6  000000
0330201  0  0.  0.  0.
*
******************************************************************************
* component 039 : pump junction 5 in broken loop                            *
******************************************************************************
*
0390000  bpumpj5  sngljun
0390101  008010002  040010001  1.3136e-4  1.0  1.0  000100
0390201  0  0.1  0.1  0.
*
******************************************************************************
* component 040 : pump by pass line 2 in broken loop                        *
******************************************************************************
*
0400000  bpmp2      pipe                * name
0400001  4                             * number of volume
0400101  1.3136e-3  4                    * flow area of volume
0400201  0.         3                  * flow area of junction
0400301  650.0e-3   1                   * flow length
0400302  650.0e-3   2
0400303  650.0e-3   4
0400401  0.         4                  * volume of volume
0400501  0.         4                  * azimuthal angle
0400601  0.         1                  * inclination angle
0400602  90.        2
0400603  0.         4
*0400701  elevation change
0400801  4.572e-4   40.89e-3    4      * roughness, hyd. dia.
0400901  0.2        0.2         1      * loss coeff.
0400902  0.2        0.2         2
0400903  0.2        0.2         3
0401001  00000      4                   * flag of volume
0401101  000000     3                   * flag of junction
0401201  003     850000.  435.  0.  0.  0.  4  * i.c. of volume
0401300  0                                 * i.c. ctrl word of junction
0401301  0.0     0.0     0.    3            * i.c. of junction
*
******************************************************************************
* component 041 : pump junction 6 in broken loop                            *
******************************************************************************
*
```

```
0410000  bpumpj6  sngljun
0410101  040040002  472010001  0.  5.  5.  000100
0410201  0  0.  0.  0.
*
*  cold leg 2 in broken loop -----------------------------------------------*
*
******************************************************************************
* component 061 : pump bypass line junction 1 in broken loop                *
******************************************************************************
*
0610000  bpumpj1  sngljun
0610101  486010002  062010001  0.  2.5  2.5  000000
0610201  0  0.  0.  0.
*
******************************************************************************
* component 062 : pump bypass line 1 in broken loop                         *
******************************************************************************
*
0620000  bpmpb1     pipe                * name
0620001  4                             * number of volume
0620101  1.3136e-3  4                    * flow area of volume
0620201  0.         3                  * flow area of junction
0620301  650.0e-3   1                   * flow length
0620302  195.0e-3   2
0620303  650.0e-3   4
0620401  0.         4                  * volume of volume
0620501  0.         4                  * azimuthal angle
0620601  0.         1                  * inclination angle
0620602  -90.       2
0620603  0.         4
*0620701 elevation change
0620801  4.572e-4   40.89e-3    4      * roughness, hyd. dia.
0620901  0.2        0.2         1      * loss coeff.
0620902  0.2        0.2         2
0620903  0.2        0.2         3
0621001  00000      4                   * flag of volume
0621101  000000     3                   * flag of junction
0621201  003     850000.  435.  0.  0.  0.  4  * i.c. of volume
0621300  0                                 * i.c. ctrl word of junction
0621301  0.0     0.0     0.    3            * i.c. of junction
*
******************************************************************************
* component 063 : pump junction 2 in broken loop                            *
```

```
********************************************************************************
*
0630000  bpumpj2  sngljun
0630101  062040002  004010001  0.  1.0e-6  1.0e-6  000000
0630201  0  0.  0.  0.
*
********************************************************************************
* component 069 : pump junction 5 in broken loop                              *
********************************************************************************
*
0690000  bpumpj5  sngljun
0690101  008010002  070010001  1.3136e-4  1.0  1.0  000100
0690201  0  0.1  0.1  0.
*
********************************************************************************
* component 070 : pump by pass line 2 in broken loop                          *
********************************************************************************
*
0700000  bpmp2      pipe                * name
0700001  4                              * number of volume
0700101  1.3136e-3  4                     * flow area of volume
0700201  0.         3                   * flow area of junction
0700301  650.0e-3   1                     * flow length
0700302  650.0e-3   2
0700303  650.0e-3   4
0700401  0.         4                   * volume of volume
0700501  0.         4                   * azimuthal angle
0700601  0.         1                   * inclination angle
0700602  90.        2
0700603  0.         4
*0700701  elevation change
0700801  4.572e-4  40.89e-3   4          * roughness, hyd. dia.
0700901  0.2      0.2      1      * loss coeff.
0700902  0.2      0.2      2
0700903  0.2      0.2      3
0701001  00000     4                   * flag of volume
0701101  000000    3                   * flag of junction
0701201  003    850000.  435.  0.   0.   0.   4  * i.c. of volume
0701300  0                                  * i.c. ctrl word of junction
0701301  0.0      0.0     0.    3             * i.c. of junction
*
********************************************************************************
* component 071 : pump junction 6 in broken loop                              *
********************************************************************************
*
0710000  bpumpj6  sngljun
0710101  070040002  492010001  0.  5.  5.  000100  * K=10.
0710201  0  0.  0.  0.
*
*
*---------------------------------------------------------------------------*
*********** control variables : for the sake of pump flow rate               *
*---------------------------------------------------------------------------*
*
********************************************************************************
* control variable 011 : pump flow rate                                       *
********************************************************************************
20501100  acldvel  sum     1.    0.     1
20501101  0.       1.   mflowj   009000000
20501102           1.   mflowj   039000000
20501103           1.   mflowj   069000000
*
.
```

Appendix B Input Deck for Drain-down Calculation (Run01)

```
*========================================================================
=====*
=     SNUTF Hot Leg Break LOCA Analysis Input Deck with RELAP5/MOD3.1       =
*========================================================================
=====*
*
***** resart input for drain down transient
*
0000100   restart transnt
0000101   run
0000103   1127              * restart number
* time step cards
0000201    28.   1.-6  1.0e-2  00003   1000    50000    2000000
*0000202   55.   1.-6  5.0e-2  00003    100    1000000  20000000
0000203 1200.   1.-6  5.0e-2  00003   1000    1000000  20000000
*0000204 2000.   1.-6  5.0e-2  00003   2000    1000000  20000000
*
*----------------------------------------------------------------------*
*                          minor edits                                  *
*----------------------------------------------------------------------*
*
0000301  p        220010000
0000302  p        372010000     * p1'
0000303  p        330010000     * p2'
0000304  p        360010000     * p3'
0000305  p        364010000     * p4'
0000306  p        472010000     * p1
0000307  p        440010000     * p2
0000308  p        460010000     * p3
0000309  p        466010000     * p4
0000310  p        610040000
0000311  p        710040000
*
0000320  tempf     372010000    * intact loop discharge
0000321  tempg     372010000    * intact loop discharge
0000322  tempf     364010000    * intact loop suction
0000323  tempg     364010000    * intact loop suction
0000324  tempf     472010000    * broken loop discharge
0000325  tempg     472010000    * broken loop discharge
0000326  tempf     466010000    * broken loop suction
0000327  tempg     466010000    * broken loop suction
0000328  tempf     492010000    * broken loop discharge
0000329  tempg     492010000    * broken loop discharge
0000330  tempf     486010000    * broken loop suction
0000331  tempg     486010000    * broken loop suction
0000332  tempf     200010000    * core upper
0000333  tempg     200010000    * core upper
*
0000340  mflowj    311000000    * intact loop hot leg flow rate
0000341  mflowj    411000000    * broken loop hot leg flow rate
0000342  mflowj    375000000    * intact loop flow rate
0000343  mflowj    475000000    * broken loop cold leg 1 flow rate
0000344  mflowj    495000000    * broken loop cold leg 1 flow rate
0000345  mflowj    991000000    * break flow : intact cold leg
0000346  mflowj    993000000    * break flow : broken cold leg 1
0000347  mflowj    995000000    * break flow : broken cold leg 2
0000348  mflowj    997000000    * break flow : reactor lower plenum
*0000349  mflowj    987000000    * sg blowdown flow
*
0000360  voidg    364010000
0000361  voidg    466010000
0000362  voidg    486010000
*
*0000370  cntrlvar  001        * pzr normalized water level
0000371  cntrlvar  002        * intact sg normalied water level
0000372  cntrlvar  003        * broken sg normalied water level
0000373  cntrlvar  021        * suction leg water leverl in intact loop (C370)
0000374  cntrlvar  022        * suction leg water leverl in broken loop 1 (C470)
0000375  cntrlvar  023        * suction leg water leverl in broken loop 2 (C490)
0000376  cntrlvar  024        * reactor water lever under legs (C160+C180+C190+C200)
*
*
*----------------------------------------------------------------------*
*                          input change                                 *
*----------------------------------------------------------------------*
*
*-blowdown---blowdown---blowdown---blowdown---blowdown---blowdown---blowdown--*
*                          blowdown simulation                          *
*-blowdown---blowdown---blowdown---blowdown---blowdown---blowdown---blowdown--*
*
*----------------------------------*
**** control cards for blowdown phase **
*----------------------------------*
*
0000521  p,220010000   ge  null  0  0.3507e6   n  * intact loop blowdown
0000522  p,220010000   ge  null  0  0.3507e6   n  * broken loop blowdown 1
0000523  p,220010000   ge  null  0  0.3507e6   n  * broken loop blowdown 2
0000524  p,220010000   ge  null  0  0.3507e6   n  * reactor blowdown
0000525  p,220010000   ge  null  0  0.39e6     n  * power trip(if p>0.37, then power off)
*0000526  p,710010000   ge  null  0  0.56e6     n  * sg blowdonw
*
*----------------------------------------------------------------------*
```

```
*                         delete or addition                                   *
*---------------------------------------------------------------------------*
*
*-------------------------------------*
*** delete cards for blowdown phase ***
*-------------------------------------*
*
0010000  apumpj1   delete
0020000  apmpb1    delete
0030000  apumpj2   delete
0040000  apmp1     delete
0070000  apumpj4   delete
0080000  apmp3     delete
0090000  apumpj5   delete
0100000  apmp2     delete
0110000  apumpj6   delete
*
0200000  aoutlet   delete
0210000  aoutletj  delete
0220000  ainlet    delete
0230000  ainletj   delete
*
0310000  bpumpj1   delete
0320000  bpmpb1    delete
0330000  bpumpj2   delete
0390000  bpumpj5   delete
0400000  bpmp2     delete
0410000  bpumpj6   delete
*
0610000  bpumpj1   delete
0620000  bpmpb1    delete
0630000  bpumpj2   delete
0690000  bpumpj5   delete
0700000  bpmp2     delete
0710000  bpumpj6   delete
*
6000000  feed_a    delete  * secondary system feedwater
6010000  feed_ja1  delete  * secondary system feedwater
7000000  feed_b    delete  * secondary system feedwater
7010000  feed_jb1  delete  * secondary system feedwater
8110000  s-hd-j2   delete  * secondary system steam dump
8900000  stmdump   delete  * secondary system steam dump
*
20501100  acldvel  delete  * control card for pump
*
*-------------------------------------*
```

```
** addition cards for blowdown phase **
*-------------------------------------*
*
******************************************************************************
* component 371 : intact discharge leg junction 1                            *
******************************************************************************
*
3710000  dlj1  sngljun
3710101  370010002  372010001  0.  0.05  0.05  020000
3710201  0  0.26086  0.26086    0.
*
******************************************************************************
* component 471 : broken discharge leg junction 1-1                          *
******************************************************************************
*
4710000  dlj1-1  sngljun
4710101  470010002  472010001  0.  0.05  0.05  020000
4710201  0  0.42635  0.42635    0.
*
******************************************************************************
* component 491 : broken discharge leg junction 2-1                          *
******************************************************************************
*
4910000  dlj2-1  sngljun
4910101  490010002  492010001  0.  0.05  0.05  020000
4910201  0  0.42635  0.42635    0.
*
*-------------------------------------*
******** intact loop blowdown **********
*-------------------------------------*
*
******************************************************************************
* component 991 : intact loop blowdown valve                                 *
******************************************************************************
*
9910000  intbdj  valve
9910101  364010002  992010001  3.4e-5  10.  10. 000100
9910201  0  0.  0.  0.
9910300  trpvlv
9910301  521
*
******************************************************************************
* component 992 : intact loop blowdown boundary                              *
******************************************************************************
9920000  intbd    tmdpvol
9920101  1.0e6  2.  0.   0.   90.  2.   4.572e-4  0.0  00000
```

```
9920200  002
9920201  0.      120000.  1.
9920202  1.0e6  120000.  1.
*
*------------------------------------*
******* broken loop blowdown ***********
*------------------------------------*
*
******************************************************************************
* component 993 : broken loop blowdown valve 1                              *
******************************************************************************
*
9930000  intbdj   valve
9930101  466010002  994010001  3.3e-5  2.  2.  000100
9930201  0  0.  0.  0.
9930300  trpvlv
9930301  522
*
******************************************************************************
* component 994 : broken loop blowdown bounday 1                              *
******************************************************************************
9940000  intbd     tmdpvol
9940101  1.0e6  2.  0.   0.   90.  2.   4.572e-4  0.0  00000
9940200  002
9940201  0.      120000.  1.
9940202  1.0e6  120000.  1.
*
******************************************************************************
* component 995 : broken loop blowdown valve 2                              *
******************************************************************************
*
9950000  intbdj   valve
9950101  486010002  996010001  3.3e-5  2.  2.  000100
9950201  0  0.  0.  0.
9950300  trpvlv
9950301  523
*
******************************************************************************
* component 996 : broken loop blowdown bounday 2                              *
******************************************************************************
9960000  intbd     tmdpvol
9960101  1.0e6  2.  0.   0.   90.  2.   4.572e-4  0.0  00000
9960200  002
9960201  0.      120000.  1.
9960202  1.0e6  120000.  1.
*
*------------------------------------*
********* reactor blowdown *************
*------------------------------------*
*
******************************************************************************
* component 997 : reactor blowdown valve                                    *
******************************************************************************
*
9970000  rxbdj   valve
9970101  160010001  998010001  3.52e-5  2.  2.  000100
9970201  0  0.  0.  0.
9970300  trpvlv
9970301  524
*
******************************************************************************
* component 998 : reactor blowdown boundary                                   *
******************************************************************************
9980000  rxbd     tmdpvol
9980101  1.0e6  2.  0.   0.   90.  2.   4.572e-4  0.0  00000
9980200  002
9980201  0.      120000.  1.
9980202  1.0e6  120000.  1.
*
*------------------------------------*
*** sg blowdown for pressure control *** This will be deleted soon after blowdown
*------------------------------------*
******************************************************************************
* component 987 : sg blowdown valve                                           *
******************************************************************************
*
**9870000  sgbdj   valve
**9870101  810010001  988010001  0.29e-4  2.  2.  000100
**9870201  0  0.  0.  0.
**9870300  trpvlv
**9870301  526
*
******************************************************************************
* component 988 : sg blowdown boundary                                        *
******************************************************************************
**9880000  sgbd     tmdpvol
**9880101  1.0e6  2.  0.   0.   90.  2.   4.572e-4  0.0  00000
**9880200  002
**9880201  0.      120000.  1.
**9880202  1.0e6  120000.  1.
*
*---------------------------------------------------------------------------*
```

```
* general table                                                        *
*-----------------------------------------------------------------------*
* core heater power at C18002 & C19001
20288800   power
20288801   -10.0     0.0e3
20288802     0.1     0.0e3
20288803     5.0     0.0e3
20288804     7.0     0.0e3
20288805     8.0     0.0e3
20288806  1000.0     0.0e3
*
* core heater power at C19002 & C19003
20288900   power
20288901   -10.0     0.0e3
20288902     0.1     0.0e3
20288903     5.0    10.0e3
20288904     7.0    10.0e3
20288905     8.0     0.0e3
20288906  1000.0     0.0e3
*
*
*-----------------------------------------------------------------------*
************ control variables : for the sake of blowdown phase          *
*-----------------------------------------------------------------------*
*
*********************************************************************************
* control variable 021 : suction leg water level in intact loop (C370)       *
*********************************************************************************
20502100  intlvl  sum    1.   0.65  1
20502101  0.       0.65   voidf   370010000
*
*********************************************************************************
* control variable 022 : suction leg water leverl in broken loop 1 (C470)     *
*********************************************************************************
20502200  brklvl1  sum    1.   0.455  1
20502201  0.        0.455    voidf   470010000
*
*********************************************************************************
* control variable 023 : suction leg water leverl in broken loop 2 (C490)     *
*********************************************************************************
20502300  brklvl2  sum    1.   0.455  1
20502301  0.        0.455    voidf   490010000
*
*********************************************************************************
* control variable 024 : reactor water lever under legs (C160+C180+C190+C200) *
*********************************************************************************
20502400  rxlvl   sum     1.     0.928     1
20502401  0.      0.08    voidf   160010000
20502402          0.148   voidf   180010000
20502403          0.1     voidf   180020000
20502404          0.1     voidf   190010000
20502405          0.2     voidf   190020000
20502406          0.2     voidf   190030000
20502407          0.1     voidf   200010000
*
.
.
```

Appendix C Input Deck for Post-blowdown Calculation (Run01)

```
*==========================================================================
=====*
=       SNUTF Hot Leg Break LOCA Analysis Input Deck with RELAP5/MOD3.1       =
*==========================================================================
=====*
*
***** restart input for post blowdown in hot leg break transient
*
0000100  restart transnt
0000101  run
0000103  27194                    * restart number
* time step cards
0000201    28.    1.-6  1.0e-2  00003    1000    50000     2000000
0000202 1200.    1.-6  5.0e-2  00003    1000     1000000  20000000
0000204 1205.       1.0e-6   5.0e-4  00003     200  2000000     20000000
0000205 1250.       1.0e-6   2.0e-3  00003     500     20000     20000000
0000206 1320.       1.0e-6   2.0e-3  00003     500     20000     20000000
*
*------------------------------------------------------------------------*
*                              trip                                          *
*------------------------------------------------------------------------*
*
0000531  time  0   ge   null  0   1200.0   n   -1.0 * break
0000532  time  0   ge   null  0   1200.0   n   -1.0 * SI Initiation
0000533  time  0   gt   null  0   1.0e6     n          * motor valve close
*
*------------------------------------------------------------------------*
*                              minor edits                                   *
*------------------------------------------------------------------------*
*
0000301  p          220010000   * reactor top head
0000302  p          720010000   * sg top head
0000303  p          730010000   * sg top head
0000304  p          954010000   * discharge tank
*
0000310  tempf      400010000   * rx side broken section
0000311  tempg      400010000   * rx side broken section
0000312  tempf      430010000   * sg side broken section
0000313  tempg      430010000   * sg side broken section
0000314  tempf      160010000   * rx lower plenum
0000315  tempg      160010000   * rx lower plenum
*
0000330  mflowj     951000000   * reactor side broken section
0000331  mflowj     961000000   * sg side broken section
0000332  mflowj     475000000   * broken loop cold leg 1
0000333  mflowj     471000000   * broken loop cold leg 1
0000334  mflowj     495000000   * broken loop cold leg 2
0000335  mflowj     491000000   * broken loop cold leg 2
0000336  mflowj     301000000   * intact loop hot leg
0000337  mflowj     375000000   * intact loop hot leg
0000338  mflowj     901000000   * total si flowrate
0000339  mflowj     902010000   * si flowrate to intact loop
0000340  mflowj     902020000   * si flowrate to broken loop 1
0000341  mflowj     902030000   * si flowrate to broken loop 2
*
0000360  cntrlvar  021          * intact loop cold leg water level
0000361  cntrlvar  022          * broken loop cold leg water level
0000362  cntrlvar  023          * broken loop cold leg water level
0000363  cntrlvar  024          * reactor water level
0000364  cntrlvar  025          * broken loop u tube water level 1
0000365  cntrlvar  026          * broken loop u tube water level 2
0000366  cntrlvar  027          * broken loop suction leg water level 1
0000367  cntrlvar  028          * broken loop suction leg water level 2
0000368  cntrlvar  029          * cntrlvar  025 + cntrlvar  027
0000369  cntrlvar  030          * cntrlvar  026 + cntrlvar  028
0000370  cntrlvar  031          * discharge amount through reactor side broken section
0000371  cntrlvar  032          * discharge amount through sg side broken section
0000372  cntrlvar  002          * intact loop sg normalized water level
0000373  cntrlvar  003          * broken loop sg normalized water level
*
*0000380  httemp     190010103
*
*------------------------------------------------------------------------*
*                            delete or addition                              *
*------------------------------------------------------------------------*
*
*----------------------------------------*
**  delete cards for post blowdown phase  **
*----------------------------------------*
*
9910000  intbdj  delete
9920000  intbd   delete
9930000  intbdj  delete
9940000  intbd   delete
9950000  intbdj  delete
9960000  intbd   delete
9970000  rxbdj   delete
9980000  rxbd    delete
*
4110000  btub_ij1  delete  * delete means separation valve close
```

```
*
*-----------------------------------------*
** addition cards for post blowdown phase **
*-----------------------------------------*
*
********************************************************************************
* component 111 : downcomer connection between left and right
********************************************************************************
*
1110000  dccon  sngljun
1110101  110010003  120010004  0.  10.  10.  000003
1110201  0  0.  0.  0.
*
*--------------------------------------------------------------------*
*                        input change                                *
*--------------------------------------------------------------------*
*
*--- post blowdown ---- post blowdown ---- post blowdown ---- post blowdown --*
*                     post blowdown simulation                         *
*--- post blowdown ---- post blowdown ---- post blowdown ---- post blowdown --*
*
*--------------------------------------------------------------------*
*                        break simulation                            *
*--------------------------------------------------------------------*
*
*-------------------------------------------*
******** reactor side broken section **********
*-------------------------------------------*
*
********************************************************************************
* component 951 : reactor side break (simulate break valve)            *
********************************************************************************
*
9510000  rxbreakj  valve
9510101  400010002  952010001  3.2928e-3  1.  1.  000102
9510201  0  0.  0.  0.
9510300  mtrvlv
9510301  531 533  0.25  0.  100  * 0.25=1/4 sec
*
********************************************************************************
* component 952 : break pipe in reactor side                           *
********************************************************************************
9520000  brkpipe1   pipe          * name
9520001  3                       * number of volume
9520101  3.2928e-3  1             * flow area of volume
9520102  3.8705e-3  3
9520201  0.          2             * flow area of junction
9520301  200.0e-3   3              * flow length
9520401  0.          3             * volume of volume
9520501  -90.        3             * azimuthal angle
9520601  0.          2             * inclination angle
9520601  -90.        3
*9520701 elevation change
9520801  4.572e-4   70.2e-3    3 * roughness, hyd. dia.
9520901  0.          0.         2 * loss coeff.
9521001  00000       3              * flag of volume
9521101  000000      2              * flag of junction
9521201  002   1.03325e5   1.   0.   0.   0.   3  * i.c. of volume
9521300  0                                   * i.c. ctrl word of junction
9521301  0.0     0.0     0.    2               * i.c. of junction
*
********************************************************************************
* component 953 : break junction in reactor side                       *
********************************************************************************
9530000  brkjun1  sngljun
9530101  952030002  954010001  0.  2.  0.5  000000
9530201  0  0.  0.  0.
*
********************************************************************************
* component 954 : reactor side break                                   *
********************************************************************************
9540000  rxbreak    tmdpvol
9540101  0.  1.  1.0e6  0.  -90.  -1.  4.572e-4  0.0  00000
9540200  002
9540201     0.    1.05025e5   1.
*
*-------------------------------------------*
********** sg side broken section ************
*-------------------------------------------*
*
********************************************************************************
* component 961 : steam generator side break (simulate break valve)    *
********************************************************************************
9610000  sgbreakj  valve
9610101  430010001  962010001  3.2928e-3  1.  1.  000102
9610201  0  0.  0.  0.
9610300  mtrvlv
9610301  531 533  0.25  0.  100  * 0.25=1/4 sec
*
********************************************************************************
* component 962 : break pipe in steam generator side                   *
********************************************************************************
```

```
9620000  brkpipe1   pipe          * name
9620001  5                        * number of volume
9620101  3.2928e-3  1             * flow area of volume
9620102  3.8705e-3  5
9620201  0.         4             * flow area of junction
9620301  100.0e-3   1             * flow length
9620302  300.0e-3   2
9620303  400.0e-3   3
9620304  300.0e-3   4
9620305  100.0e-3   5
9620401  0.         5             * volume of volume
9620501  90.        1             * azimuthal angle
9620502  0.         2
9620503  0.         3
9620504  90.        4
9620505  0.         5
9620601  0.         1             * inclination angle
9620602  0.         2
9620603  -90.       3
9620604  0.         4
9620605  -90.       5
*9620701 elevation change
9620801  4.572e-4   70.2e-3    5 * roughness, hyd. dia.
9620901  0.05       0.05      4 * loss coeff.
9621001  00000      5            * flag of volume
9621101  000000     4            * flag of junction
9621201  002   1.03325e5   1.   0.   0.   0.   5  * i.c. of volume
9621300  0                                    * i.c. ctrl word of junction
9621301  0.0      0.0     0.    4              * i.c. of junction
*
******************************************************************************
* component 963 : break junction in steam generator side                     *
******************************************************************************
9630000  brkjun1  sngljun
9630101  962050002  964010001  0.  2.  0.5  000000
9630201  0  0.  0.  0.
*
******************************************************************************
* component 964 : steam generator side break                                 *
******************************************************************************
9640000  sgbreak    tmdpvol
9640101  0.  1.  1.0e6  0.  -90.  -1.  4.572e-4  0.0  00000
9640200  002
9640201     0.     1.05025e5   1.
*
*-----------------------------------*
```

```
********** safety injection ************
*-----------------------------------*
*
******************************************************************************
* component 900 : si water source                                            *
******************************************************************************
9000000  siwater    tmdpvol
9000101  3.2928e-3  0.  1.0e6  0.  0.  0.  4.572e-4  0.0  00000
9000200  003  0   p  902010000
9000201  0.      0.      333.15
9000202  1.0e12   1.0e12  333.15
*
******************************************************************************
* component 901 : si junction                                                *
******************************************************************************
*
9010000  sijun  tmdpjun
9010101  900010002  902010001  0.
9010200  1   532
9010201  0.     0.    0.    0.
9010202  3.     2.5   0.    0.
9010203  1210.   2.5   0.    0.
9010204  1.0e6   2.5   0.    0.
*
******************************************************************************
* component 902 : si line                                                    *
******************************************************************************
9020000  siline    branch
9020001  3         0
9020101  1.3132e-3  500.0e-3  0.  0.  0.  0.  4.572-4   40.89e-3  00000
9020200  002    350000.  1.
9021101  902010002  910010001  0.  2.   1000.   000100
9022101  902010002  920010001  0.  1.   1000.   000100
9023101  902010002  930010001  0.  1.   1000.   000100
9021201  0.       0.       0.
9022201  0.       0.       0.
9023201  0.       0.       0.
*
*--------- to intact loop  ------------
*
******************************************************************************
* component 910 : si pipe 1 in broken loop                                   *
******************************************************************************
*
9100000  sitoa      pipe             * name
9100001  2                           * number of volume
```

```
9100101  9.6486e-4  2                    * flow area of volume
9100201  0.         1                    * flow area of junction
9100301  100.0e-3   2                    * flow length
9100401  0.         2                    * volume of volume
9100501  180.       2                    * azimuthal angle
9100601  -60.       2                    * inclination angle
*9100701 elevation change
9100801  4.572e-4  35.05e-3    2    * roughness, hyd. dia.
9100901  1.      1000.       1      * loss coeff.
9101001  00000     2                 * flag of volume
9101101  000000    1                 * flag of junction
9101201  002    350000.  1.  0.   0.   0.   2    * i.c. of volume
9101300  0                                 * i.c. ctrl word of junction
9101301  0.0      0.0      0.    1          * i.c. of junction
*
******************************************************************************
* component 911 : si initiation valve to intact loop                          *
******************************************************************************
9110000  sivlva     valve
9110101  910020002  374010001  0.  0.5  1000.  000100
9110201  0     0.      0.      0.
9110300  trpvlv
9110301  532
*
*--------- to broken loop 1 ------------
*
******************************************************************************
* component 920 : si pipe 1 in broken loop                                    *
******************************************************************************
*
9200000  si2b1      pipe                 * name
9200001  2                               * number of volume
9200101  3.4402e-4  1                    * flow area of volume
9200102  1.9602e-4  2
9200201  0.         1                    * flow area of junction
9200301  100.0e-3   2                    * flow length
9200401  0.         2                    * volume of volume
9200501  0.         2                    * azimuthal angle
9200601  -60.       2                    * inclination angle
*9200701 elevation change
9200801  4.572e-4  20.929e-3    1    * roughness, hyd. dia.
9200802  4.572e-4  15.798e-3    2
9200901  1.      1000.       1      * loss coeff.
9201001  00000     2                 * flag of volume
9201101  000100    1                 * flag of junction
9201201  002    350000.  1.  0.   0.   0.   2    * i.c. of volume
9201300  0                                 * i.c. ctrl word of junction
9201301  0.0      0.0      0.    1          * i.c. of junction
*
******************************************************************************
* component 921 : si initiation valve to broken loop 1                        *
******************************************************************************
9210000  sivlvb1    valve
9210101  920020002  474010001  0.  0.5  1000.  000100
9210201  0     0.      0.      0.
9210300  trpvlv
9210301  532
*
*--------- to broken loop 2 ------------
*
******************************************************************************
* component 930 : si pipe 2 in broken loop                                    *
******************************************************************************
*
9300000  si2b2      pipe                 * name
9300001  2                               * number of volume
9300101  3.4402e-4  1                    * flow area of volume
9300102  1.9602e-4  2
9300201  0.         1                    * flow area of junction
9300301  100.0e-3   2                    * flow length
9300401  0.         2                    * volume of volume
9300501  0.         2                    * azimuthal angle
9300601  -60.       2                    * inclination angle
*9300701 elevation change
9300801  4.572e-4  20.929e-3    1    * roughness, hyd. dia.
9300802  4.572e-4  15.798e-3    2
9300901  1.      1000.       1      * loss coeff.
9301001  00000     2                 * flag of volume
9301101  000100    1                 * flag of junction
9301201  002    350000.  1.  0.   0.   0.   2    * i.c. of volume
9301300  0                                 * i.c. ctrl word of junction
9301301  0.0      0.0      0.    1          * i.c. of junction
*
******************************************************************************
* component 931 : si initiation valve to broken loop 2                        *
******************************************************************************
9310000  sivlvb1    valve
9310101  930020002  494010001  0.  0.5  1000.  000100
9310201  0     0.      0.      0.
9310300  trpvlv
9310301  532
*
```

```
*------------------------------------------------------------------------*
* general table                                                          *
*------------------------------------------------------------------------*
* break valve   stem vs open area
20210000  normarea
20210001  -1.        0.
20210002  0.         0.
20210003  0.1        0.001
20210004  0.2        0.01
20210005  0.3        0.03
20210006  0.4        0.175
20210007  0.5        0.5
20210008  0.6        0.7
20210009  0.7        0.96
20210010  0.8        0.99
20210011  0.9        0.999
20210012  1.0        1.0
*
* core heater power at C18002 &C19001
20288800   power
20288801   -10.0     15.0e3
20288802     0.1     15.0e3
20288803     5.0     15.0e3
20288804  6000.0     15.0e3
*
* core heater power at C19002 &C19003
20288900   power
20288901   -10.0     15.0e3
20288902     0.1     15.0e3
20288903     5.0     15.0e3
20288904  6000.0     15.0e3
*
*------------------------------------------------------------------------*
************ control variables : for the sake of blowdown phase          *
*------------------------------------------------------------------------*
*
******************************************************************************
* control variable 024 : rx normalized water level   (C160+C180+C190+C200)   *
******************************************************************************
20502400  rxlvl   sum     1.0776     0.  1  * 1.0776=1/0.928
20502401  0.      0.08     voidf   160010000
20502402          0.148    voidf   180010000
20502403          0.1      voidf   180020000
20502404          0.1      voidf   190010000
20502405          0.2      voidf   190020000
20502406          0.2      voidf   190030000
20502407          0.1      voidf   200010000
*
******************************************************************************
* control variable 025 : u tube normalized water level 1 in broken loop      *
******************************************************************************
20502500  utublvl1  sum   6.0976e-1   0.  1  *6.0976e-1=1/(0.82*2)
20502501  0.      4.1e-1   voidf   450080000
20502502          4.1e-1   voidf   450070000
20502503          4.1e-1   voidf   450060000
20502504          4.1e-1   voidf   450050000
*
******************************************************************************
* control variable 026 : u tube normalized water level 2 in broken loop      *
******************************************************************************
20502600  utublvl2  sum   6.0976e-1   0.  1  *6.0976e-1=1/(0.82*2)
20502601  0.      4.1e-1   voidf   452040000
20502602          4.1e-1   voidf   452030000
20502603          4.1e-1   voidf   452060000
20502604          4.1e-1   voidf   452050000
*
******************************************************************************
* control variable 027 : suction leg normalized water level 1 in broken loop  *
******************************************************************************
20502700  sleglvl1  sum   1.9048  0.  1     *1.9048=1/(0.1+0.18+0.245)
20502701  0.      100.0e-3   voidf   460010000
20502702          1.8e-1     voidf   462010000
20502705          2.45e-1    voidf   464010000
*
******************************************************************************
* control variable 028 : suction leg normalized water level 2 in broken loop  *
******************************************************************************
20502800  sleglvl2  sum   1.9048  0.  1     *1.9048=1/(0.1+0.18+0.245)
20502801  0.      100.0e-3   voidf   480010000
20502802          1.8e-1     voidf   482010000
20502805          2.45e-1    voidf   484010000
*
******************************************************************************
* control variable 029 : suction leg + u tube normalized lvl 2 in broken loop *
******************************************************************************
20502900  leglvl12  sum   4.6189e-1  0.  1    *4.6189e-1=1/(1.64+0.525)
20502901  0.      1.64    cntrlvar   025
20502902          0.525   cntrlvar   027
*
******************************************************************************
* control variable 030 : suction leg + u tube normalized lvl 2 in broken loop *
******************************************************************************
```

```
20503000  leglvl2  sum   4.6189e-1  0.  1     *4.6189e-1=1/(1.64+0.525)
20503001  0.        1.64   cntrlvar   026
20503002            1.525  cntrlvar   028
*
********************************************************************************
* control variable 031 : discharge amount through reactor side broken section *
********************************************************************************
20503100  rxdisch  integral   1.  0.  1
20503101  mflowj   951000000
*
********************************************************************************
* control variable 032 : discharge amount through sg side broken section        *
********************************************************************************
20503200  sgdisch  integral   1.  0.  1
20503201  mflowj   961000000
*
********************************************************************************
* control variable 033 : si water source pressure setting                       *
********************************************************************************
20503300  sipres   sum      1.      300000.   0
20503301  5000.   1.        p     220010000
*
********************************************************************************
* control variable 034 : heat to the fluid in core                              *
********************************************************************************
20503400  qtocore  sum      1.     60000.   0
20503401  0.         1.     q     180020000
20503402             1.     q     190010000
20503403             1.     q     190020000
20503404             1.     q     190030000
*
```

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11. ABSTRACT *(200 words or less)*

SNUF experiment on hot leg break large break loss of coolant accident during post-blowdown was analyzed by RELAP5. As same with the procedure of SNUF experiment, normal operation and blowdown phase were simulated in order, and the initial condition was obtained and compared with the experimental initial condition. The analysis of post-blowdown phase showed that t he behavior of primary pressure can be properly simulated by RELAP5 when sufficient heat source is modeled. Resultantly, the release from reactor side broken section and steam generator side broken section were properly predicted. The pressure rise in the second step of pressure behavior was partially well predicted, where the pressure increased by the steam generation in core. The release from the steam generator side broken section was predicted to be little except when there exists large pressure difference between primary system and break boundary. Break size did not affect much on the overall behavior to some degree.

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