



# International Agreement Report

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## Assessment of RELAP5/MOD3.2 With the LSTF Experiment Simulating a Loss of Residual Heat Removal Event During Mid-Loop Operation

Prepared by  
K. W. Seul, Y. S. Bang, S. Lee, H. J. Kim

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## **Abstract**

The potential for the RELAP5/MOD3.2 code was assessed for the loss of residual heat removal (RHR) event during the mid-loop operation. The predictability of major thermal hydraulic phenomena was evaluated for the long term transient. The results of two typical cases, cold leg opening (CLO) case with water-filled steam generators (SGs) and pressurizer opening (PRO) case with emptied SGs were compared with experimental data conducted at ROSA-IV/LSTF in Japan.

It was found that the code was capable of simulating the system responses to the loss-of-RHR event during the reduced inventory operation. The thermal hydraulic transport process including noncondensable gas behavior was reasonably predicted with an appropriate time setup and CPU time. Overall, the code well predicted the major thermal hydraulic phenomena during the transient.

## **Executive Summary**

Recently, the loss-of-RHR during the reduced inventory operation was of great concern since there have occurred many events associated with it and the potential for the significant risk through the PRA study has been identified. Also, in analytical approach on the issue, it was revealed that there were many difficulties in getting convergence of transient calculation, such as very long computational time and severe flow oscillations in the core region, since the fluid flow and power conditions were very low during the loss-of-RHR event. In particular, it was difficult for the code to calculate the transport process of the mixture gas phase including noncondensable gas. Recently, the USNRC developed the modified version, RELAP5/MOD3.2 code, which incorporates new models and improvements based on the MOD3.1 version to resolve the deficiencies in the code with respect to the analysis of the loss-of-RHR event.

The objective of the present analysis is to assess the potential of the RELAP5/MOD3.2 code in predicting the system behavior following the loss-of-RHR event, and to evaluate the major thermal hydraulic phenomena for a long term transient. To do this, the calculated results are compared with the experiments which were conducted at the ROSA-IV/LSTF in Japan. Two typical geometry conditions considered in the assessment are cold leg opening (CLO) case with water-filled SGs and pressurizer manway opening (PRO) case with emptied SGs. The CLO case was to simulate the geometry conditions during the maintenance of reactor coolant pump and the PRO case was to simulate an open manway on the top of the pressurizer.

The calculation results involved pressure and thermal responses, water level and loop behavior, noncondensable gas behavior and discharged flow through the opening during the long term transient for the both cases. Also, the required CPU time and the estimated system mass errors were discussed in view point of the code performance. The overall conclusions through the present study are as follows:

- 1) The RELAP5/MOD3.2 code was capable of simulating the system responses to the loss-of-RHR event during the reduced inventory operation. Especially, thermal hydraulic

transport process including noncondensable gas behavior was reasonably predicted with an appropriate time step and CPU time. However, there were some code deficiencies such as an estimation of too large system mass errors and severe flow oscillations in the core region.

- 2) For the two typical geometry cases, the code predicted well the major phenomena during the long term transient, such as the coolant boiling off in the core, system pressurization, the occurrence of loop seal clearing (LSC), the migration of the noncondensable gas, liquid hold up in pressurizer, core uncovery and so on. Also, the overall trend of system pressures and fluid temperatures and the water level behavior agreed well with the experiment.
- 3) However, in the CLO case, the heat transfer to the SG secondary side was overestimated due to an excessive condensation on the U-tube wall by a large amount of steam migration toward the SG U-tubes. Thus, the onset of the LSC was a little delayed as compared to the experiment. In the PRO case, the maximum pressure in core upper plenum was overshot due to an excessive steaming in the core region and the liquid hold up in the pressurizer was also overestimated. Thus, the core heat up initiated much earlier than in the experiment. In view point of safety ensurance, the delay of the LSC, the overestimation of the maximum pressure and the earlier initiation of core heat up could give conservative results since it required earlier operator action following the loss-of-RHR event.
- 4) Two type of core models were considered for sensitivity study. There were no significant differences between both models, but the multi-dimensional effect on natural circulation flow in the core region was somehow compensated by the two channel core nodalization. Thus, the coolant temperature in the core region was predicted more accurately in case of two channel core model.

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## I. Introduction

The Residual Heat Removal (RHR) system is used to operate with the reactor inventory reduced to mid-water level of the primary loop (mid-loop operation) for a maintenance or inspection of components such as steam generator (SG) U-tubes and reactor coolant pump (RCP) during a plant outage in pressurized water reactor (PWR). Recently, the loss-of-RHR was of great concern, since there have occurred many events associated with it and the potential for the significant risk has been identified. The major causes of these events have been found to be a loss of vital ac power, an inadvertent closure of isolation valve in the RHR suction line, and a loss of RHR flow due to air ingestion into the RHR pump. Some of these events resulted in boiling of the reactor vessel coolant and eventually the possibility to uncover the core if the loss of RHR conditions should continue for a long time period [1, 2].

In order to understand thermal hydraulic process following the loss-of-RHR event, analytical studies as well as experimental studies have been performed. In analytic approach, the predictability of the major thermal hydraulic phenomena was evaluated mainly using the best-estimate transient analysis codes such as RELAP5. However, there were many difficulties in calculating the transient process [3, 4], especially in consumption of very long calculational time and occurrence of severe flow oscillations. These problems were found to be due to system configuration of reduced mass inventory under low pressure and existence of noncondensable gas. H. Nakamura et al. [3] performed calculation using the RELAP5/MOD3 v5m5 for the ROSA-IV/LSTF experiment that simulated a loss-of-RHR event during a mid-loop operation after reactor shut-down in a typical Westinghouse type PWR. It was reported that the code predicted well the overall trend of the experimental data, however considerable discrepancies were found in results for phenomena with multi-dimensional effects such as steam migration and natural circulation flow. The analysis also revealed that there were other problems of the code such as a nature of one dimensional code, an overestimation of void fraction and oscillatory flow in core, and difficulty in getting convergence for the gas phase equilibrium. S. Banerjee and Y.A. Hassan [4] also

performed the simulation of the loss-of-RHR event during the mid-loop operation using the same code. The calculation results were compared with the same experimental data which were obtained from the ROSA-IV/LSTF in Japan. It was reported that there was good qualitative agreement between the measured and the calculated data, however the calculation were computationally exhaustive and required extreamly small time steps.

The difficulty in calculation has been found to be caused in the transport process of the gas phase, in which steam and noncondensable gases exist simultaneously, especially during severe flow oscillations resulted from the boil off in core. Recently, the USNRC developed the modified version, RELAP5/MOD3.2, which incorporates new models and improvements based on the RELAP5/MOD3.1 version to resolve the deficiencies in the code with respect to the analysis of the loss-of-RHR event. In particular, in this version, the numerical schemes of the code to handle the appearance, transport and disappearance of noncondensable gases in hydrodynamic volumes were upgraded significantly and also the cross flow model was improved by including gravity and wall friction terms.

However, the predictability of the RELAP5/MOD3.2 code on thermal hydraulic phenomena has not been evaluated under the low flow and low pressure conditions. Also, the numerical improvements of the code have not been assessed under the reduced mass inventory operation. Thus, the objective of the present analysis is to assess the potential of the RELAP5/MOD3.2 in predicting the system behavior following the loss-of-RHR event during the mid-loop operation, and to evaluate the major thermal hydraulic phenomena for a long term transient. To do this, the calculated results are compared and evaluated with the experiments which were conducted at the ROSA-IV/LSTF in Japan.

The Chapter II includes a description of the LSTF and experimental conditions and procedures. A code description and modelling of the facility including nodalization and control logics are described in Chapter III. The calculation results are discussed in

detail with experimental data in Chapter IV. In particular, the discussion involves an effect of nodalization in the core, consumption of CPU time, an estimated mass error as well as an evaluation of the major phenomena following the loss-of-RHR event. The code run statistics are also described in this chapter. The conclusions obtained through the present study are summarized in Chapter V. Finally, the RELAP5/ MOD3.2 input deck for steady state and transient run are attached as an Appendix A and B.

## **II. Experimental Facility and Conditions**

### **II.1. Facility Description**

The Large Scale Test Facility (LSTF) of the Rig of Safety Assessment-IV (ROSA-IV) program is a 1/48 volumetrically scaled model of a Westinghouse type 3,423 MWt four loop pressurized water reactor (PWR). Figure 1 shows the overall flow diagram of the LSTF. The facility includes a reactor pressure vessel, two symmetric primary loops and steam generators (SG), pressurizer and ECCS including RHR system. The pressure vessel contains a core with full length fuel of 1,104-rods (3.66 m) simulating rod bundle, a cylindrical downcomer surrounding the core, upper and lower plena, and a upper head. The fuel rods consist of the electrical heated of 1,008 and the unheated of 96. The core bypass region is not simulated. The core power can simulate decay heat up to 14 % of the 1/48-scaled nominal PWR core power. The facility has the same major component elevation as the reference PWR to simulate the natural circulation phenomena and also has large loop pipes to simulate the major two phase phenomena in an actual plant. The four primary loops of the reference PWR were represented by two loops with an equal volume. The hot legs and cold legs were sized to conserve the volume scaling and the ratio of the length to square root of the pipe diameter,  $L/D^{0.5}$  for the reference PWR, in expectation that the flow regime transitions in the primary loops can be simulated appropriately by taking this scaling approach. Each primary loop includes an active steam generator (SG) with 141 full height U-tubes and an active reactor coolant pump (RCP).

In measurement systems, more than 2,000 instruments were installed to measure transient parameters which include temperature, pressure, differential pressure and fluid density. The partial pressure of air in gas phase was estimated from the local temperature measurement. Visual observation was also performed using video probes in the SG inlet plenum, horizontal legs and vessel upper plenum. In particular, the onset of steam condensation in the U-tubes was detected by monitoring the condensate flow from the SG U-tubes into the hot leg. The detailed measurement systems such as

the installed locations, measuring ranges, estimated accuracy and data acquisition system were described in reference [5].

## II.2. Experimental Conditions

In experiment for the simulation of loss-of-RHR event during mid-loop operation, four different cases were performed with different location of the opening on the RCS pressure boundary to simulate typical plant geometry during maintenance [6]; cold leg opening (CLO) case to simulate the plant geometry during the maintenance of the reactor coolant pump, hot leg opening (HLO) case to represent an open manway on the SG inlet plenum and a nozzle dam installed between the opening and the reactor pressure vessel, pressurizer opening (PRO) case to simulate an open manway on the pressurizer, and no-opening (NOO) case for the closed RCS condition. The areas of the opening for each experiment were equivalent to 5 %, 10 % and 33.5 % of cold leg cross area, respectively.

The initial liquid level in the primary loop was set approximately to the centerline of the horizontal legs to simulate a mid-loop operation; the crossover legs were thus filled with liquid. The SG secondary sides were either filled to the normal level with water (above 10 m from the tube sheet) or empty. The core power was 0.6 % (430 kW) of the scaled moninal PWR power and was kept at this value throughout the experiments, to simulate the decay power at approximately one day after the reactor shut-down. The primary coolant temperature was controlled using the RHR system typically at 334 ~ 337 K and 313 ~ 320 K in the hot leg and the cold leg, respectively; the coolant was taken out the nozzles at the bottom of both hot legs, pumped through a simulated RHR heat exchanger and injected into both cold legs through the ECCS nozzles. The initial pressure was atmospheric in both primary and secondary loops with the relief valves on the pressurizer and SGs latched open. The upper portion of the primary and secondary systems and components above the water level was filled with noncondensable gas, an air.

The experiment was initiated by isolating the RHR system from the primary loop and by closing the pressurizer relief valves at the same time. The SG relief valves were left open and no operator action was taken unless the core uncovering started. When the fuel cladding temperature exceeded about 830 K, the CLO case experiment was terminated by injecting manually the ECCS into the cold legs. In PRO case, auxiliary feedwater was injected into the SG in intact loop to reduce the RCS pressure and to terminate the experiment.

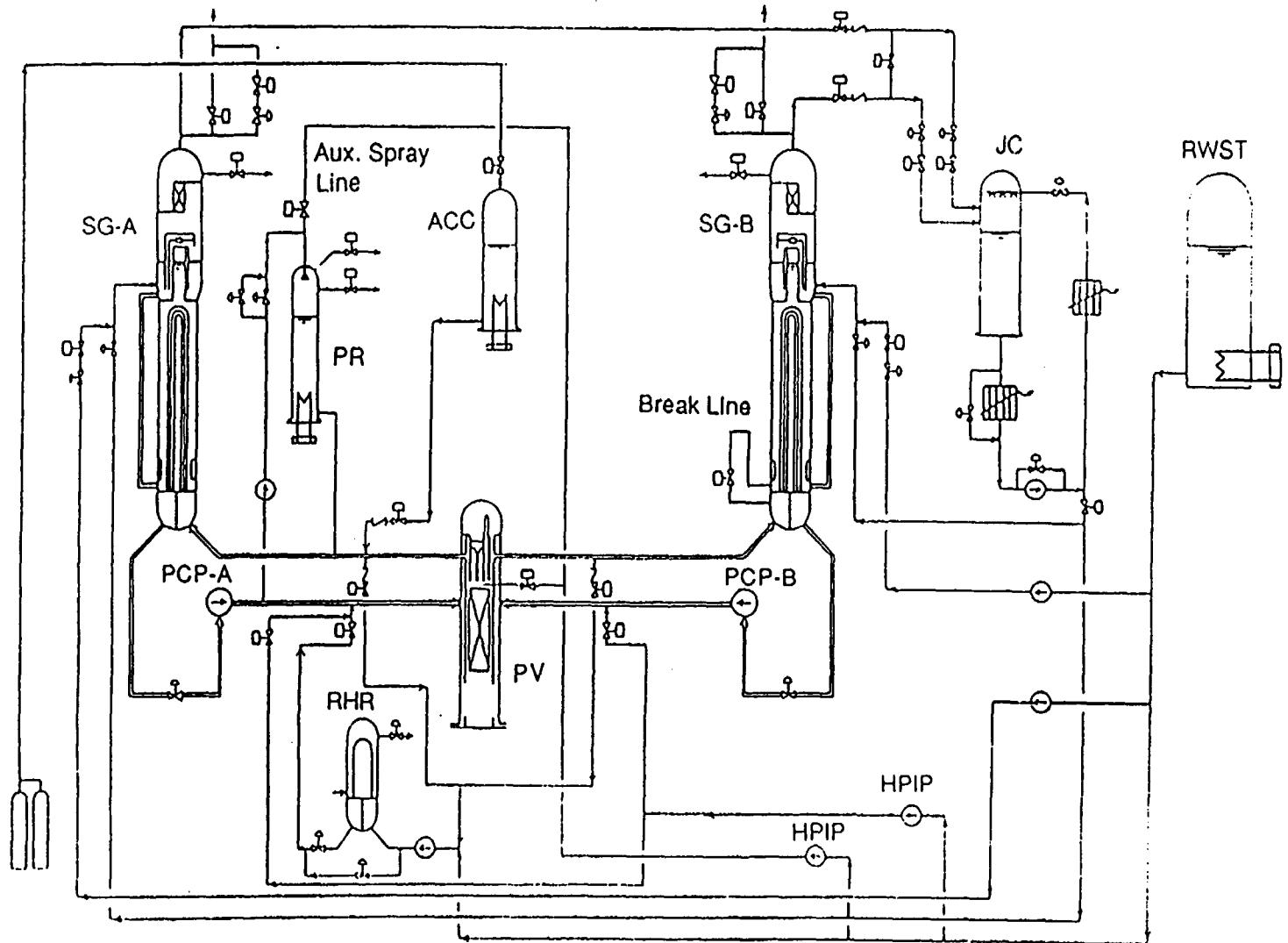


Figure 1 ROSA-IV LSTF Flow Diagram

### **III. Analysis Code and Modeling**

#### **III.1. Code Description**

The RELAP5 is internationally well recognized best-estimate system transient analysis code, based on a non-homogeneous and non-equilibrium model for one dimensional two phase flow system [7]. Basically, this code solves six field equations including constitutive models and correlations. It uses a partially implicit numerical scheme to permit economical calculation of system transients. The RELAP5/MOD3.2 version was improved from the RELAP5/MOD3.1. In particular, these improvements include the modification of crossflow model, the numerics to treat with the transport process of noncondensable gases and the new option of the wall condensation in presence of noncondensable gases. In this study on the code assessment for systems behavior following the loss-of-RHR event, the unmodified released code version of the MOD3.2 is used on a main frame computer, DEC workstation 5000/240 with UNIX operating system.

#### **III.2. Modeling Description**

Figure 2 shows the nodalization to simulate the LSTF facility with the RELAP5 code. The modeling is based on 179 hydrodynamic volumes connected by 199 junctions and 202 heat structures. In the reactor pressure vessel elements (volumes 100 to 156), the volumes corresponding to the downcomer, the lower plenum and upper plenum, the core, the upper head and the guide thimble channel are defined. The core is modeled as two types of noding schemes as shown in Fig. 3; single channel core is modeled with 12 hydraulic volumes, in which only one serie of heat structures is adopted to simulate the fuel assembly, and two channel core is also modeled as two series channel with 12 volumes and heat structures per each channel connected by crossflow junctions. This arrangement is adopted to assess the multi-dimensional effect such as natural circulation flow in the core region. The power distribution of the two channel core is 60 % for high power channel and 40 % for low power channel. A pipe

connection (volume 156) between the upper head (volume 152) and the upper plenum of the reactor vessel (volumes 128 to 140) is introduced to simulate the guide thimble channel path existing in the facility.

The two loops of the LSTF system are represented by an intact-loop (volumes 400 to 499) and a broken-loop (volumes 200 to 299) in an almost symmetrical way. Each loop consists of a hot leg, SG inlet and outlet plena, SG U-tube channel, loop seal, reactor coolant pump, and a cold leg. In addition, the pressurizer is connected to the hot leg in intact-loop through the surge line elements. The secondary sides of two SGs (volumes 300 to 399 and 500 to 599) are simulated using an identical schematization. They consist of a downcomer, boiling section, steam separator and a steam dome. The auxiliary feedwater lines are modeled by time dependent junctions with imposed flow rates. The relief and safety valves are also connected to the SG steam dome using valve components.

Both SG U-tubes are modeled with 12 volumes. In particular, fine noding scheme was used at the inlet portion of the U-tube, as shown in Fig. 2, which is to accurately simulate the steam migration and condensation phenomena. The RHR system is modeled by time dependent volumes and junctions connected to the hot leg and the cold leg in both intact loop and broken loop.

In this study, two typical cases of the geometrical configurations of the plant are analyzed to assess the code, that is, the cold leg opening (CLO) case with water-filled SGs and pressurizer manway opening (PRO) case with emptied SGs. The openings are modeled by a trip valve and single volume. The opening sizes are equivalent to 5 % and 33.5 % of cold leg cross area for CLO case and PRO case, respectively. The openings are located at centerline of the cold legs and at the top of the pressurizer, respectively.

In the noncondensable model of the RELAP5, the steam/noncondensable mixture is assumed to be in thermal equilibrium and the saturation properties of the liquid and

steam are assumed to be a function of the partial pressure of the steam. These assumptions intend to force the phasic temperatures and the saturation temperature to the same value. It causes a reduced driving potential for the interfacial mass and heat transfer models. Consequently, low interfacial heat transfer regimes, such as the vertical stratification flow regime, may give heat transfer coefficients that are too low for stable calculation. Under this situation, the RELAP5 user's guide [7] recommends that the vertical stratification model (VSM) should be turned off on a volume basis. According to this guideline, the VSM option was turned off at the volumes in the core.

In addition, the general and specific practices for applying RELAP5 including standard procedures, option selection related to volume and junction, special model applications such as break model and crossflow model, control and trip logics and so on, are used according to the user's guidance. Hence, there are no deviations from the user guidelines described in RELAP5/MOD3 code manual, volume V.

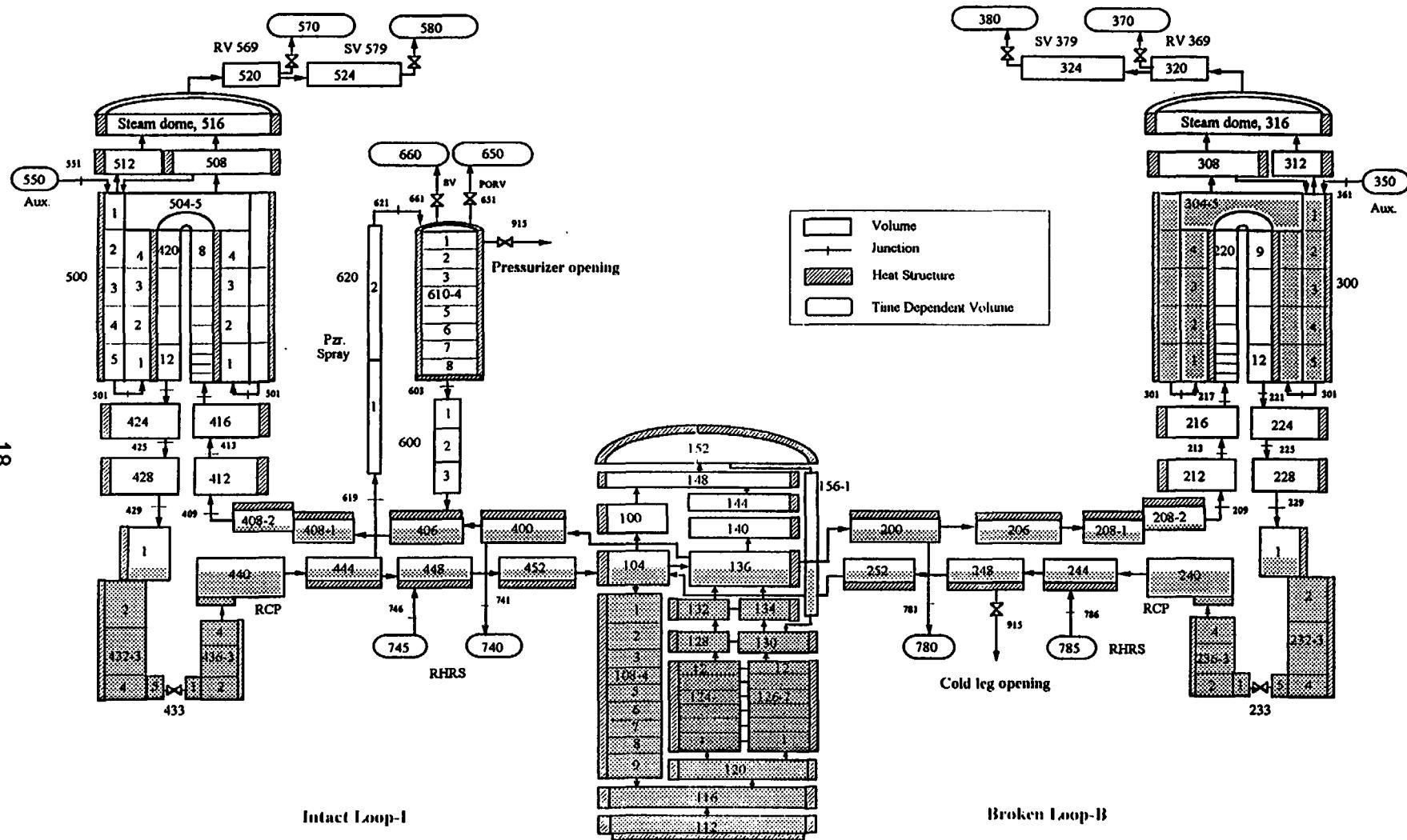


Fig. 2 RELAP5 Nodalization of ROSA-IV LSTF for Simulation of a Loss-of-RHR Event during Mid-loop Operation

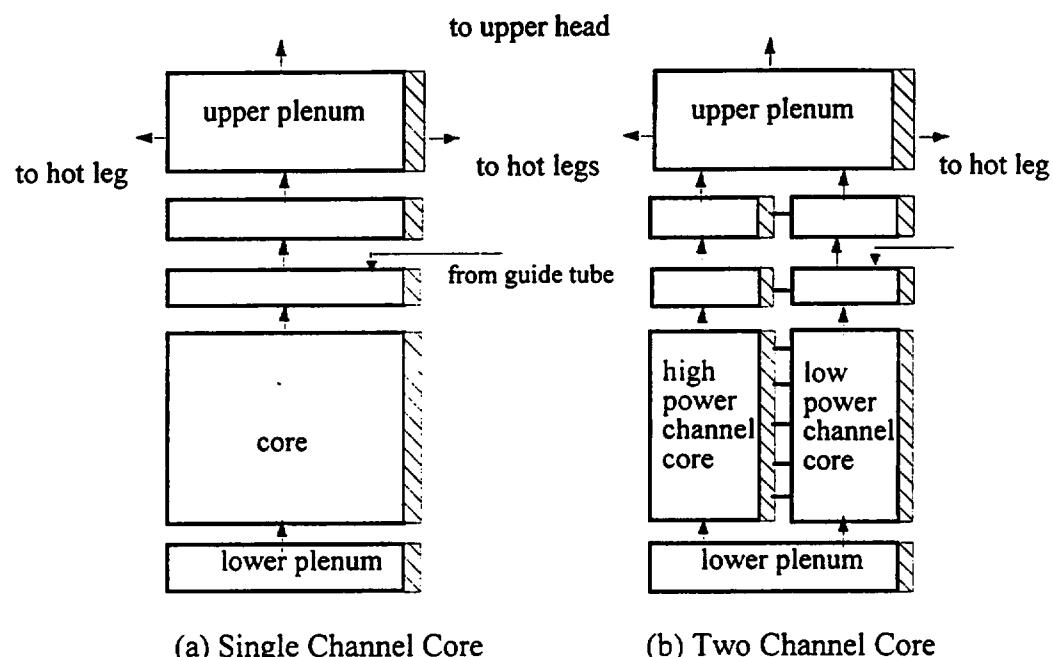


Fig. 3. Core Nodalization for Sensitivity Study

## **IV. Results and Discussion**

### **IV.1. Initial/Boundary Conditions and Event Description**

The initial steady-state conditions were obtained from new transient run up to 1,000 seconds. Transient calculation started with the loss-of-RHR flow at this time. Table 1 shows comparison of initial conditions between the experiment and the calculation and Table 2 represents initial boundary conditions for steady-state and transient runs. The core power was 430 kW to correspond to the decay heat at about 20 hours after the reactor shut-down. SG secondary sides were filled to the normal level with water of room temperature for CLO case and were completely emptied for PRO case. Liquid temperature at inlet of RHR system was 334 ~ 337 K, the outlet liquid temperature was 318 ~ 320 K and the mass flow rate at each loop was 3.0 ~ 3.2 kg/s. The pressurizer and SGs relief valves were opened to remain an atmospheric pressure. The water levels in hot and cold legs were remained at the middle of the loop and an above part of the water was filled with a noncondensable gas, an air. The calculated initial mass inventory in primary side was 2,590 kg for CLO case and 2,686 kg for PRO case. The major calculated parameters of the primary and secondary sides agreed well with the measured values as shown in Table 1.

The transient calculation was initiated by decreasing linearly the RHR flow rate from the initial value to zero for 20 seconds and by opening either the cold leg opening valve for CLO case or the pressurizer opening valve for PRO case. The pressurizer relief and safety valves were closed at the same time. The calculation was attempted up to over 14,000 seconds (about 4 hours) for the CLO case and 9,000 seconds (2.5 hours) for the PRO case until an operator took an action to stop the experiment. The results of calculation were compared with the experimental data obtained in open literature [3, 6, 8]. The origin of the experimental data including the estimated accuracy of the measurement devices and the corresponding RELAP5 parameters are listed in Table 3 and 4 for the CLO case and the PRO case, respectively.

Table 1. Comparison of Initial Conditions

Major Parameters	Experiment; CLO/PRO	RELAPS; CLO/PRO
■ Core power (kW)	430 / 430	430 / 430
■ Hot leg temperature (K)	334 / 337	334.1 / 337.1
■ Cold leg temperature (K)	318 / 320	318.0 / 320.0
■ Primary pressure (MPa)	0.1013 / 0.1013	0.1013 / 0.1013
■ Water level at loops (m)	middle of loop	middle of loop
- hot leg void		0.41 / 0.30
- cold leg void		0.51 / 0.21
■ Secondary pressure (MPa)	0.1013 / 0.1013	0.1013 / 0.1013
■ Secondary fluid temperature (K)	317 / 317	317.0 / 317.0
■ Water level in SG (m)	10 / empty	10.08 / empty
■ Initial coolant inventory (kg)	-	2590 / 2686
■ RHR flowrate (kg/s)	-	3.2 / 3.0
■ Noncondensable gas	air / air	air / air

Table 2. Initial Boundary Conditions for Steady-State and Transient Runs

	Steady State	Transient	Remarks
■ Presurizer Relief valve	open	close	junc-651
■ Presurizer Safety valve	open	close	junc-661
■ SG-BL Relief valve	open	open	junc-369
■ SG-BL Safety valve	open	close	junc-379
■ SG-IL Relief valve	open	open	junc-569
■ SG-IL Safety valve	open	close	junc-579
■ RHRs operation - suction part - discharging part	yes	no	junc-781/741 junc-786/746
■ Nozzle Dam	no	no	-
■ Cold leg opening (5 % equivalent break)	no	yes	junc-915
■ Pressurizer manway opening (33.5 % equivalent break)	no	yes	junc-915

■ IL: Intact Loop, BL: Broken Loop, SG: Steam Generator, RHRs: Residual Heat Removal System

Table 3 List of Measured and Calculated Parameters for CLO Case

Major Parameters	Origin of Measured Data	Full Scale Accuracy*	Calculated Parameters
▪ Pressure at hot leg-IL	Ref. 3	0.32 FS	p-400010000
▪ Pressure at cold leg-IL	Ref. 3	0.32 FS	p-452010000
▪ DP at crossover leg downside-IL	Ref. 3	0.32 FS	cntrlvar-755
▪ DP at crossover leg upside-IL	Ref. 3	0.32 FS	cntrlvar-753
▪ DP at crossover leg downside-BL	Ref. 3	0.32 FS	cntrlvar-756
▪ DP at crossover leg upside-BL	Ref. 3	0.32 FS	cntrlvar-757
▪ DP at core	Ref. 3	0.32 FS	cntrlvar-761
▪ Core fluid temperature at mid	Ref. 3	0.616 FS	tempf-124060000
▪ Fuel cladding temperature	Ref. 3	0.616 FS	httemp-124101101
▪ Core upper plenum temperature	Ref. 3	0.616 FS	tempf-136010000
▪ Water temperature at hot leg-IL	Ref. 3	0.735 FS	tempf-400010000
▪ Water temperature at cold leg-IL	Ref. 3	0.735 FS	tempf-452010000
▪ Water temperature in SG-BL	Ref. 3	0.777 FS	tempf-304010000
▪ Water temperature in SG-IL	Ref. 3	0.777 FS	tempf-504010000
▪ Gas temp. at SG-IL inlet plenum	Ref. 3	0.735 FS	tempg-416010000
▪ Gas temp. at SG-BL inlet plenum	Ref. 3	0.735 FS	tempg-216010000
▪ Gas temperature in bottom Pzr.	Ref. 3	0.735 FS	tempg-610030000
▪ Gas temperature in upper Pzr.	Ref. 3	0.735 FS	tempg-610080000
▪ Condensate rate at SG-IL U-inlet	unavailable	-	gammaw-420010000
▪ Condensate rate at SG-BL U-inlet	unavailable	-	gammaw-220010000
▪ Collapsed water level in RPV	unavailable	-	cntrlvar 125
▪ Flow rate through cold leg opening	unavailable	-	mflowj-915000000
▪ Flow rate through guide tube	unavailable	-	mflowj-152020000
▪ Void fraction at hot leg-BL	unavailable	-	voidg-200010000
▪ Void fraction at cold leg-BL	unavailable	-	voidg-252010000
▪ Void fraction in core upper plenum	unavailable	-	voidg-136010000
▪ Total noncondensable gas mass	unavailable	-	cntrlvar-930
▪ Noncondensable mass in U-tubes	unavailable	-	cntrlvar-929
▪ Noncondensable mass in RPV	unavailable	-	cntrlvar-880
▪ CPU time	-	N/A	cputime-0
▪ Calculated time step	-	N/A	dt-0
▪ Courant time step	-	N/A	dtcnrt-0
▪ Estimated mass error	-	N/A	emass-0

Table 4 List of Measured and Calculated Parameters for PRO Case

Major Parameters	Origin of Measured Data	Full Scale Accuracy*	Calculated Parameters
▪ Pressure at upper plenum	Ref. 6	0.32 FS	p-136010000
▪ DP at upper plenum	Ref. 6	0.32 FS	cntrlvar-754
▪ DP at core	Ref. 6	0.32 FS	cntrlvar-761
▪ Fuel cladding temperature	Ref. 6	0.616 FS	httemp-124101101
▪ Water temperature at hot leg-IL	Ref. 6	0.735 FS	tempf-400010000
▪ Water temperature at cold leg-IL	Ref. 6	0.735 FS	tempf-452010000
▪ Collapsed water level in Pzr.	Ref. 6	0.32 FS	cntrlvar-126
▪ Collapsed water level in RPV	Ref. 6	0.32 FS	cntrlvar-125
▪ Mixture density at hot leg-IL	Ref. 6	unavailable	rho-400010000
▪ Mixture density at cold leg-IL	Ref. 6	unavailable	rho-452010000
▪ Flow rate through Pzr. opening	unavailable	-	mflowj-915000000
▪ Void fraction at hot leg-IL	unavailable	-	voidg-400010000
▪ Void fraction at cold leg-IL	unavailable	-	voidg-452010000
▪ Void fraction at surge line	unavailable	-	voidg-600020000
▪ Vapor velocity in surge line	unavailable	-	velgj-600020000
▪ Flow regime in surge line	unavailable	-	floreg-600030000
▪ Total noncondensable gas mass	unavailable	-	cntrlvar-930
▪ Noncondensable mass in U-tubes	unavailable	-	cntrlvar-929
▪ Noncondensable mass in Pzr.	unavailable	-	cntrlvar-679
▪ CPU time	-	N/A	cputime-0
▪ Calculated time step	-	N/A	dt-0
▪ Courant time step	-	N/A	dtcrrnt-0
▪ Estimated mass error	-	N/A	emass-0

▪ IL: Intact Loop, BL: Broken Loop, RPV: Reactor Pressure Vessel, Pzr: Pressurizer

DP: Differential Pressure, N/A: Not Applicable

\* Detailed Information was described in Ref. 5

The overall system behavior during the transient is summarized as follows. First, the coolant in primary side become stagnated due to the loss-of-RHR flow. The coolant temperature in core increases gradually to a saturation value and boiling starts at about 500 seconds after the loss-of-RHR event. The pressure in hot sides such as reactor vessel upper plenum, upper head and hot legs increases due to the boiling in the core and the steam migrates toward SGs and pressurizer through the hot legs. The primary coolant is discharged either through the cold leg opening or through the pressurizer manway opening since the pressure difference is increased due to the steaming. Due to the continuous system pressurization, the loop seal clearing (LSC) occurs in crossover leg for the CLO case. For the PRO case, the liquid is hold up in pressurizer in the primary side. And then the core coolant is redistributed from the core region over the loops. Eventually, core uncovering is caused by the decreased mass inventory in the core region and the core heat up is initiated and the transient is ended at this time. Tables 5 and 6 represent the comparison of the predicted timing of the major events with the experiment for both cases. The detailed discussion of the calculated results is described below section. As a base calculation, the case of two channel core model in the CLO case and the case of single channel core model in the PRO case are analyzed and discussed.

Table 5. Timing of The Major Phenomena for CLO Case

Major Events (unit : second)	LSTF	RELAPS/MOD3.2
▪ Loss-of-RHR system	1000	1000
▪ Boiling start	1500	1600
▪ Saturation of upper plenum liquid	1590	1790
▪ Steam discharge into upper head	2130	2130
▪ First core heat up start	2950	-
▪ First loop seal clearing (LSC)	3440	3840
▪ Condensate accumulating start	6300	6400
▪ Second loop seal clearing (LSC)	-	9500
▪ Second core heat up start	11920	12000
▪ Termination (ECCS injection)	16800	14000

Table 6. Timing of The Major Phenomena for PRO Case

Major Events (unit : second)	LSTF	RELAPS/MOD3.2
▪ Loss-of-RHR system	1000	1000
▪ Boiling start	1500	1600
▪ Saturation of upper plenum liquid	1600	1800
▪ Reaching maximum pressure	2200	3200
▪ Liquid inflow into pressurizer	2220	2900
▪ Maximum liquid hold up	3600	3700
▪ Stable liquid hold up	3600	4000
▪ Core heat-up start	9400	6400
▪ Termination (Aux. feed injection)	11000	9000

## **IV.2. Analysis Results for CLO Case**

### **IV.2.1. Pressure Response**

Figure 4 shows the pressure behavior in hot and cold legs in intact loop after the loss-of-RHR event, which occurred at 1,000 seconds during the mid-loop operation. At about 1,500 seconds, the liquid in core started to boil and the steam migrated toward the hot legs from the core through core upper plenum. Thus, the pressure in the hot leg started increasing rapidly at about 1,600 seconds. The calculated pressure agreed well with the experiment in the early phase. At about 2,100 seconds, the pressurization rate reduced immediately. This was because a steam flow through guide tubes was established at this time as shown in Fig. 5. The guide tubes were initially submerged under water in upper plenum. As the water level decreased below the guide tube bottom opening due to the boil off, the steam started to be discharged into upper head with large volume.

However, the calculation showed that the pressurization rate was still lower than in the experiment. Such a low pressurization rate resulted in delaying an occurrence of loop seal clearing (LSC). This difference could be explained in association with condensation phenomena on SG U-tubes wall during this phase. Actually in the experiment, the steam condensation was not occurred before the LSC, while in the calculation, a significant amount of steam was condensed at the inlet part of the SG U-tubes. As a result, the pressurization became relatively low during this phase. The condensation phenomena will be further discussed in below section.

With continuously steaming in the core, pressure difference between hot and cold legs increased gradually. Eventually at about 3,740 seconds, when the calculated pressure in the hot leg reached 0.138 MPa which is almost the same value as in the experiment, the LSC occurred in crossover legs. And then the pressure dropped immediately to a little higher value than in the cold leg pressure. The LSC timing was later by 400 seconds than in the experiment, which occurred at 3,440 seconds. This

delay, as described above, was due to the low pressurization rate before the LSC, which was caused by an excessive steam condensation on SG inlet U-tubes wall.

Since, as a result of the LSC, the gas flow path was formed from hot leg to cold leg through crossover leg, the steam penetrated the SG U-tubes and began to condense on the entire U-tubes wall. In the experiment, the loop seal was completely cleared in broken loop side and partial LSC in intact loop side. However, in the calculation, it was predicted in the opposite side each other, i.e., complete LSC in the intact loop and partial LSC in the broken loop. In actual, the occurrence location of the complete LSC could be changed, depending on the initial conditions such as water and gas distribution in a loop and power distribution in a core. Anyway, in spite of the difference in occurrence location of the LSC, the overall thermal hydraulic phenomena such as depressurization and condensation was not influenced because of the symmetry in the loop configurations. Figures 6 and 7 show the comparison of differential pressure behavior at downflow and upflow sides of crossover legs. When the LSC occurred, as shown in Fig. 6, the crossover leg was immediately emptied. The calculation well predicted the overall LSC behavior. In the other loop side, the differential pressure was predicted a little high after the LSC, especially in the upflow side, as shown in Fig. 7. This partial LSC resulted in underestimating coolant inventory in the core because an inflow to the core through the cold leg was lower than in the experiment. Figure 8 shows clearly that the core differential pressure was underestimated after the LSC.

Figure 6 also shows that the condensate from the SG U-tube wall started to accumulate in upflow side from about 6,400 seconds. Such a liquid accumulation in the crossover leg resulted in preventing the gas flow from the hot leg toward the cold leg, namely limited the steam condensation on SG U-tube wall, and then the pressure in the hot leg resulted in re-increasing gradually as shown in Fig. 4. The calculated pressure shows a similar behavior to the experiment even though the pressure was slightly overpredicted after 7,000 seconds. The calculation also shows an earlier second LSC at 9,420 seconds than the experiment. It was because the pressure

increased a little fast by more accumulation of the condensate in the calculation than in the experiment. Actually, the second LSC in the experiment was induced at 16,800 seconds by the steam condensation on the ECCS coolant injected into the cold legs to terminate the experiment.

In summary, the pressure behavior in the hot leg was reasonably predicted and the pressure behavior in the cold leg excellently agreed with the experiment, even though there were some differences such as the LSC delay and the partial LSC.

#### IV.2.2. Thermal Response

Figure 9 represents liquid temperatures behavior at inlet, mid-section and outlet of the reactor core with high power. The experimental data are fluid temperatures at mid-section of the core. Following the loss-of-RHR event at 1,000 seconds, coolant in the core became stagnated and the liquid temperature immediately increased. The highest liquid temperature was located first at upper part of the core, however, because of cosine shape of power distribution, the liquid temperature at the mid-height of the core became the highest. After the temperature reached saturation value, the coolant started to boil off and the temperature remained constant. The calculation agreed well with the experiment.

Figure 10 shows liquid temperatures in hot and cold legs in broken loop. They also increased with some delay following the increasing of fluid temperature in the core. After the saturation of steam in core upper plenum at about 1,500 seconds, the liquid temperature in the hot leg increased stepwise to the steam temperature in the experiment, and the calculation also showed the similar trend. The experimental data compared in this figure were measured at the ceiling of the horizontal pipe. It implies that the temperature, which measured after the legs were sufficiently voided, was a steam temperature. Therefore, the measured temperature showed a little difference with the calculated liquid temperature after the LSC.

Figure 11 shows liquid temperatures at the bottom of the SG secondary sides in

both loops. The calculated liquid temperature in broken loop SG began to increase earlier than the measured one. It implies that some of the core decay heat was transferred to the SG secondary side in the calculation, while not in the experiment. In other words, a significant amount of steam migrated into SG U-tubes and condensed on the U-tubes wall earlier than in the experiment. Figure 12 shows clearly that the steam had begun to condense on the SG U-tube wall in the broken loop from about 2,000 seconds before the LSC occurred. In actual, the experiment indicated that the flow pattern of the gas phase in the loop was a vertically stratified non-equilibrium flow with separation between air and steam phase. In this situation, the air flow could prevent the steam migration into U-tubes and limit the condensation rate. However, in the calculation, the gas phase was assumed as a thermal equilibrium homogeneous mixture and then the effect of noncondensable gas was underestimated. As a result, the code overestimated the condensation rate, especially in the broken loop occurred the LSC.

Figure 11 also indicated that, after the LSC, the calculated liquid temperature in intact loop rapidly increased with higher rate than in the experiment. It implies that the steam condensation concentrated in the inlet part of the U-tube for a short time period. During this phase, there was no condensation at middle and upper part of the U-tubes. Figure 13 shows the liquid temperatures in SG side along the vertical direction. The calculation showed clearly that the temperature started to increase first in the bottom part of the SG secondary side just after the LSC and increased stepwise along the vertical axis. Eventually, all the calculated values reached the same temperature. However, the measured temperatures showed a gradual rise and were nearly flat along the vertical axis [3]. This difference was caused by the one dimensional model of the SG secondary sides in the calculation. In actual, the flow in secondary sides indicated three dimensional natural circulation resulted from the temperature difference. The one dimensional nature as well as the assumption of the homogeneous equilibrium mixture of the gas phase, was well known to be substantial problems in RELAP5/MOD3.2 code. In spite of the one dimensional nature of the code, the calculation showed that the heat transfer into the secondary side from the primary side was accurately

predicted.

#### **IV.2.3. Water Level and Loop Behavior**

After the coolant in core started to boil off, the water level was decreased by break flow through cold leg opening. Figure 14 shows that the collapsed water level in reactor vessel was decreasing to the active core region with some oscillations. Due to the decreased water level, hot legs and core upper plenum with a mid-water level in the early phase were voided from about 2,000 seconds as shown in Figures 15 and 16. However, the cold legs remained mid-water level before the LSC even with severe void oscillations. This was due to a kind of manometric behavior; because the pressure in hot sides such as the core upper plenum and the hot leg is relatively high to the cold sides such as cold leg and core downcomer, the water level in the cold leg remained high by the compression of the water. When the LSC occurred, the cold legs became completely voided and the collapsed water level in reactor vessel increased immediately by an inflow of the water from the crossover and cold legs.

After the LSC, due to the voided cold legs, the break flow through the cold leg opening became nearly stop. Figure 17 shows clearly that there was no the break flow after the LSC. Although the break flow reduced to zero after the LSC, the core coolant continued boiling and steaming, and was redistributed toward crossover legs by the condensation on the SG U-tube wall. Eventually, the water level in the core reduced enough to initiate a core heat up.

#### **IV.2.4. Core Heat up**

In the experiment, since the water level in reactor vessel decreased rapidly by the discharge through cold leg opening before the LSC, the top part of the core was uncovered for a very short time period. This first core heat up occurred locally just on a few number of the fuel rods at top part of the core and the fuel rod surface temperatures reached maximum 600 K. After completion of the LSC, as discussed previous section, the core water level recovered and the fuel rods were quenched. Due

to the continuous steaming in the core and steam condensation in SG U-tubes, the reactor vessel coolant was redistributed gradually to the leg sides and then the second core heat up was initiated from 10,920 seconds (182 minutes) following the loss-of-RHR event. The maximum fuel surface temperature exceeded 830 K at 81 minutes after the core uncover. In the calculation, the first core heat up did not occur because the core was modeled simple nodes such as an averaged volume. Figure 18 shows comparison of the fuel cladding temperatures at the region of the core. The experiment data were measured at 3.66 m and 3.02 m from the core bottom and the calculated was chosen at 2.90 m from the bottom. As compared with the data at the same height of the core, the calculated core heat up at the middle of the core (below 3.05 m) was initiated earlier by about 1,300 seconds than in the experiment, but the heat up rate well agreed with the experiment. Also, the core heat up at the top of the core (at 3.66 m) started at almost same time, but the heat up rate was a little larger than in the experiment, which was not shown in the figure. It was due to the incorrect void distribution in the core region and underprediction of the core differential pressure, as shown in Fig. 8. When the fuel cladding temperature exceeded 830 K, the experiment was terminated by ECCS injection and the calculation was also ended at this time.

#### IV.2.5. Gas Phase Behavior

Initially, total mass of noncondensable gas of about 5.25 kg existed in primary system. Due to increasing of steam partial pressure in core upper plenum, the noncondensable gas was migrated along with the steam into the hot legs and SG U-tubes inside. Figure 19 shows the noncondensable gas behavior in each component during the transient. After steaming in the core, it showed clearly that the air inside reactor vessel was completely pushed out at about 2,000 seconds and total air mass rapidly reduced. It implies that the air was discharged through the cold leg opening. However, the air mass inside U-tubes temporally increased before the LSC, because the air migration into SG U-tubes was simultaneously accompanied with the steam transport. The steam condensation inside the U-tube, before the LSC, was discussed above section. When the LSC occurred, the air mass in primary system rapidly

decreased, especially inside U-tube, since direct steam flow path was formed from hot leg to cold leg.

In the code, the gas phase was treated as homogeneous mixture of air and steam with thermal equilibrium. With this code model and one dimensional noding nature, it is not easy to accurately predict the gas migration behavior. However, the gas phase temperature is calculated in terms of steam partial pressure and then, from variation of the gas temperatures, existence of steam and steam concentration can be found in a volume. In other words, if the gas temperature in a volume was correctly predicted, then it can be said that an amount of steam in the volume was well predicted qualitatively. Figure 20 shows comparison of gas temperatures in SG inlet plenum. The code predicted well the trend of the experiment. It implies that steam migration into SG U-tube through the hot legs side was appropriately predicted in spite of the limitation of one dimensional code. Also, Figure 21 shows comparison of gas temperatures with elevation inside pressurizer. The calculated gas temperatures had a similar trend to the experiment but they overpredicted a little although the initial steam concentration was slightly high. It implies that a little more steam was migrated to the pressurizer than in the experiment. As a result, it can be said that the steam transport into the hot legs and the pressurizer was reasonably predicted, in spite of some limitations of the RELAP5/MOD3.2 code such as one dimentional nature and assumption of the homogeneous mixture with thermal equilibrium.

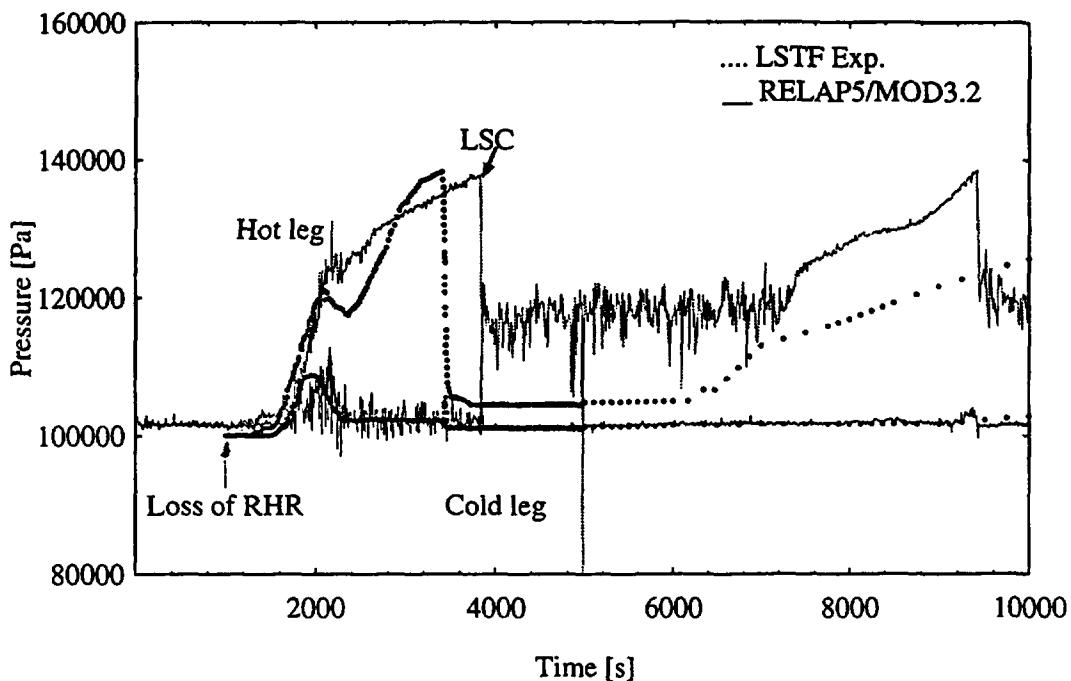


Fig. 4 Comparison of Pressures at Hot and Cold legs in Intact Loop

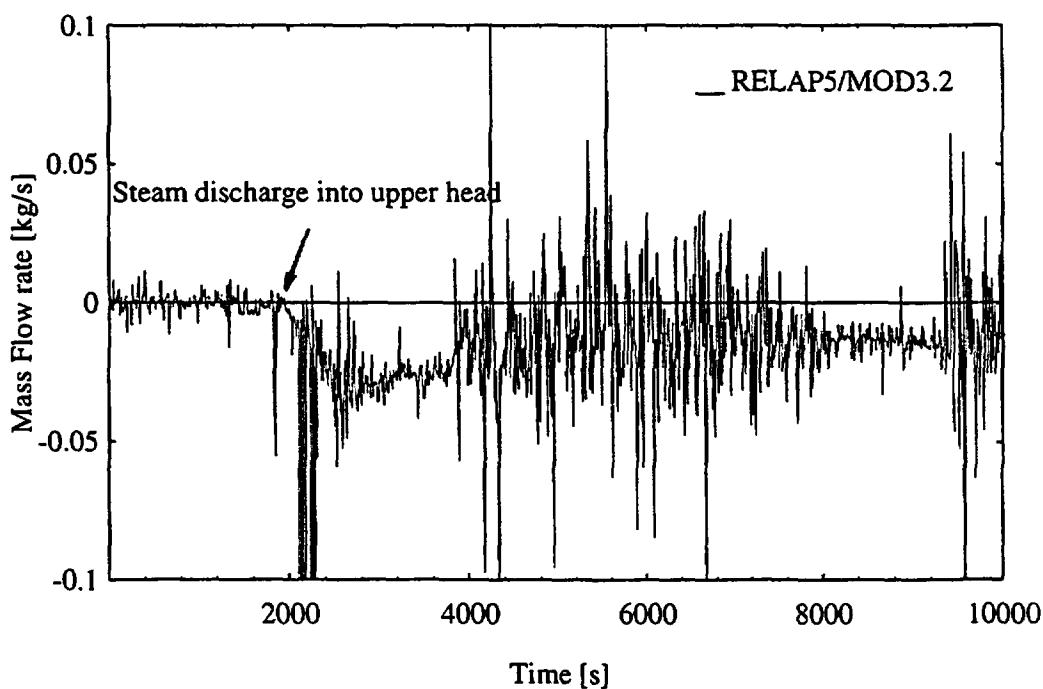


Fig. 5 The Calculated Flow Rate between Guide Tubes and Upper Head

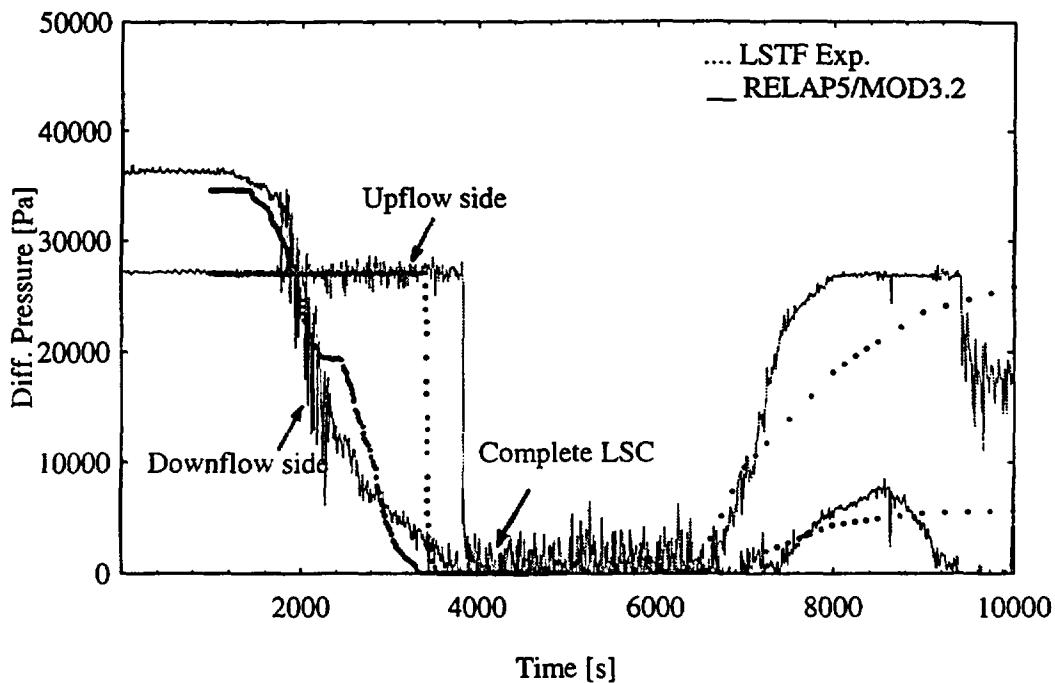


Fig. 6 Comparison of Differential Pressures at Crossover leg in Broken Loop

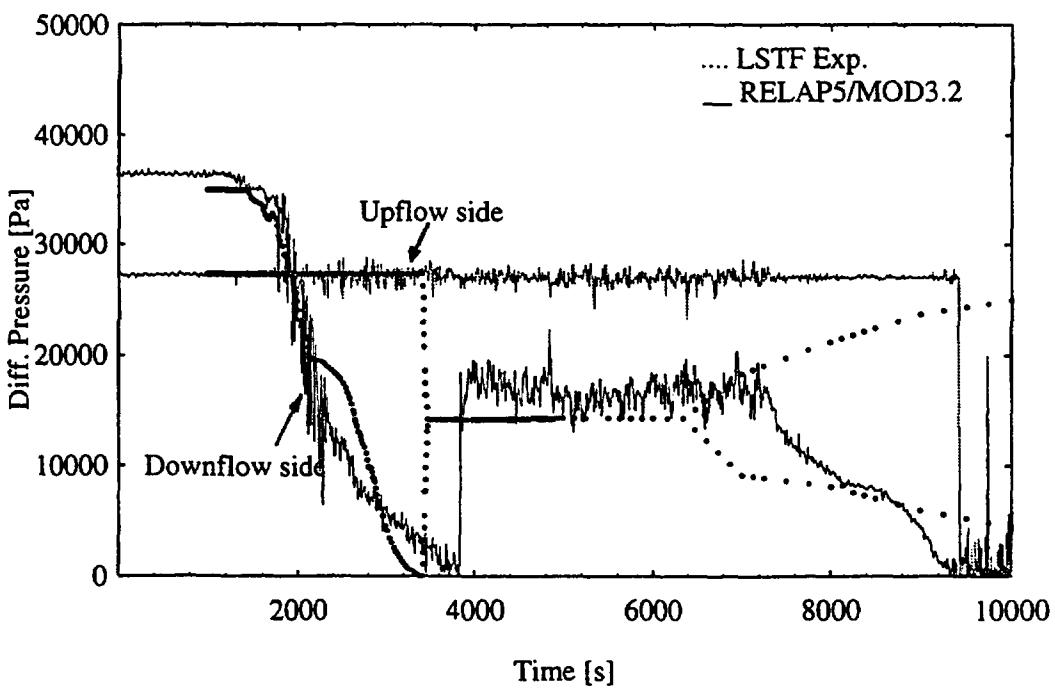


Fig. 7 Comparison of Differential Pressures at Crossover leg in Intact Loop

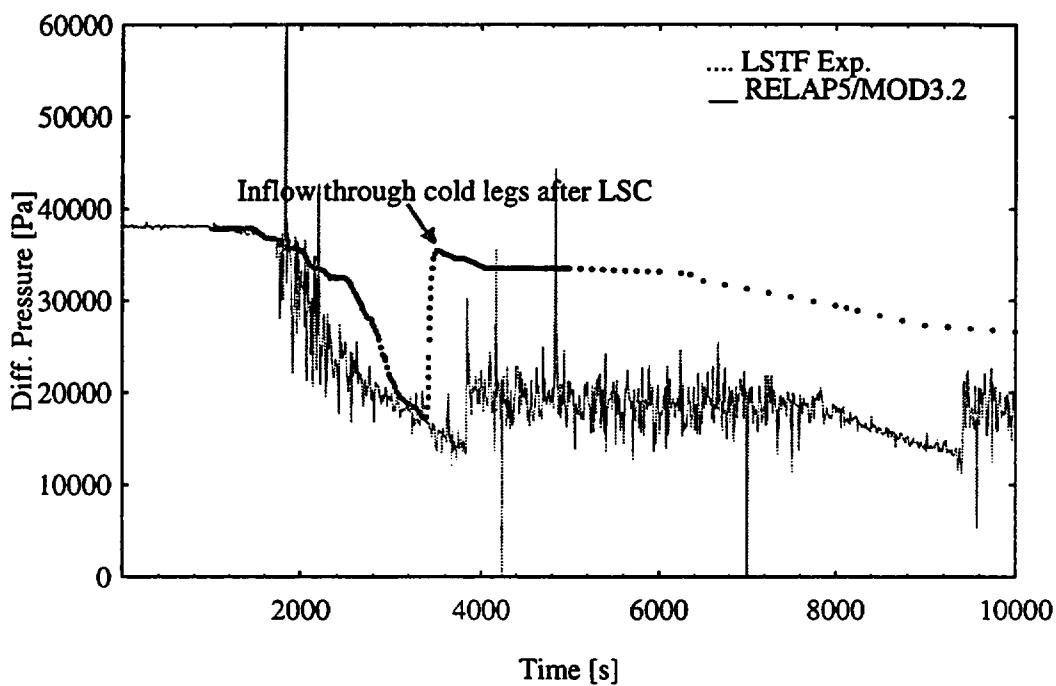


Fig. 8 Comparison of Differential Pressures at Reactor Core

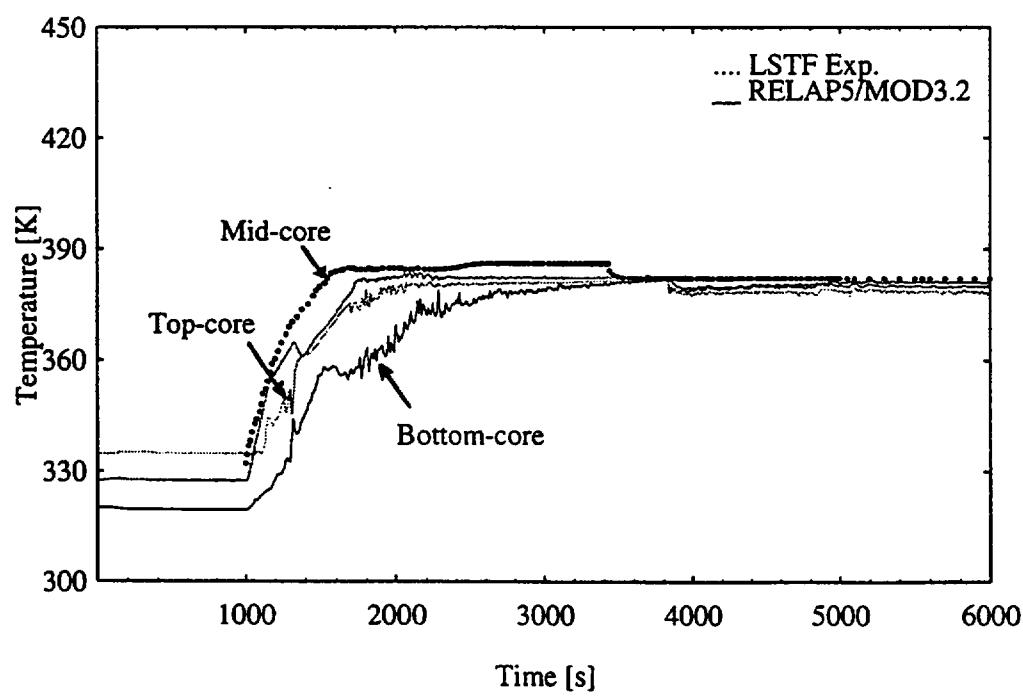


Fig. 9 Comparison of Liquid Temperatures in Core

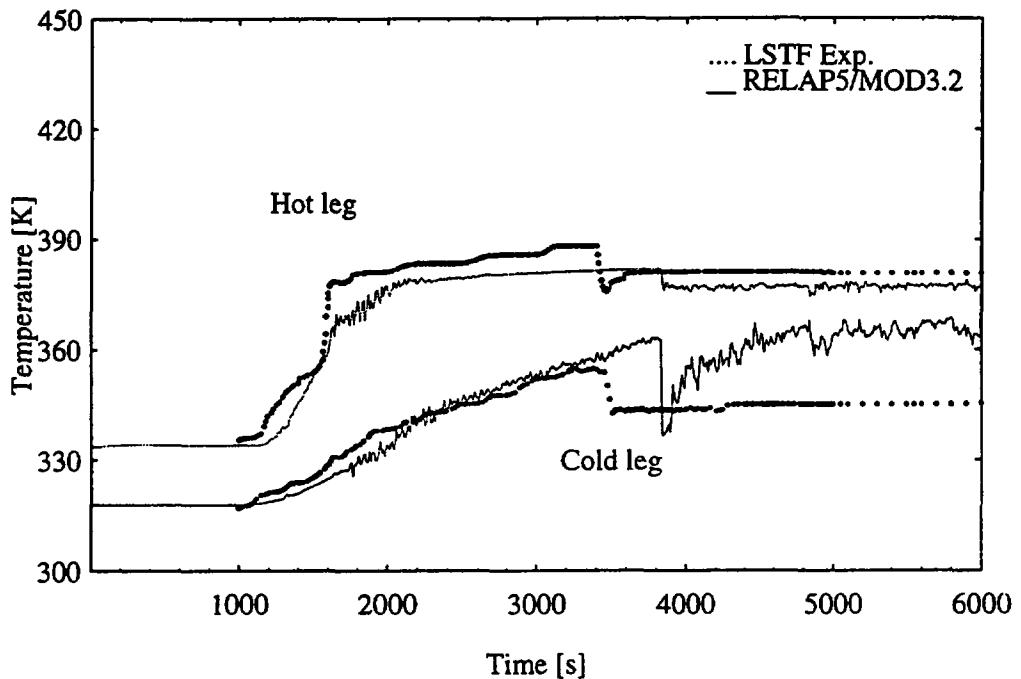


Fig. 10 Comparison of Fluid Temperatures at Hot and Cold legs in Intact Loop

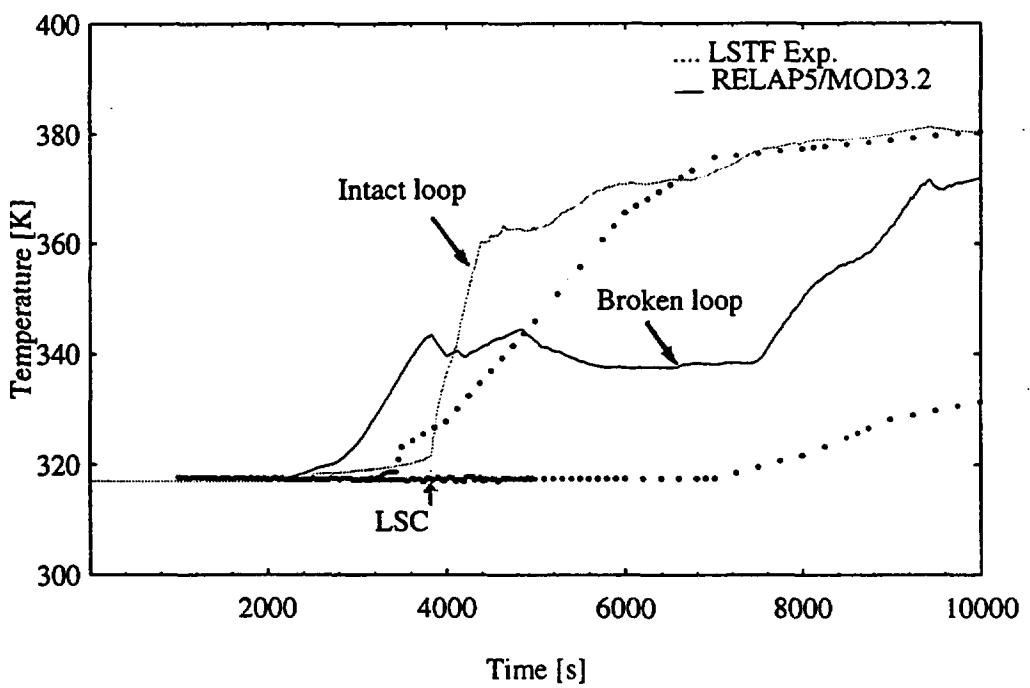


Fig. 11 Comparison of Water Temperatures in SG Secondary Side

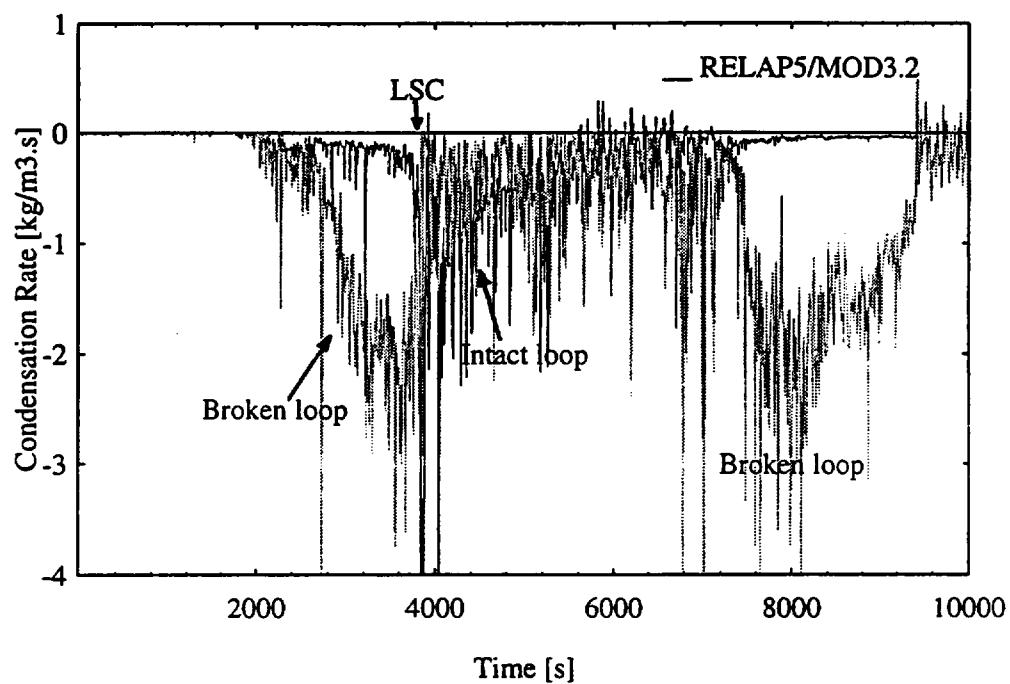


Fig. 12 The Calculated Condensation Rate on SG Inlet U-tube wall

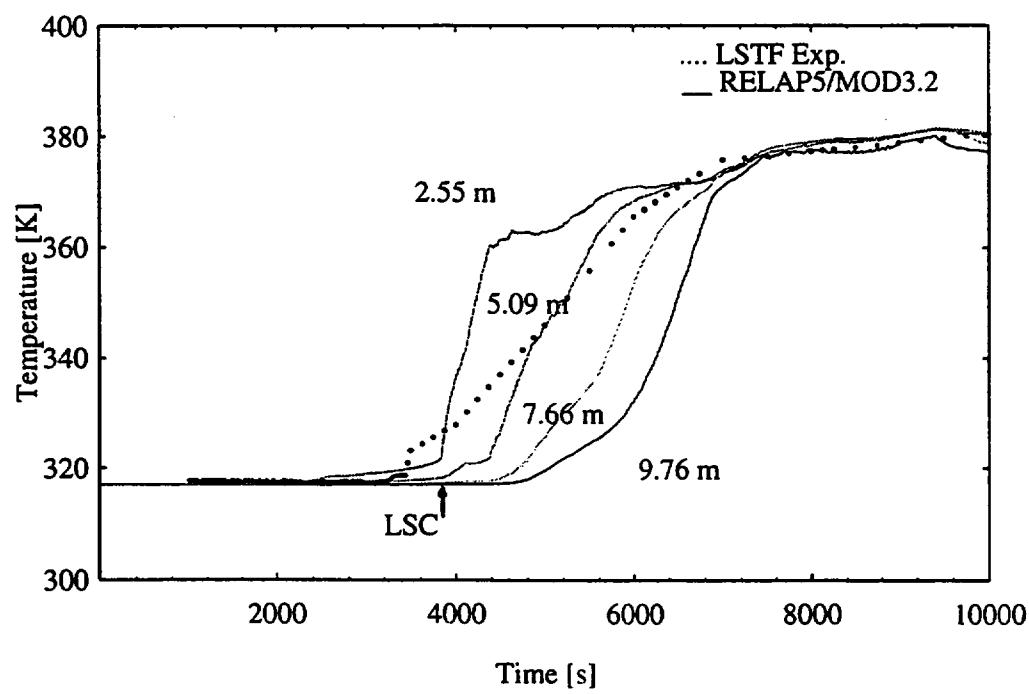


Fig. 13 Comparison of Water Temperatures with Elevation in SG Secondary Side

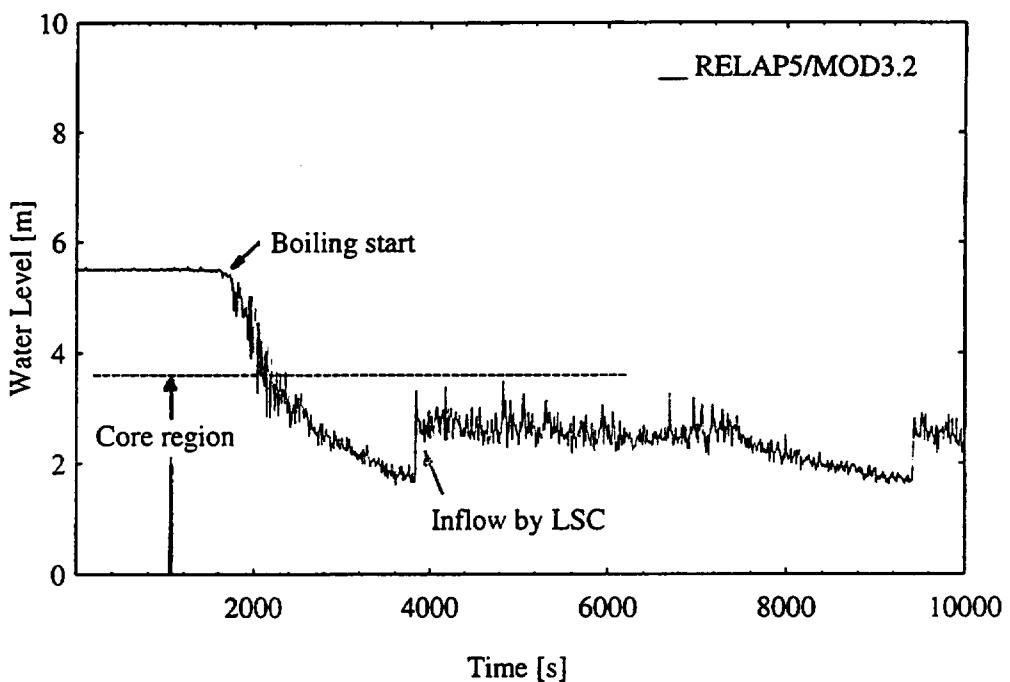


Fig. 14 The Collapsed Water Level in Reactor Pressure Vessel

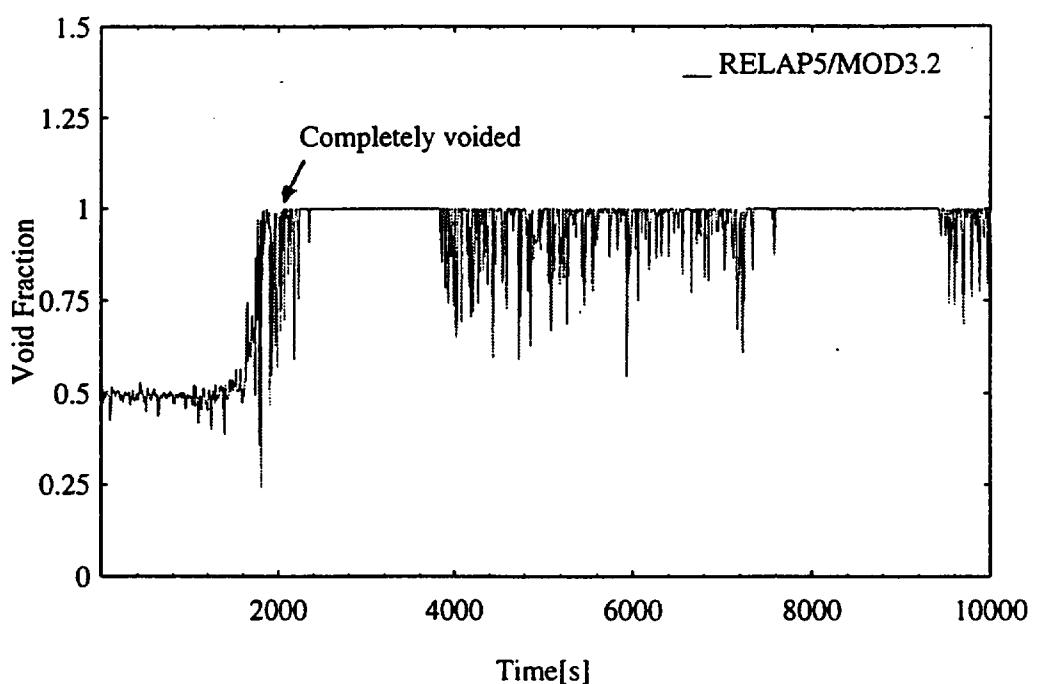


Fig. 15 The Calculated Void Fraction in Core Upper Plenum

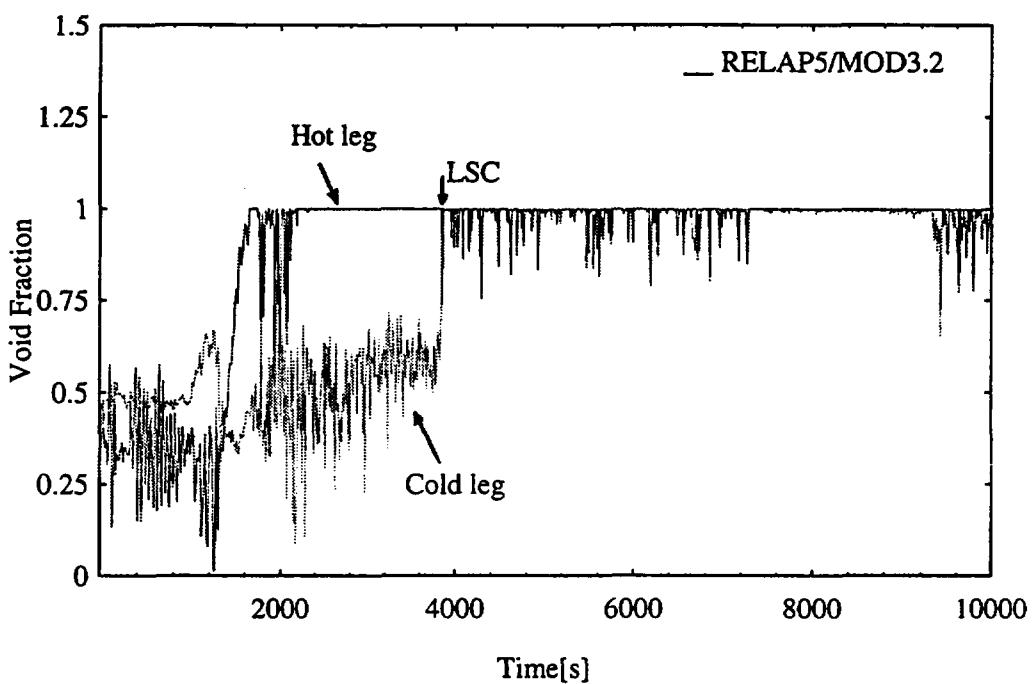


Fig. 16 The Calculated Void Fraction at Hot and Cold legs in Broken Loop

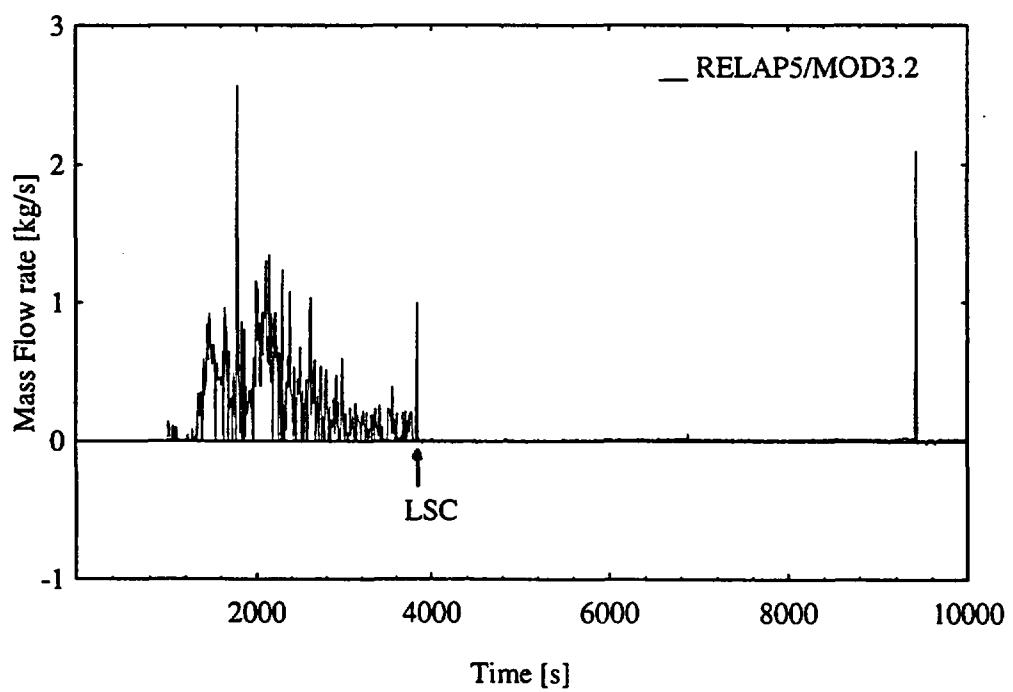


Fig. 17 The Break Flow Rate through the Cold leg Openning

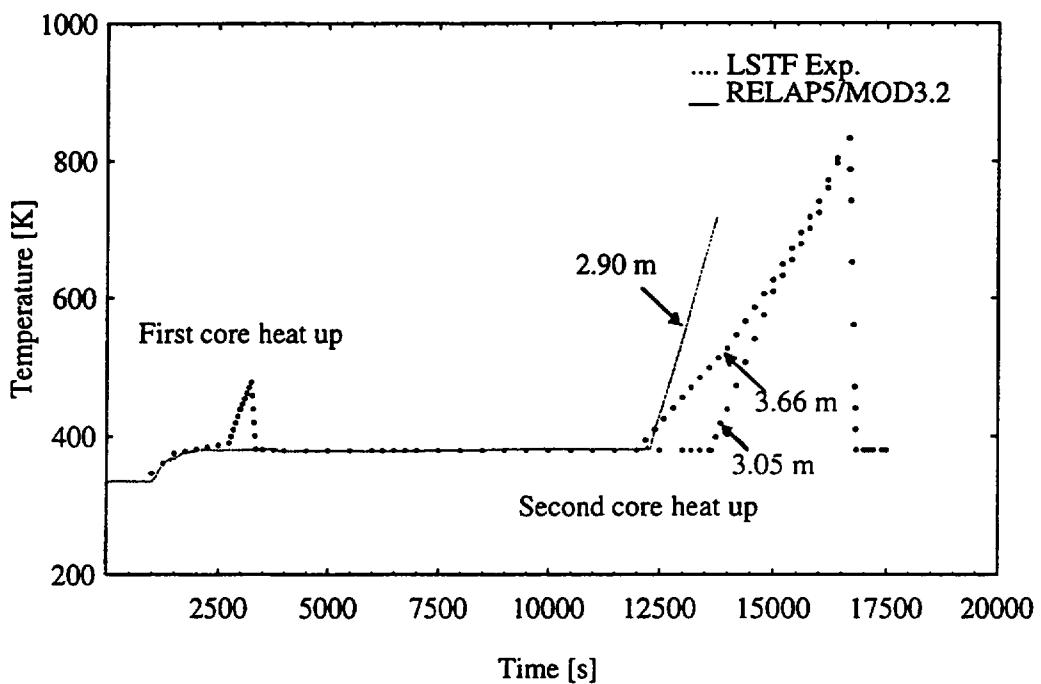


Fig. 18 Comparison of Fuel Cladding Temperatures

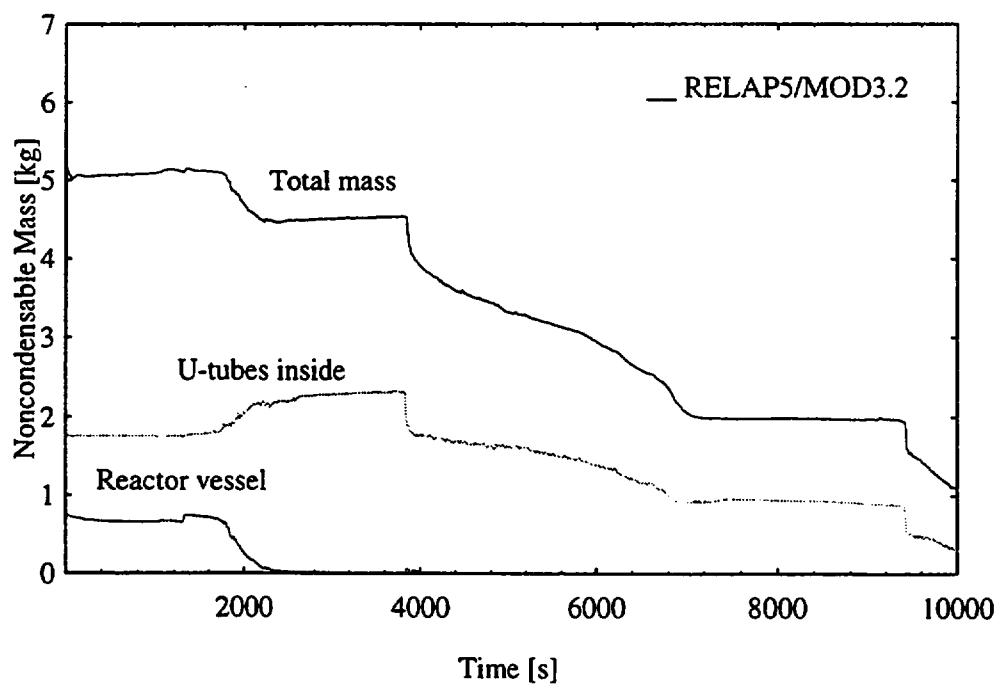


Fig. 19 The Calculated Noncondensable Mass in Primary System

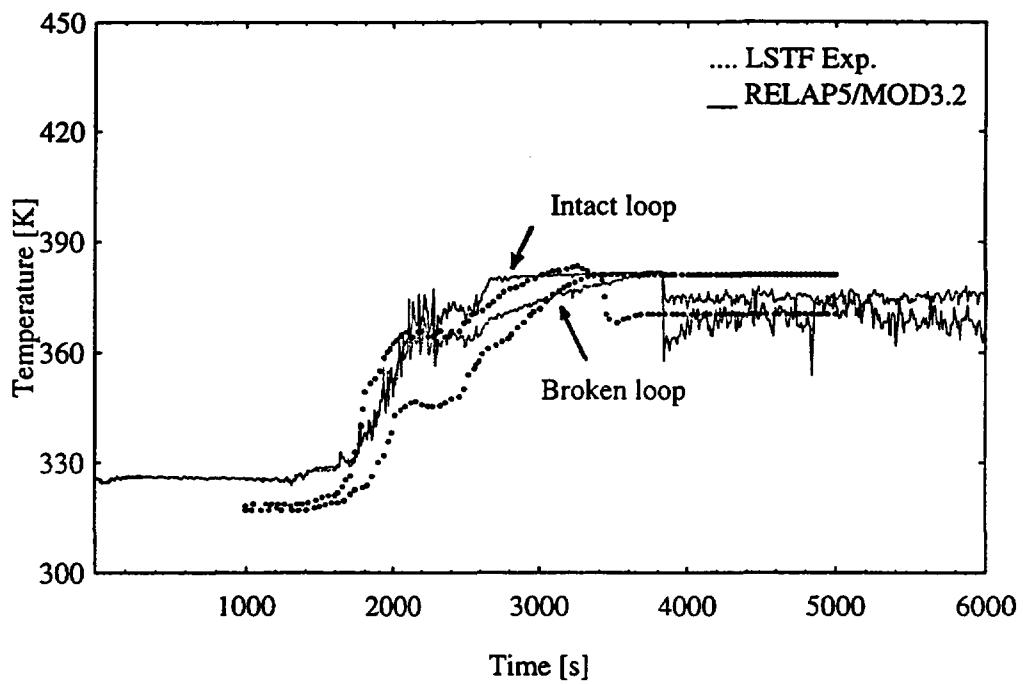


Fig. 20 Comparison of Steam Temperatures at SG Inlet Plenum

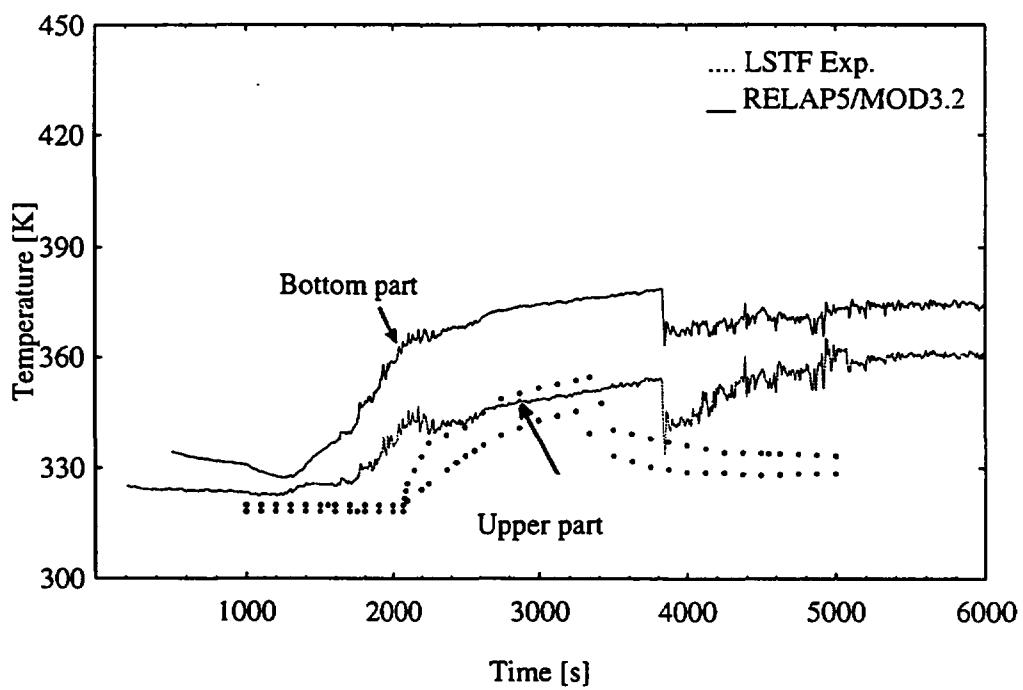


Fig. 21 Comparison of Steam Temperatures in Pressurizer

## **IV.3. Analysis Results for PRO Case**

### **IV.3.1. Pressure Responses**

Since the initial conditions in PRO case were nearly identical to the CLO case, the calculated transient had almost the same behavior until boiling in core was initiated. Due to steaming in the core, pressure in reactor vessel started to increase and core coolant moved into hot leg sides. Figure 22 shows comparison of the pressure behavior in core upper plenum with the experiment after the loss-of-RHR event occurred at 1000 seconds. A starting time of pressure increase and pressurization rate agreed well with the experiment but the maximum pressure was overpredicted a little. This difference was caused by an excessive vaporization in core region and by an overprediction of the water level in hot legs. Figure 23 shows that differential pressure between core bottom and upper plenum was quite underpredicted after the coolant boiling as compared to the experiment. In other words, the void fraction in the core region was overpredicted due to the excessive vaporization and voiding. As a result, the core coolant excessively moved toward hot leg sides by the steam volume expansion. Such an underprediction of the core coolant inventory could be also found in case of CLO calculation as shown in Fig. 8.

Because the hot legs were fully filled with the water for a longer time interval than in the experiment, the steam flow toward pressurizer was prevented by a water blockage in surge line during this period. Thus, the calculated pressure in upper plenum continued increasing for a longer time than in the experiment. As a result, the maximum pressure was overpredicted. When the steam flow path from the upper plenum to the pressurizer opening was formed due to the high pressure difference, the pressure stopped increasing and started to decrease rapidly. After the steam flow was stabilized, the pressure remained nearly constant. In this phase, the calculated agreed well with the experiment. Figure 24 shows that the discharging flow through the pressurizer opening started at about 3200 seconds, resulting in rapidly decreasing the pressure and the stable outflow was formed from about 4000 seconds, resulting in

keeping nearly the constant pressure. As a result, since the code unsatisfactorily overpredicted the coolant mass inventory in the hot legs, the surge line and core region, the calculated pressure resulted in overshooting the experiment in the rising phase of the pressure.

#### **IV.3.2. Thermal Responses**

Shown in Fig. 25 is comparison of liquid temperatures in hot leg of intact loop with the experiment and Fig. 26 shows fuel cladding temperatures in the eleventh node from bottom among the total of 12 nodes. Due to the loss-of-RHR, the calculated liquid temperatures increased rapidly in the early phase and overshot a little the experiment owing to the overprediction of pressure in reactor vessel. However, after the discharging flow through opening became stabilized from about 4000 seconds, it remained constant saturation temperature, which agreed well with the experiment. Liquid temperature in broken loop also had nearly the same behavior.

As the coolant was discharged through the pressurizer opening, the core coolant mass inventory decreased slowly as shown in Fig. 23. Such decreased core inventory caused an uncovered core and the core heat up, which occurred at 9400 seconds in the experiment. As described above, due to the underprediction of coolant inventory in the reactor vessel, the calculated heat up was initiated earlier by 3000 seconds than in the experiment as shown in Fig. 26. When the fuel cladding temperature exceeded 830 K, auxiliary feedwater was injected into the SG in intact loop to remove the heat energy in the experiment. The calculation also stopped at this fuel cladding temperature.

#### **IV.3.3. Water Level and Loop Behavior**

Due to excessively voiding in the core, the large amount of core coolant moved into hot legs and then the water level in the loop rised up to the top part of the hot leg. After filling up the hot leg, the water level in pressurizer started to increase rapidly by liquid insurge through surge line because the manway at the top of the pressurizer was opened. Figure 27 shows comparison of the collapsed water level in the pressurizer

with the experiment. The calculated water level started to increase a little later by 600 seconds and were quite overpredicted. As described above, the overshooting of the pressure resulted in the excessive and late rising of the water level. Figure 28 shows that the void fraction in the bottom part of the surge line became zero in the rising phase of pressure, i.e., the surge line was rapidly filled with water as the pressure increased to the maximum value. As a result, the overprediction of the water level in hot legs caused an overshooting of the water level in pressurizer. Even after the surge line was completely being emptied from about 4000 seconds, the calculated water level remained higher value, even though the pressure agreed well with the experiment. Such large water hold up in the pressurizer came from an overprediction of interfacial drag between two phases, because the relative velocities in the pressurizer were calculated very high, although the corresponding experimental data were not available.

Figures 29 and 30 show comparison of calculated mixture density in hot leg and cold leg with those in the experiment. They show clearly that the water level reached to the top part of the hot leg and remained the full level for a longer time period, for over 1000 seconds, even with severe oscillations during this phase. Whereas the experiment shows that the water level in the hot leg rapidly dropped at about 1600 seconds and the hot leg was not fully filled with the water throughout almost transient. As described above, the reason for the overprediction of the water level in the hot legs was the excessive inflow of the core coolant from the reactor vessel. These figures also show that the coolant in the loop was completely emptied at 4000 seconds earlier than in the experiment. Figure 31 also shows that the void fraction at hot legs in broken loop became nearly 1.0 about 4000 seconds when the discharging flow was stabilized. It implies that the discharged mass flow through the opening was overpredicted, but unfortunately the data on the discharged flow rate was not available. Anyway, such an overprediction of the discharged flow rate caused earlier heat up in the core region as shown in Fig. 26.

In this assessment, the surge line pipe was simply modelled 3 horizontal nodes with inclined angle of 30 ~ 40 degree, whereas it has actually complicated geometry. For

sensitivity study, a model with 9 horizontal and vertical nodes for the surge line was attempted to assess. However, there were no significant differences in the calculation results. As shown in Fig. 32, the surge line had horizontal stratified flow (HSF) regime in the early phase because the mass flux is very small. The bubbly flow (BF) was intermittently formed from 2200 seconds before the liquid inflow into pressurizer was formed. Because the HSF and BF with void fraction of almost zero prevented the steam flow toward pressurizer opening from the hot legs, the pressure in hot leg side continued to increase until the steam flow was formed by sufficient differential pressure. When the water level in hot leg dropped sufficiently at about 3300 seconds, the gas velocity in the surge line started to increase as shown in Fig. 33. The sufficient gas velocity hold up the water in the pressurizer and the steam generated in the core was stably discharged through pressurizer opening. In the experiment, the measured void fraction, even though the data was not available, showed that the surge line horizontal part was generally steam-filled throughout almost transient and the flow regime might be mist or annular mist flow where liquid is carried away by the gas flow. As a consequence, the code unsatisfactorily predicted the flow pattern in the loop including the surge line, especially in the rising phase of pressure, because of the incorrect prediction of the coolant inventory in the hot legs and the core region. Eventually, the steam flow path through the surge line was established a little later and the liquid hold up and water level in the pressurizer were overpredicted.

#### IV.3.4. Noncondensable gas behavior

Figure 34 shows noncondensable gas behavior during the transient. The initial total mass of 5.22 kg existed in primary system and decreased rapidly just after the steam flow toward pressurizer opening was formed at about 3400 seconds. The experiment showed that the gas flow in the hot leg was multi-dimensional when the net flow was very small, with air-rich gas stagnating at the pipe bottom and steam flow creeping only the ceiling towards the SG. However, steam condensation did not occur in the SG U-tubes wall since the tubes were still filled with an air and the secondary sides of U-tubes were completely emptied. Thus the rapid change of the air fraction in SG U-tubes

was not occurred, whereas it occurred just after the loop seal clearing in the CLO case. It implies that the effect of noncondensable gas was not important in the PRO case because the steam condensation phenomena was not dominant during all the transient.

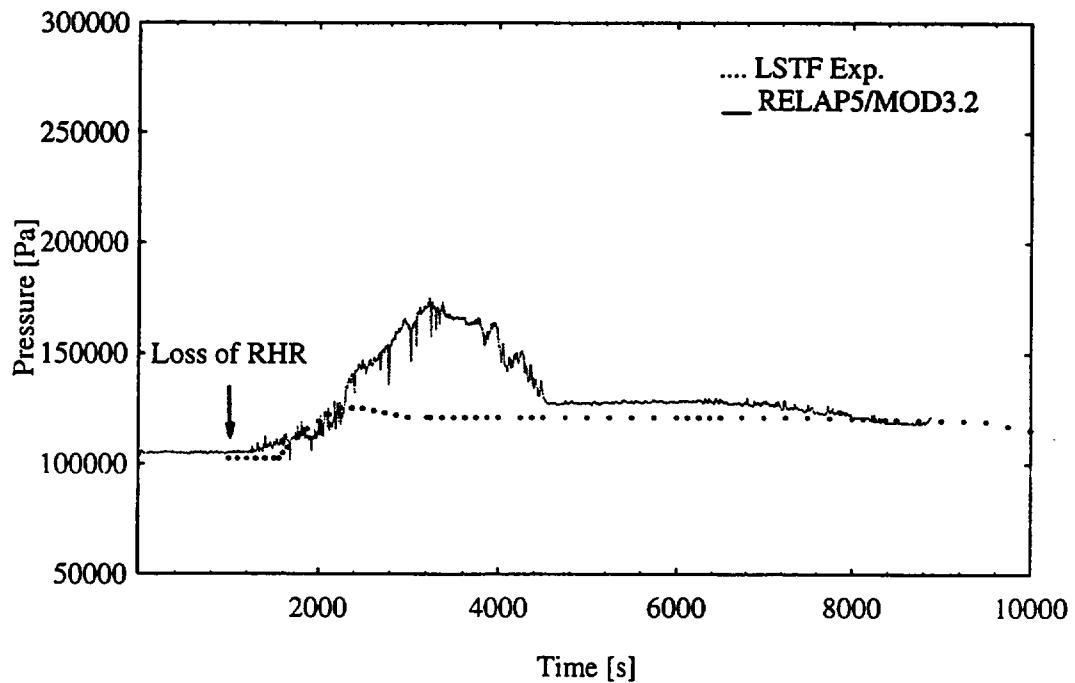


Fig.22 Comparison of Pressures in Core Upper Plenum

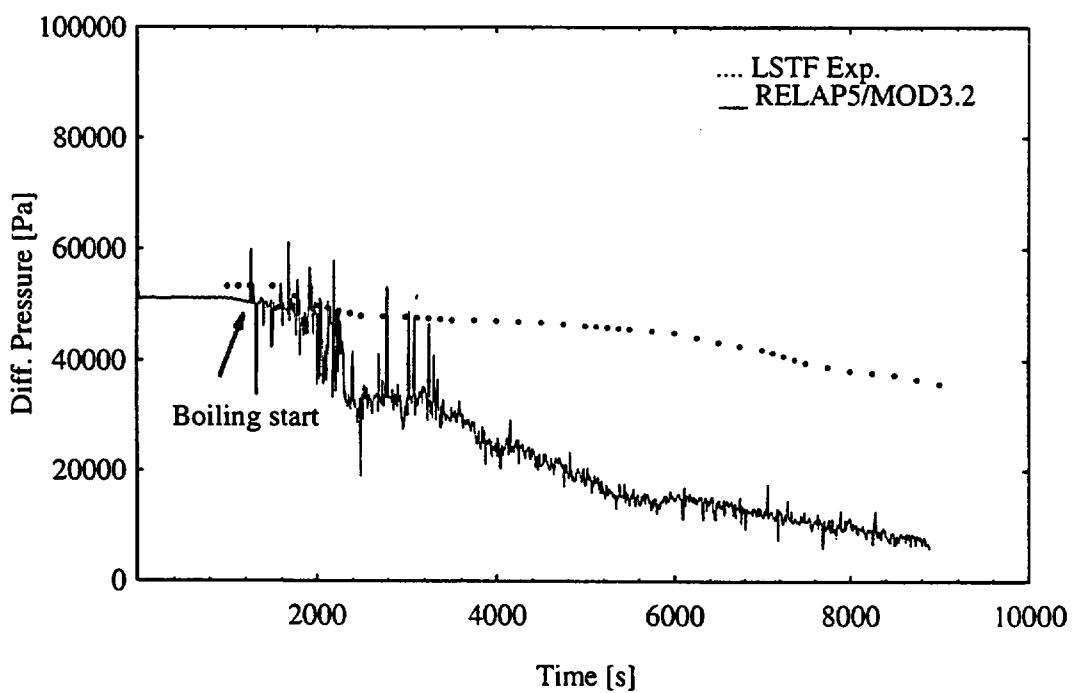


Fig.23 Comparison of Differential Pressures Between Core Bottom and Upper Plenum

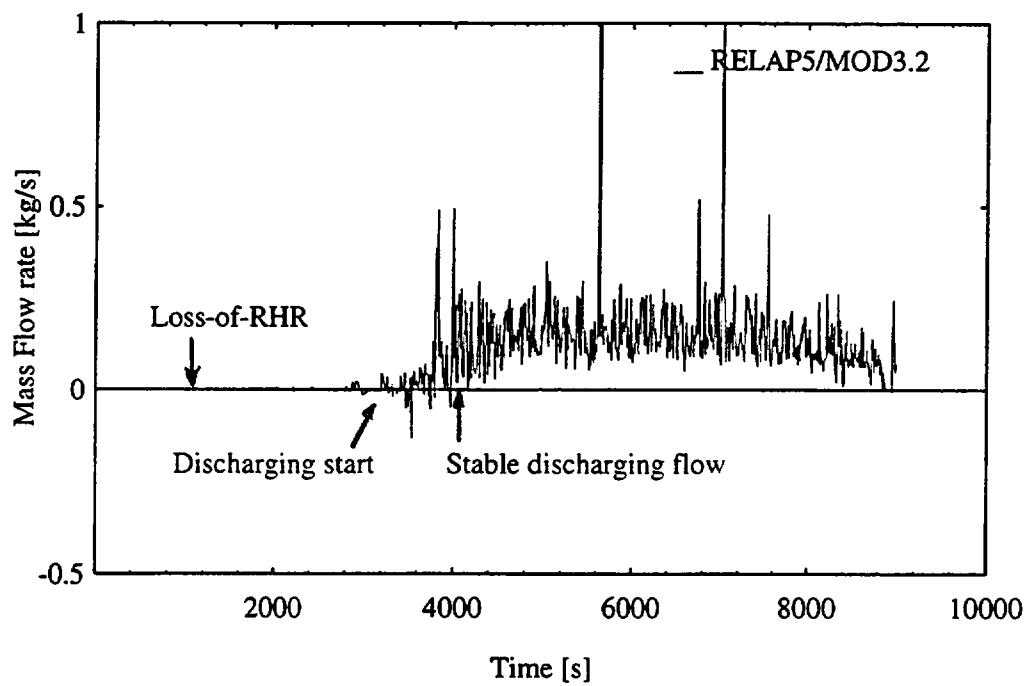


Fig. 24 The Discharged Flow Rate Through Pressurizer Manway Openning

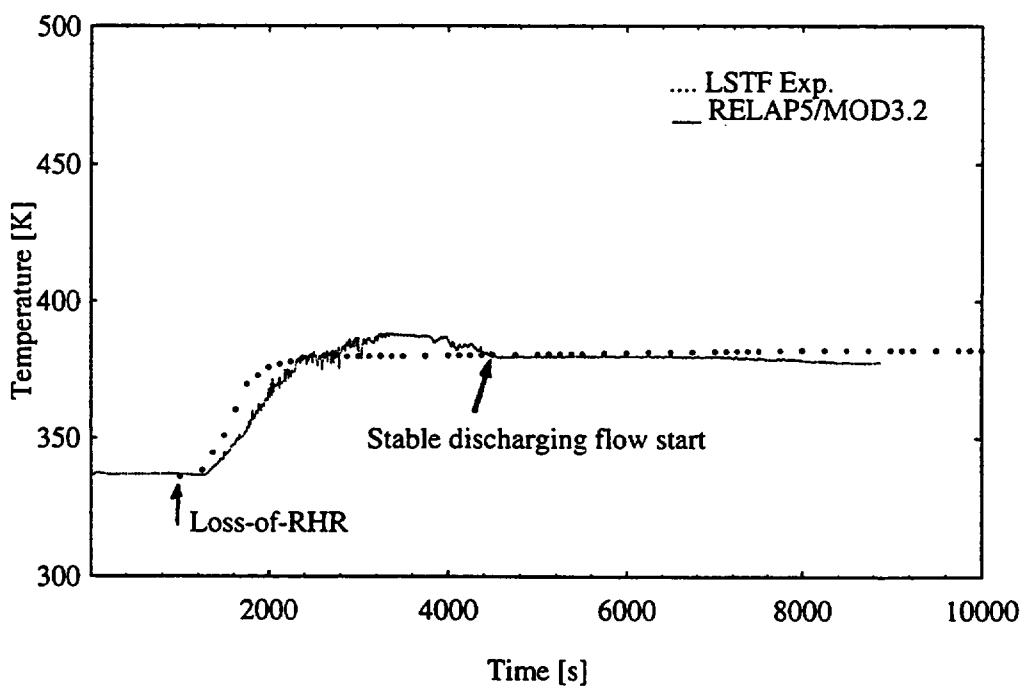


Fig. 25 Comparison of Liquid Temperatures at Hot leg in Intact Loop

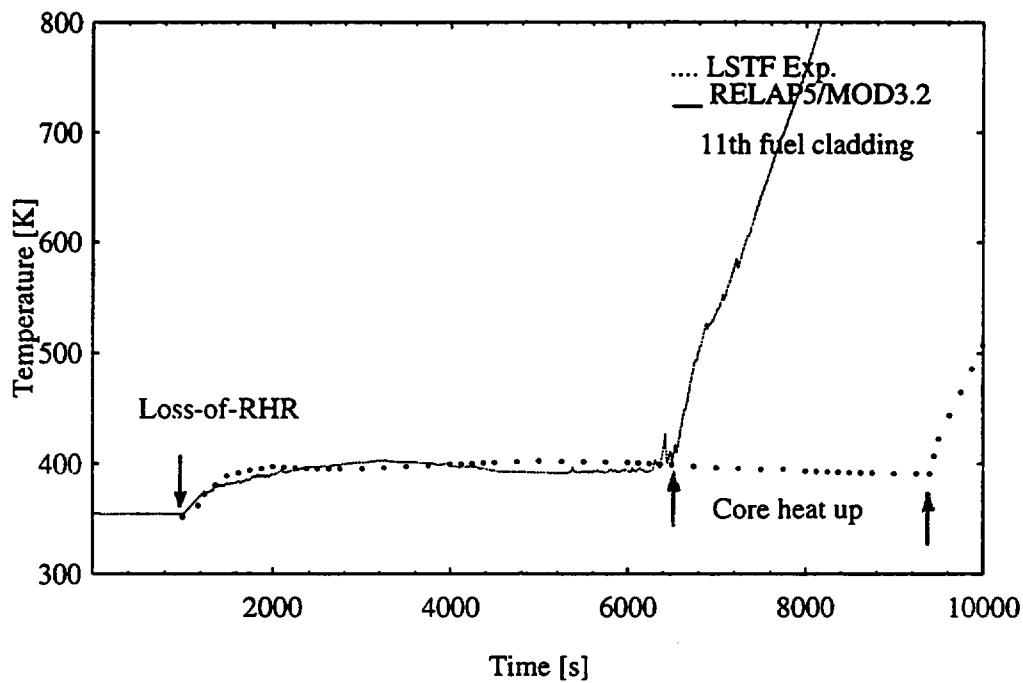


Fig. 26 Comparison of Fuel Cladding Temperatures

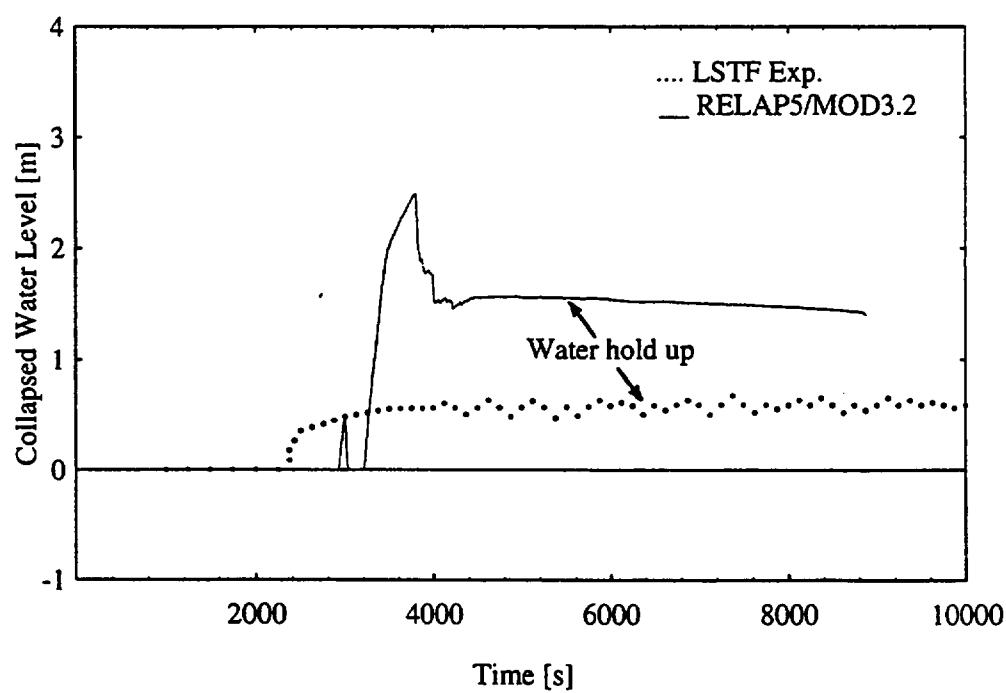


Fig. 27 Comparison of Collapsed Water Levels in Pressurizer

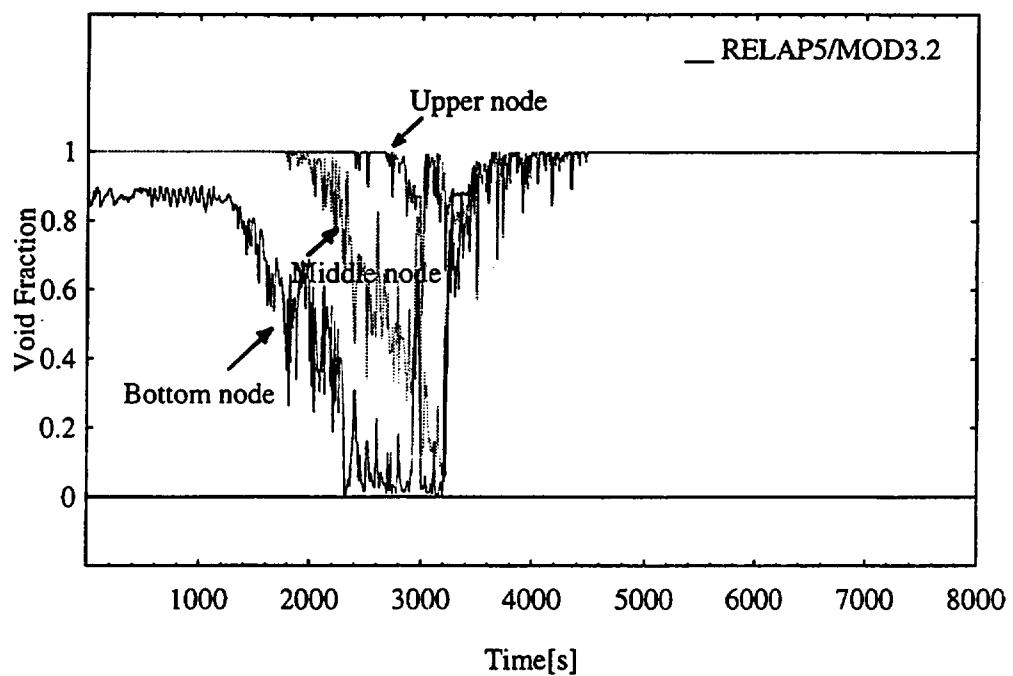


Fig. 28 The Calculated Void Fractions in Surge Line

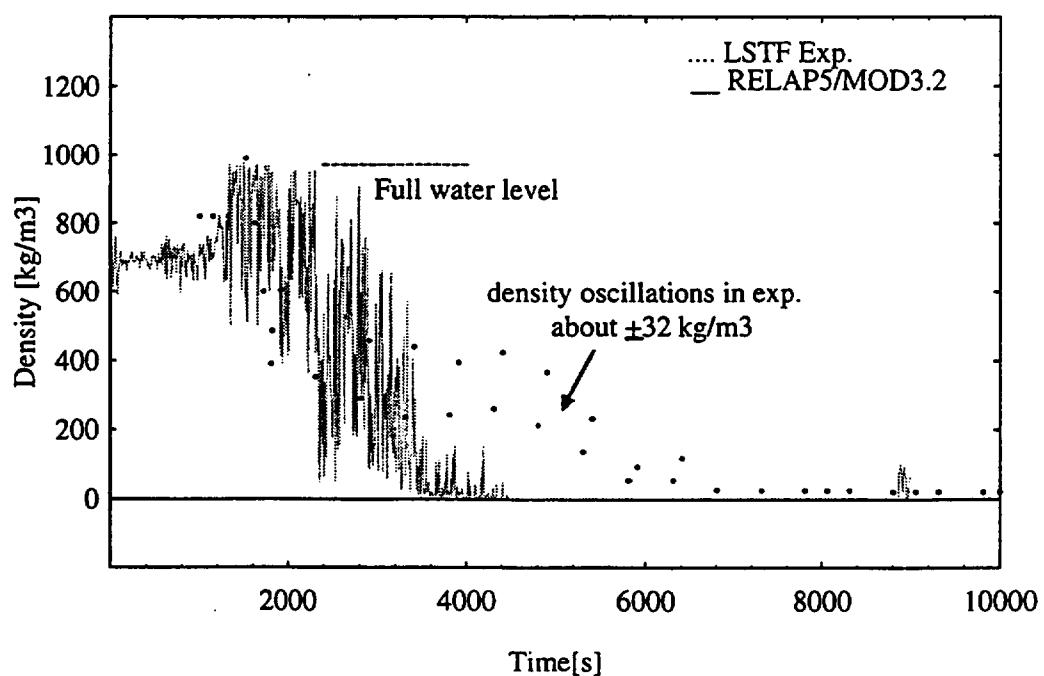


Fig. 29 The Calculated Fluid Density at Hot Leg in Broken Loop

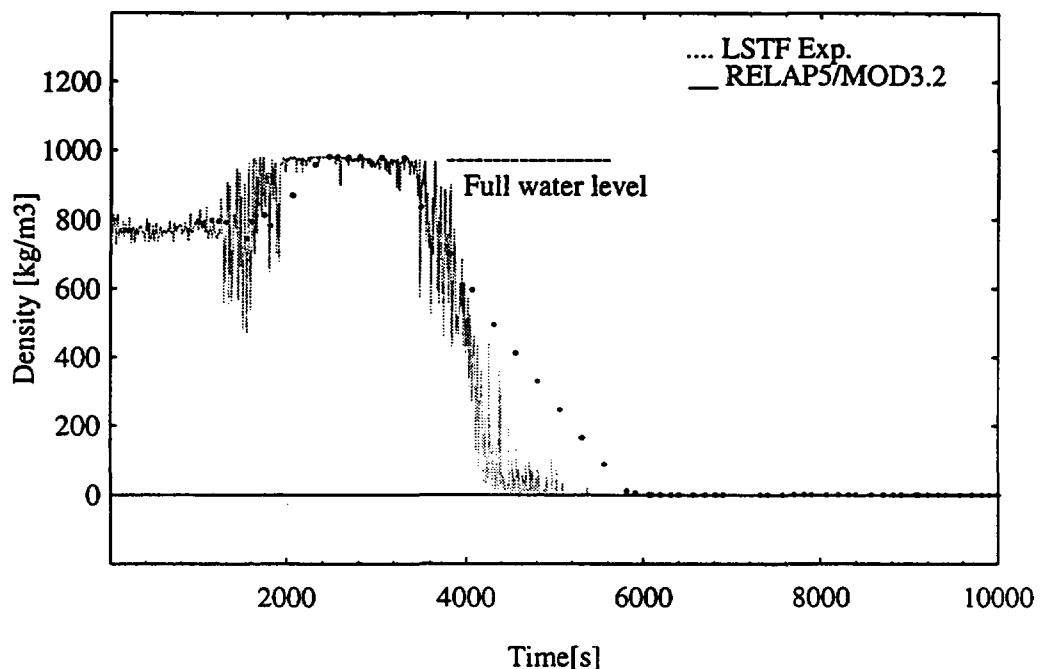


Fig. 30 The Calculated Fluid Density at Cold Leg in Broken Loop

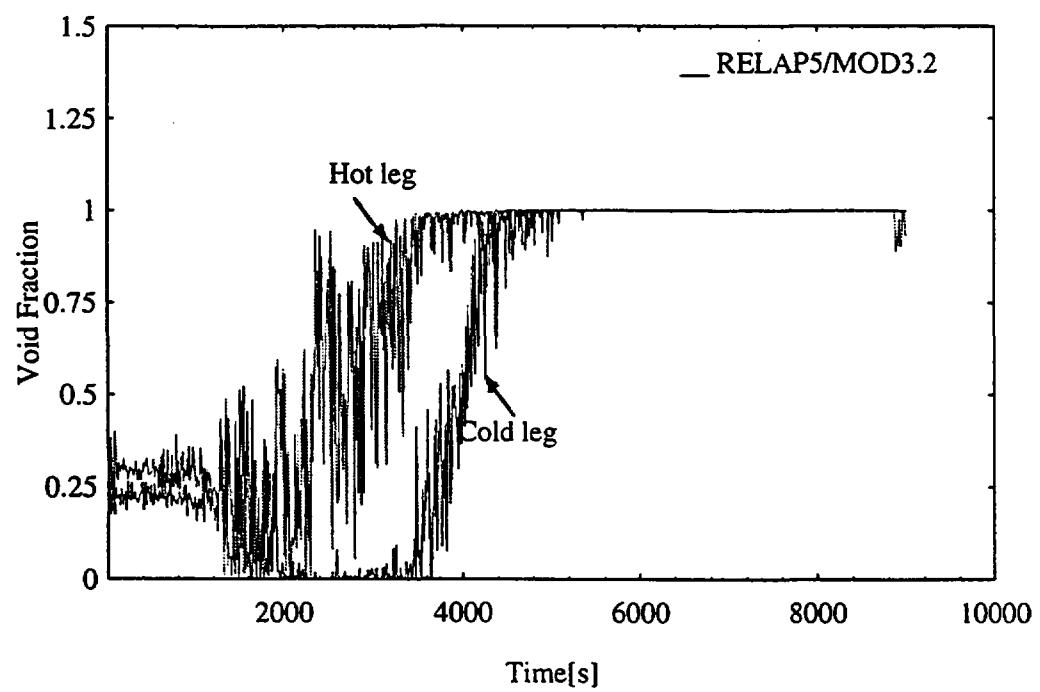


Fig. 31 The Calculated Void Fractions at Hot and Cold legs in Broken Loop

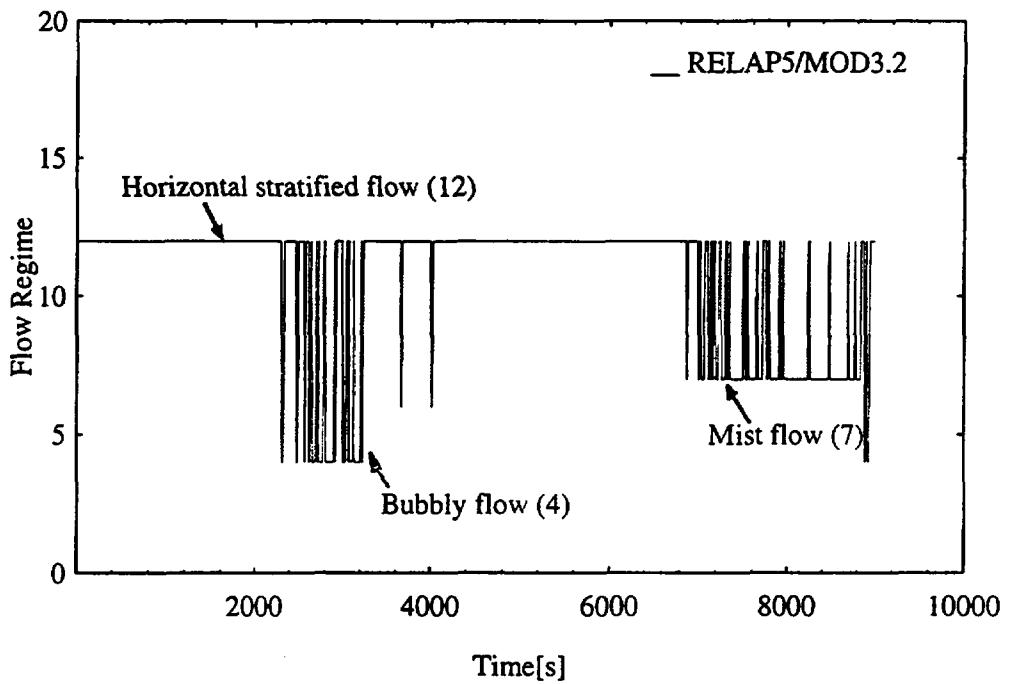


Fig. 32 Flow Regimes in Surge Line

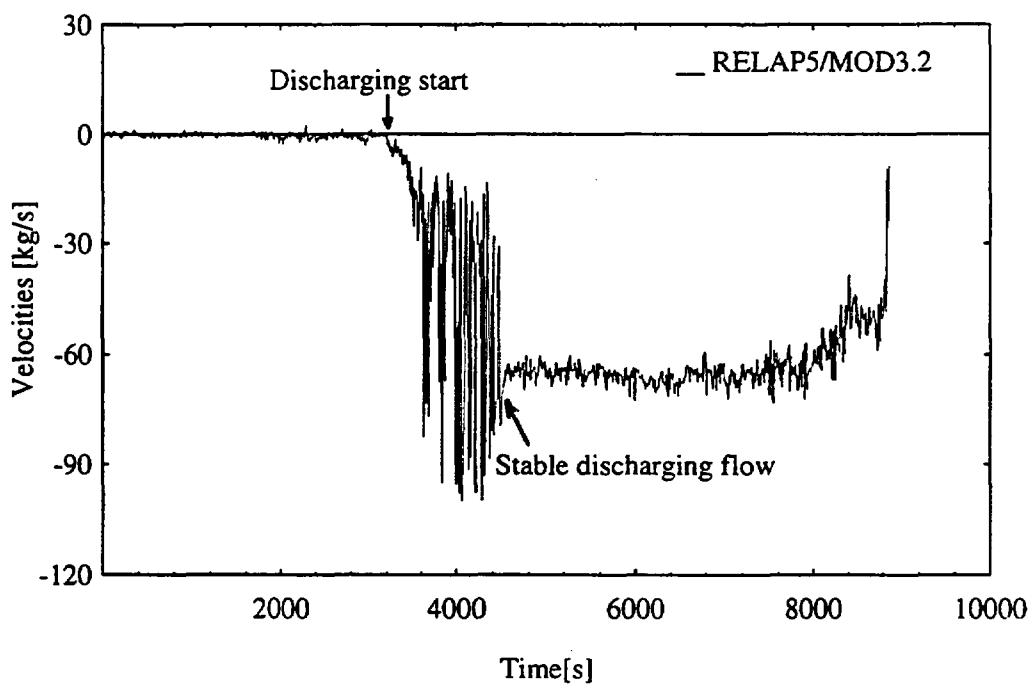


Fig. 33 The Calculated Gas Velocity in Surge Line

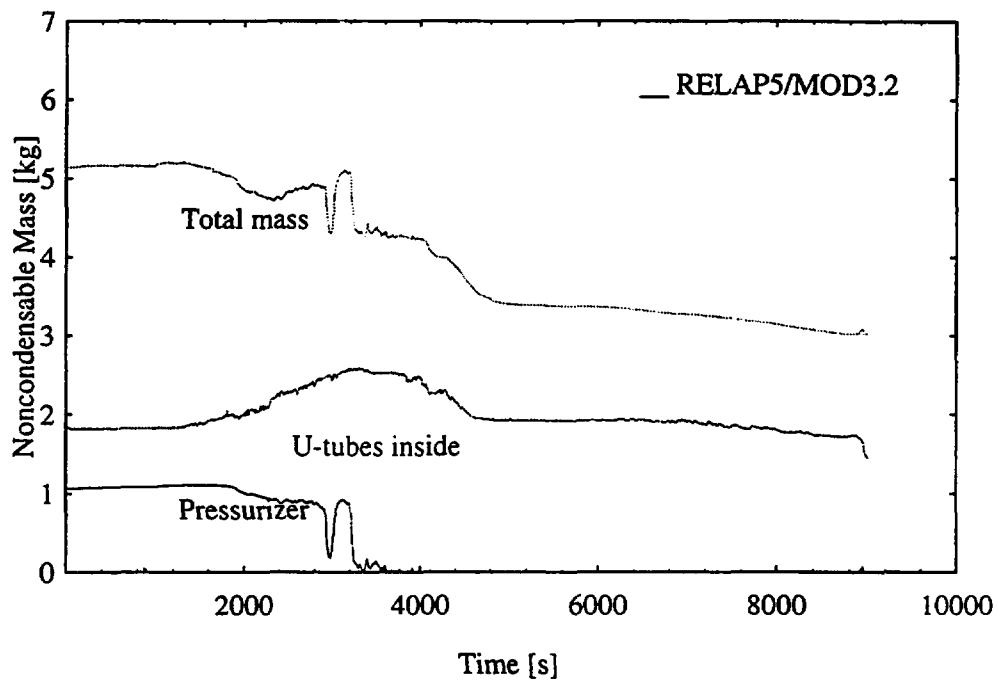


Fig. 34 The Calculated Noncondensable Mass in Primary System

## **IV.4. Discussion**

### **IV.4.1. CPU time and Mass Error**

There have been many difficulties in getting convergence of transient calculation following the loss-of-RHR event during the mid-loop operation. In particular, it was difficult for the code to calculate the transport process of the mixture gas phase involving noncondensable gas under low flow and low pressure conditions. When the noncondensable gases enter a volume which was filled with steam, the extremely small size of time step was required and the long CPU time was consumed. For example, the calculation performed by H. Nakamura et. al. [3], using the RELAP5/MOD3 v5m5 code on FACOM M-780/20 scalar computer, took CPU time of 37.2 hours to simulate the transient of 3831 seconds. Also, the calculation performed by S. Banerjee et. al. [4] took over 60 hours of CPU time for the same transient of 3040 seconds, even using the CRAY-YMP super-computer. In addition, those calculations were halted at transient time of less than 4000 seconds and eventually the long term system behavior could not be analyzed.

In present calculation using the RELAP5/MOD3.2 version on a DEC station 5000/240, it just took the CPU time of about 6 hours to simulate the transient of 3500 seconds, which is nearly 10 times fast. Table 6 shows comparison of the computational times for the CLO case. Figure 35 shows the required CPU times for the CLO and PRO cases. Transient run started at 1000 seconds and the running was successfully performed without any failure during the transient calculation. The calculated shows that the two channel core model required more CPU time of 1.3 times than the single channel core model, but similar CPU time was required for both cold leg opening (CLO) case and pressurizer opening (PRO) case.

As a result, the present study showed that the MOD3.2 version was capable of simulating the thermal hydraulic processes including noncondensable gases with appropriate time step and CPU time following the loss-of-RHR event during the reduced inventory operation. Even though there were still some flow oscillations, the

major phenomena such as a loop seal clearing and a gas migration during the transient were well predicted with appropriate computational speed.

Table 7. Comparison of the Computational Times

Items	Nakamura et. al.[3]	Banerjee et. al. [4]	Present
▪ Code	RELAP5/MOD3/5m5	RELAP5/MOD3/5m5	RELAP5/MOD3.2
▪ Machine	FACOM M-780/20 Scalar computer	CRAY-YMP Super computer	DEC-5000/240 Workstation
▪ Transition time	3831 sec.	3040 sec.	3500 sec.
▪ CUP time	37.2 hours	60 hours	6 hours
▪ Core model	two channel	single channle	two channel
▪ Max. time step	N/A	0.005 sec.	0.1 sec.
▪ Mass error	N/A	N/A	43 kg

In addition to the computational time problem, it has been known that the RELAP5/MOD3 code predicts too large system mass errors during the transient under low power and low flow conditions. In general, this excessive mass error is caused by several situations such as the truncation errors in the linearization procedures, the use of incorrect properties in the numerical scheme, the first appearance of noncondensable gas in a volume and so on. In order to mitigate the mass error in RELAP5/MOD3 code, if the excessive mass error is detected, the time step is repeated at a reduced interval. The system mass error,  $\varepsilon_{srm}$ , is given as nondimensional form as follows:

$$\varepsilon_{srm} = 2 \sum_{i=1}^N [V_i(\rho_i - \rho_{mi})]^2 / \sum_{i=1}^N (V_i \rho_i)^2$$

where  $\rho_i$  and  $\rho_{mi}$  are the total density of the i-th volume obtained from the state relationship and the mass continuity equation, respectively. The  $V_i$  is the element volume and N is the number of the volume.

In present calculation for both cases with two channel core model, the mass error in primary system was estimated about 90 ~ 100 kg, that was nearly 4 % of initial coolant mass inventory for the transient of 2.8 hours. Figure 36 shows the estimated mass errors behavior with the transient time. The mass error was rapidly generated for the early phase of coolant boiling and thereafter it gradually rised. Because the large mass error could significantly reduce the reliability of the calculational data, these mass errors should be reduced to the negligible value. Therefore, a numeric scheme to remove reasonably the mass errors should be considered and developed in the RELAP/MOD3.2 version.

#### IV.4.2. Effect of Core Nodalization

The nodalization scheme in core is known to have influence on calculation time and thermal hydraulic behavior in primary system [3]. In this assessment, two type of core nodes were considered for a sensitivity study as shown in Fig. 3. As discussed above section, two channel core model required a little more CPU time and caused a little larger mass error than the single channel core model. In addition to the computational time, two channel core model could provide somehow the resolution of the problems resulted from one-dimensional nature of the RELAP5 code such as negligence of natural circulation flow in the core region during the coolant boiling phase. Adversely, it could also give an unrealistic flow behavior such as too fast circulation flows or incorrect flow direction in the core. Figure 37 shows the mass flow rate at mid-core junction for the case of two channel core model. After the loss of RHR event at 1000 seconds, the natural circulation flow was formed during about 700 seconds. Thereafter, there was severe flow oscillations of the vertical and horizontal direction, which did not occurred in the experiment. In case of single channel core model, there was no natural circulation flow but more severe flow oscillations of the vertical direction occurred. These flow oscillations were caused by void oscillations in the core region. The PRO case also showed similar flow oscillations. As a result, it can be stated that the code unsatisfactorily predicted the flow behavior in the core region under low flow and low power conditions.

In spite of the unrealistic flow behavior, the two channel nodalization gave a little more stable flow than the single channel noding and well predicted the coolant mixing in the reactor vessel due to the natural circulation flow. Figure 38 shows the liquid temperatures in core upper plenum for the CLO case. It represents clearly that the two channel core model agreed with the experiment better than the single channel core model. It implies that the multi-dimensional flow characteristic in the core region was compensated by the two channel core nodalization because the fluid in the core was well mixed by the natural circulation flow. Thus, the two channel core predicted a little close to the experiment the major phenomena such as the onset of boiling and the timing of loop seal clearing.

#### IV.5 Run Statistics

The main computer used in the present calculation was a DEC workstation 5000/240 with UNIX operating system. The required CPU time for the CLO and PRO cases following the loss-of-RHR event was shown in Fig. 35. Figures 39 and 40 show the Courant time limit and advanced time step size with respect to a real transient time for both cases. The maximum time step size was 0.1 second for all the transient and the calculation was runned reasonably with time step below the Courant Limit. For example, the required CPU time to simulate the transient time of 10,000 seconds was 165,222 seconds including 8.7 seconds for input processing for CLO case with two channel core node. The attempted advancement was 228,694 time steps. For the PRO case with single channel core, the required CPU time for the transient of 8,000 seconds was 83,522.7 seconds and the attempted advancement was 153,949 time steps. Therefore, the grind times of both cases can be calculated as follows;

##### (1) For CLO-Two channel core model case

- CPU time                       $CPU = 165,222.0 - 8.7 = 165,213.3 \text{ sec}$
- Number of time step         $DT = 238,730 - 10,036 = 228,694$
- Number of Volume             $C = 179$

- Transient Real Time	$RT = 10,000 \text{ sec}$
- Grind Time	$GT = CPU \times 1000 / (CxDT) = 4.036 \text{ CPU msec/vol/step}$

(2) For PRO-Single channel core model case

- CPU time	$CPU = 83,522.7 - 8.0 = 83,514.7 \text{ sec}$
- Number of time step	$DT = 153,949 - 10,059 = 143,890$
- Number of Volume	$C = 158$
- Transient Real Time	$RT = 8,000 \text{ sec}$
- Grind Time	$GT = CPU \times 1000 / (CxDT) = 3.673 \text{ CPU msec/vol/step}$

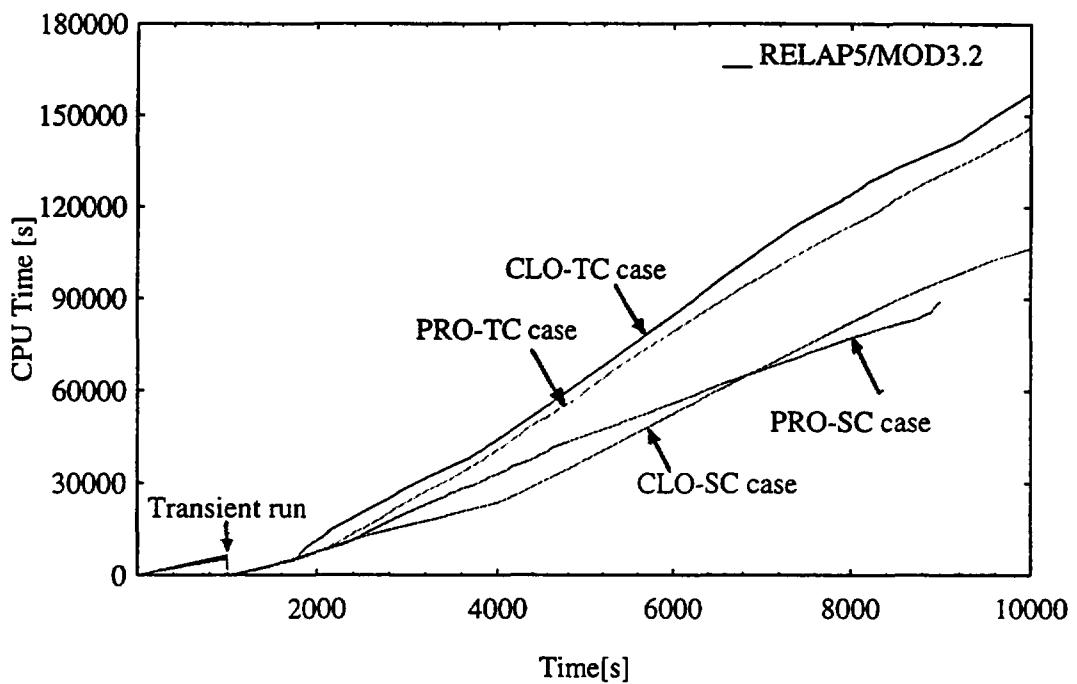


Fig. 35 The CPU Times for CLO and PRO Cases

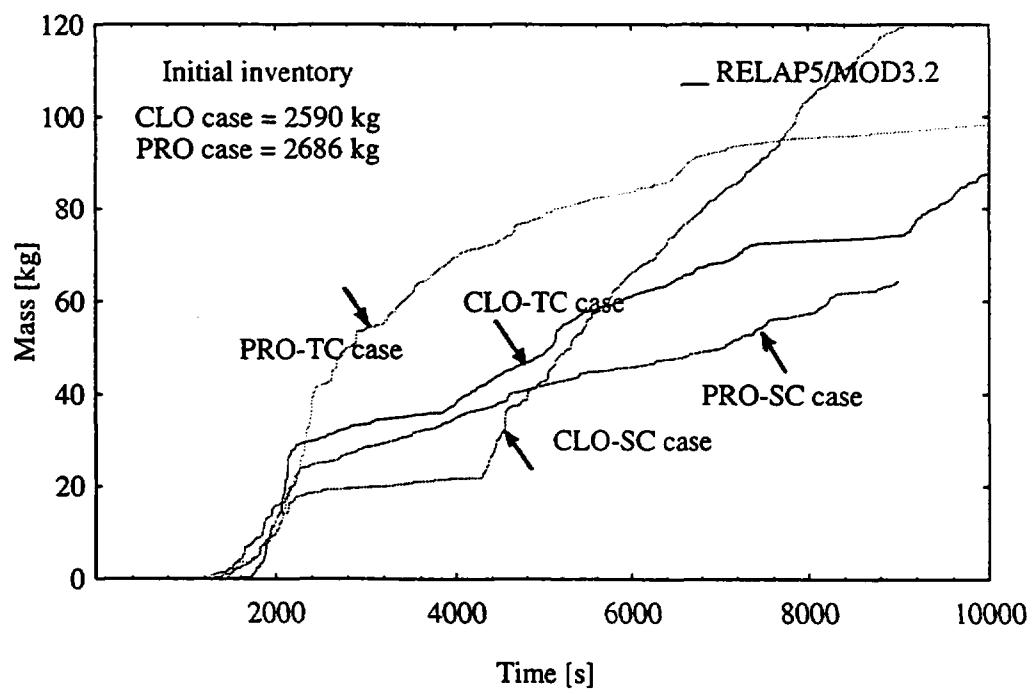


Fig. 36 The Estimated Mass Errors for CLO and PRO Cases

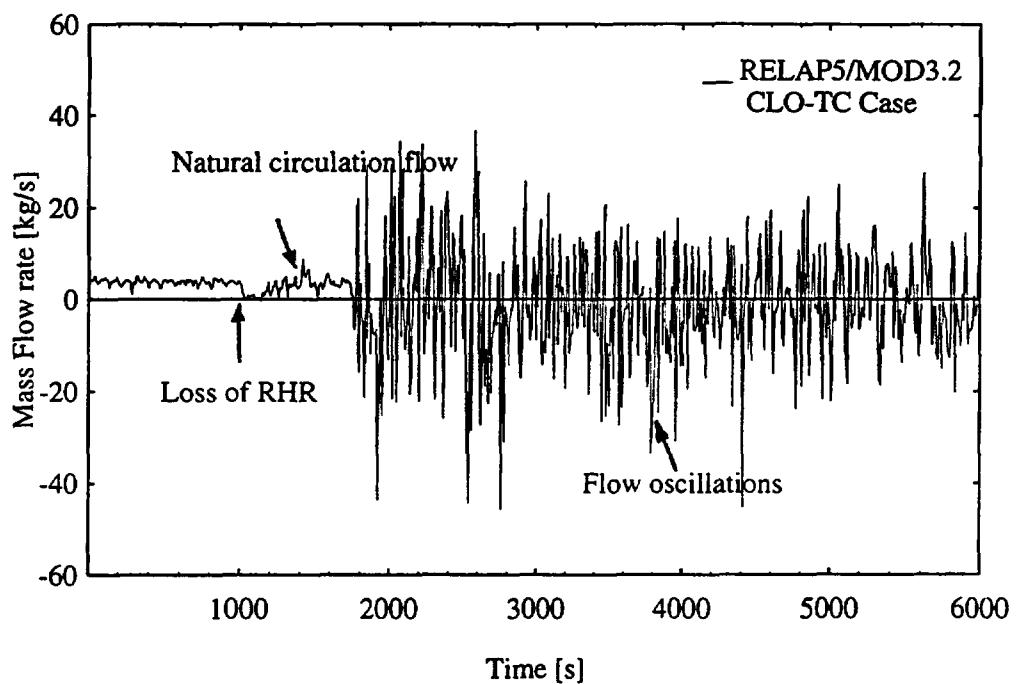


Fig. 37 The Calculated Flow rate at Mid-Core Junction

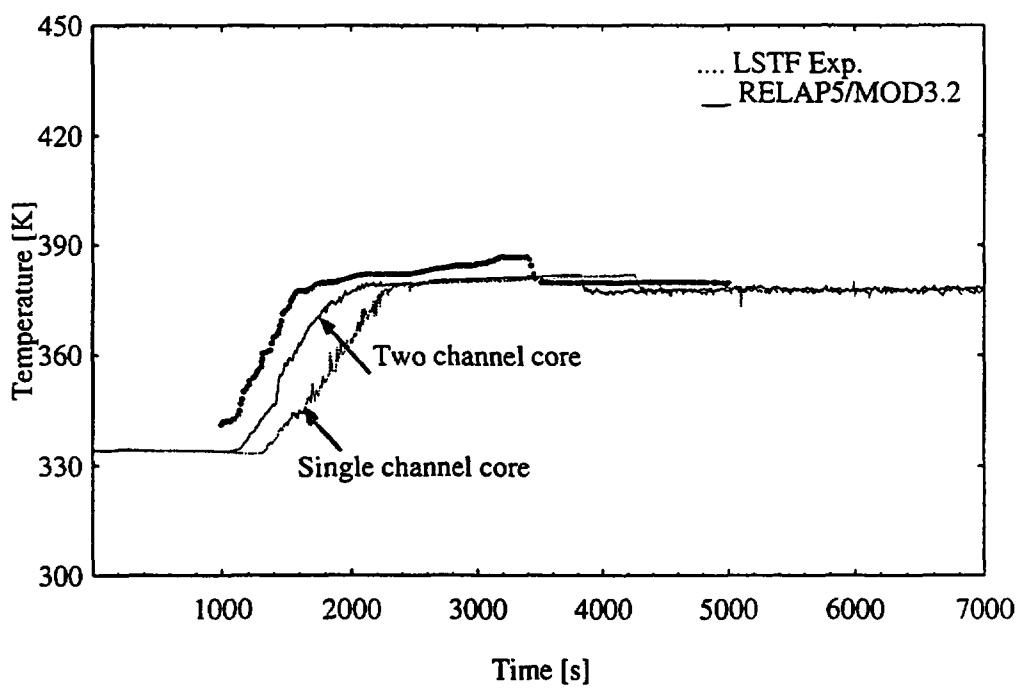


Fig. 38 Comparison of Fluid Temperatures in Core Upper Plenum

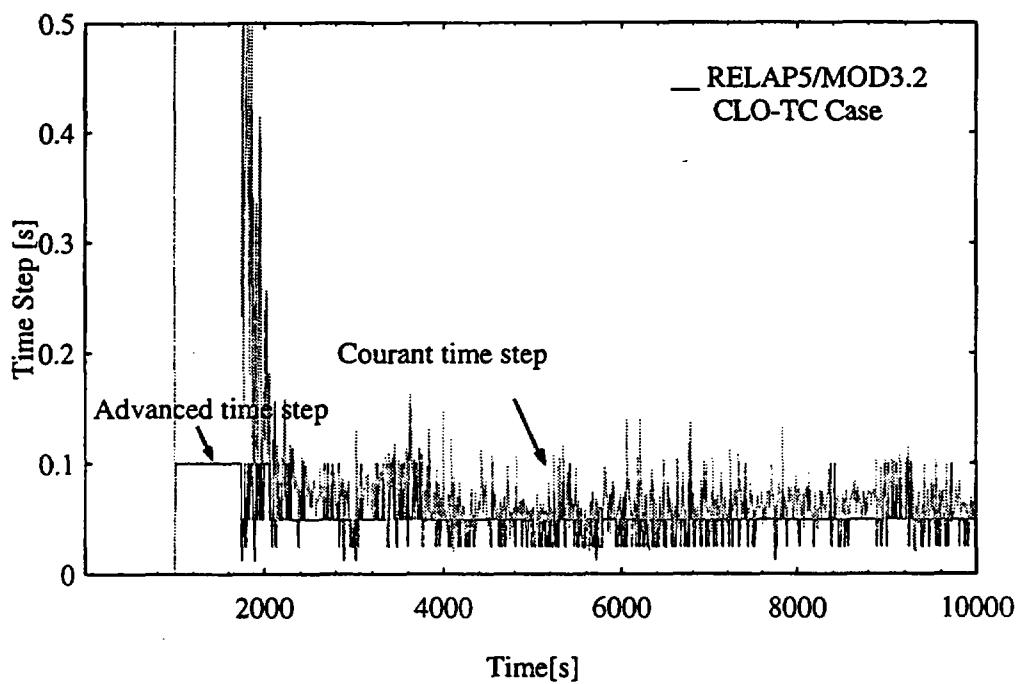


Fig. 39 The Advanced Time Step for CLO Case

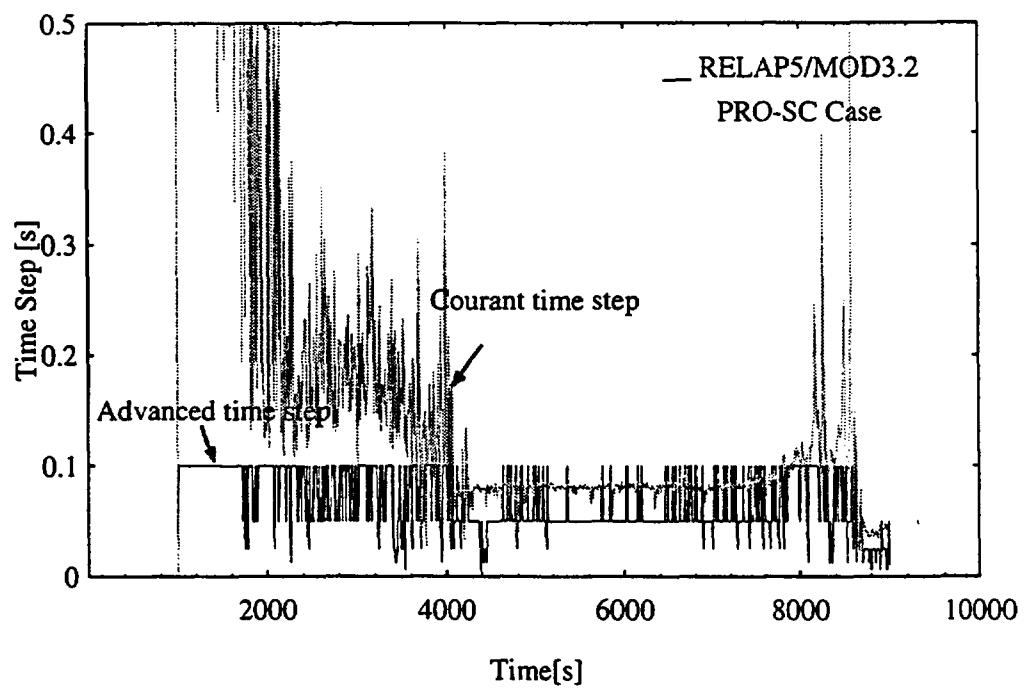


Fig. 40 The Advanced Time Step for PRO Case

## V. Conclusions

The potential for the RELAP5/MOD3.2 code was assessed for the loss-of-RHR event during the mid-loop operation and the predictability of major thermal hydraulic phenomena was also evaluated for the long term transient. The calculations were compared with two cases of experiments, cold leg opening (CLO) case with water-filled SGs and pressurizer manway opening (PRO) case with emptied SGs, which were conducted at ROSA-IV/LSTF in Japan. The CLO case was to simulate the geometry conditions during the maintenance of reactor coolant pump and the PRO case was to simulate an open manway on the top of the pressurizer.

- 1) From the present study, it was found that the RELAP5/MOD3.2 code was capable of simulating the system responses to the loss-of-RHR event during the reduced inventory operation. Especially, thermal hydraulic transport process including noncondensable gas behavior was reasonably predicted with an appropriate time step and CPU time. However, there were some code deficiencies such as an estimation of too large system mass errors and severe flow oscillations in the core region.
- 2) For the two typical geometry cases, the code predicted well the major phenomena during the long term transient, such as the coolant boiling off in the core, system pressurization, the occurrence of loop seal clearing (LSC), the migration of the noncondensable gas, liquid hold up in pressurizer, core uncovering and so on. Also, the overall trend of system pressures and fluid temperatures and the water level behavior agreed well with the experiment.
- 3) However, in the CLO case, the heat transfer to the SG secondary side was overestimated due to an excessive condensation on the U-tube wall by a large amount of steam migration toward the SG U-tubes. Thus, the onset of the LSC was a little delayed as compared to the experiment. In the PRO case, the maximum pressure in core upper plenum was overshot due to an excessive steaming in the core region and the liquid hold up in the pressurizer was also overestimated. Thus, the core heat up

initiated much earlier than in the experiment.

- 4) Two type of core models were considered for sensitivity study. There were no significant differences between both models, but the multi-dimensional effect on natural circulation flow in the core region was somehow compensated by the two channel core nodalization. Thus, the coolant temperature in the core region was predicted more accurately in case of two channel core model.

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- [7] EG&G Idaho, "RELAP5/MOD3 Code Manual: User's Guide and Input Requirements", NUREG/CR-5535, INEL-95/0174, Volume 1-5, August 1995.
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## **Appendix A**

### **Input Deck for the Assessment of the Loss-of-RHR Event with the Cold Leg Opening (Steady State and Transient Input Deck)**



```

*****
*          *
=      LSTF Mid-loop : Steady State Input Deck      *
*          for relap5/mod3.2 Assessment      *
*          *
*      Cold leg Opening Case      *
*****
100    new    transnt
101    run
102    si    si
105    50.0   100.0
*
110    air
115    1.0
*
120    124010000  0.00  h2o    primary
121    304010000  7.9639 h2o    secnd-b
122    504010000  7.9639 h2o    secnd-i
123    900010000  0.00  h2o    contain
*
*      time step control
*
201    1000.0  1.0e-6  0.1   3    100   10000  10000
*
20800001  pps    610020000
20800002  pps    152010000
20800003  pps    136010000
20800004  pps    420010000
20800005  pps    220010000
20800008  gammaw  420010000
20800009  gammaw  220010000
*
*****
*      minor edits
*****
*
301    p     610010000  * pqr pressure
302    p     516010000  * sg-i
303    p     316010000  * sg-b
304    p     452010000  * cold leg-i
305    p     252010000  * cold leg-b
306    p     400010000  * hot leg-i
307    p     200010000  * hot leg-b
308    cntrivar 124    * core level
309    cntrivar 125    * vessel level
310    cntrivar 312    * sg-b level
311    cntrivar 512    * sg-i level
312    cntrivar 753    * crossover leg-i up
313    cntrivar 755    * crossover leg-i down
314    cntrivar 756    * crossover leg-b down
315    cntrivar 757    * crossover leg-b up
316    cntrivar 761    * core dp
317    cntrivar 763    * upper plenum dp
318    cntrivar 888    * core power
319    cntrivar 915    * integrated break flow
320    tempf   124010000  * bottom-core temp.
321    tempf   124020000  *
322    tempf   124030000  *
323    tempf   124040000
324    tempf   124050000
325    tempf   124060000
326    tempf   124070000
327    tempf   124080000
328    tempf   124090000
329    tempf   124100000
330    tempf   124110000
331    tempf   124120000
332    tempf   136010000
333    htemp   124100109
334    htemp   124100209
335    htemp   124100309
336    htemp   124100409
337    htemp   124100509
338    htemp   124100609
339    htemp   124100709
340    htemp   124100809
341    htemp   124100909
342    htemp   124101009
343    htemp   124101109
344    htemp   124101209
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347    tempf   208010000
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355    tempf   408010000
356    tempf   416010000
357    tempf   420010000
358    tempf   444010000
359    tempf   448010000
360    tempf   452010000
361    tempf   610080000
362    tempf   610040000
363    tempf   610010000
364    voidf   104010000
365    voidf   136010000
366    voidf   200010000
367    voidf   206010000
368    voidf   208010000
369    voidf   212010000
370    voidf   228010000
371    voidf   232010000
372    voidf   232050000
373    voidf   236040000
374    voidf   244010000
375    voidf   248010000
376    voidf   252010000
377    voidf   400010000
378    voidf   406010000
379    voidf   408010000
380    voidf   412010000
381    voidf   428010000
*
*      top-cladding temp.
*      hot leg-b
*      hot leg-b temperature
*      hot leg-b temperature
*      sg-b inlet plenum
*      sg-b inlet
*      cold leg-b temperature
*      cold leg-b temperature
*      cold leg-b
*      hot leg-i
*      hot leg-i temperature
*      hot leg-i temperature
*      sg-i inlet plenum
*      sg-i inlet
*      cold leg-i temperature
*      cold leg-i temperature
*      cold leg-i
*      pqr bottom
*      pqr middle
*      pqr top
*      vessel inlet void
*      vessel outlet void
*      hot leg void
*
*      sg-b inlet void
*      sg-b outlet void
*      cross leg void
*
*      rcp suction void
*      rcp discharge void
*      cold leg void
*      cold leg void
*      hot leg void
*
*      sg-i inlet void
*      sg-i outlet void

```

382	voidf	432010000	* cross leg void	1080303	0.610	8							
383	voidf	432050000	*	1080304	1.2588	9							
384	voidf	436040000	* rcp suction void	1080601	-90.0	9							
385	voidf	444010000	* rcp discharge void	1080701	-0.6757	1							
386	voidf	448010000	* cold leg void	1080702	-0.8670	2							
387	voidf	452010000	* cold leg void	1080703	-0.610	8							
388	mflowj	108040000	* downcommer flowrate	1080704	-1.2588	9							
389	mflowj	124060000	* core flowrate	1080801	4.573e-5	0.106	9						
390	mflowj	208010000	* hot leg-b flowrate	1081001	0001000	9							
391	mflowj	217000000	* sg-b inlet flowrate	1081101	0000	8							
392	mflowj	252010000	* cold leg-b flowrate	1081201	003	106580.0	318.7	0.	0.	0.	1		
393	mflowj	408010000	* hot leg-i flowrate	1081202	003	114080.0	319.2	0.	0.	0.	2		
394	mflowj	417000000	* sg-i inlet flowrate	1081203	003	121160.0	319.4	0.	0.	0.	3		
395	mflowj	741000000	* hot leg-i si	1081204	003	127010.0	319.6	0.	0.	0.	4		
396	mflowj	746000000	* cold leg-i si	1081205	003	132960.0	319.7	0.	0.	0.	5		
397	mflowj	781000000	* hot leg-b si	1081206	003	138810.0	319.8	0.	0.	0.	6		
398	mflowj	786000000	* cold leg-b si	1081207	003	144760.0	319.8	0.	0.	0.	7		
399	mflowj	915000000	* break flowrate	1081208	003	150600.0	319.8	0.	0.	0.	8		
*				1081209	003	159660.0	319.8	0.	0.	0.	9		
*****													
* variable trips													
*****													
*				1081300	1								
500	time	0	lt	null	0	0.0	n	* false	1081301	6.0	0.0	0.0	1
501	time	0	ge	null	0	0.0	n	* true	1081302	6.0	0.0	0.0	2
536	time	0	ge	null	0	0.0	l	* true	1081303	6.0	0.0	0.0	3
537	time	0	lt	null	0	0.0	l	* false	1081304	6.0	0.0	0.0	4
*				1081305	6.0	0.0	0.0		1081306	6.0	0.0	0.0	5
1000000	inannl	snglvol		1081307	6.0	0.0	0.0		1081308	6.0	0.0	0.0	6
1000101	0.0	1.5684	0.13609	0.0	-90.	-1.5684	*		1081309	6.0	0.0	0.0	7
1000102	4.57e-5	0.106	00				*						
1000200	004	101355.0	321.0	1.0									
*													
* Hydrodynamic Components													
*****													
* reactor vessel													
*****													
1000000	inannl	snglvol		1120000	lplovol	snglvol							
1000101	0.0	0.626	0.1661	0.0	90.0	0.626	4.57e-5		1120101	0.0	0.626	0.1661	
1000102	0.0104	0001000		1120102	0.0104	0001000			1120200	003	173420.0	318.0	
*				*					*				
*****													
* Hydrodynamic Components													
*****													
* reactor vessel													
*****													
1040000	inannl	branch		1160000	lowrplnm	branch							
1040001	4	1		1160001	3	1							
1040101	0.0	0.600	0.05425	0.0	-90.0	-0.600	4.57e-5		1160101	0.0	0.4762	0.0943	0.0
1040102	0.106	0001000		1160102	0.0104	0001000			1160200	003	168070.0	319.7	
1040200	004	101660.0	318.0	0.001					1161101	108010000	116010000	0.09774	1.0
1041101	104000000	100010000	0.0	0.0	0.0	0.000			1162101	112010000	116000000	0.23623	0.0
1042101	104010000	108000000	0.0	0.0	0.0	0.000			1163101	116010000	120000000	0.15931	8.34
1043101	252020002	104010003	0.03365	0.345	0.345	0101			1161201	6.0	0.0	0.0	0100
1044101	452010002	104010004	0.03365	0.345	0.345	0101			1162201	0.01	0.01	0.0	
1041201	0.001	0.001	0.0						1163201	6.0	0.0	0.0	
1042201	6.0	0.0	0.0						1162110	0.0104	1.0	1.0	1.0
1043201	3.0	0.0	0.0						1163110	0.0104	1.0	1.0	1.0
1044201	3.0	0.0	0.0					*					
*													
*****													
* corein branch													
*****													
1080000	downcmer	annulus		1200000	corein	branch							
1080001	9			1200001	2	1							
1080101	0.09774	9		1200101	0.0	1.2588	0.1821	0.0	90.0	1.2588	4.57e-5		
1080301	0.6757	1		1200102	0.0104	0001000							
1080302	0.8670	2		1200200	003	159590.0	319.7						
				1201101	120010000	124000000	0.068285	0.85	0.85	0000			
				1202101	120010000	126000000	0.068285	0.85	0.85	0000			
				1201201	3.0	0.0	0.0						



1330101	132010005	134010006	0.0	0.0	0.0	0.0003	1521201	0.01	0.01	0.0							
1330201	1	0.1	0.1	0.0			1522201	0.01	0.01	0.0							
*							*										
1340000	upplnm2	snglvol					1560000	gdetub	pipe								
1340101	0.0	0.6757	0.0530	0.0	90.0	0.6757	4.57e-5	1560001	2								
1340102	0.227	0001000					1560101	0.0	2								
1340200	003	106970.0	334.0				1560201	0.0102	1								
*							1560301	1.9260	1								
*****							1560302	1.6431	2								
1360000	upplnm	branch					1560401	0.06209	1								
1360001	5	1					1560402	0.06286	2								
1360101	0.0	0.600	0.09389	0.0	90.0	0.600	4.57e-5	1560601	-90.0	2							
1360102	0.321	0001000					1560701	-1.9260	1								
1360200	004	102100.0	334.0	0.001			1560702	-1.6431	2								
1361101	136010005	200010001	0.03370	0.265	0.265	0102	1560801	4.57e-5	0.0	2							
1362101	136010006	400010001	0.03370	0.265	0.265	0102	1560901	3.34	3.34	1							
1363101	132010000	136000000	0.07835	0.0	0.0	0000	1561001	01000	2								
1364101	134010000	136000000	0.07835	0.0	0.0	0000	1561101	0000	1								
1365101	140000000	136010000	0.14305	0.0	0.0	0000	1561201	004	101300.0	331.0	1.0	0.0	0.0	1			
1361201	3.0	0.0	0.0				1561202	004	106500.0	334.0	0.0007	0.0	0.0	0.0	2		
1362201	3.0	0.0	0.0				1561300	1									
1363201	3.0	0.0	0.0				1561301	0.01	0.01	0.0	0.0	1					
1364201	3.0	0.0	0.0				*****										
1365201	-0.01	-0.01	0.0				*										
1363110	0.321	1.0	1.0	1.0			1810000	core1	sngljun								
1364110	0.321	1.0	1.0	1.0			1810101	124010005	126010006	0.0	0.0	0.0	0.0003				
1365110	0.321	1.0	1.0	1.0			1810201	1	0.1	0.1	0.0						
*							*****										
1400000	uptopvol	snglvol					1820000	core2	sngljun								
1400101	0.0	0.3674	0.0445	0.0	90.0	0.3674	4.57e-5	1820101	124020005	126020006	0.0	0.0	0.0	0.003			
1400102	0.321	00					1820201	1	0.1	0.1	0.0						
1400200	004	101300.0	333.0	1.0			*****										
*							1830000	core3	sngljun								
1440000	tophat	snglvol					1830101	124030005	126030006	0.0	0.0	0.0	0.003				
1440101	0.0	0.897	0.1655	0.0	90.0	0.897	4.57e-5	1830201	1	0.1	0.1	0.0					
1440102	0.95	00					*****										
1440200	004	101300.0	332.0	1.0			1840000	core4	sngljun								
*							1840101	124040005	126040006	0.0	0.0	0.0	0.003				
1480000	uhmidvol	branch					1840201	1	0.1	0.1	0.0						
1480001	2	1					*****										
1480101	0.0	0.725	0.1970	0.0	90.0	0.725	4.57e-5	1850000	core5	sngljun							
1480102	0.256	00					1850101	124050005	126050006	0.0	0.0	0.0	0.003				
1480200	004	101300.0	328.0	1.0			1850201	1	0.1	0.1	0.0						
1481101	100000000	148000000	9.5e-5	0.0	0.0	0100	*****										
1482101	144010000	148000000	0.0	0.0	0.0	0000	1860000	core6	sngljun								
1481201	0.01	0.01	0.0				1860101	124060005	126060006	0.0	0.0	0.0	0.003				
1482201	-0.01	-0.01	0.0				1860201	1	0.1	0.1	0.0						
*							*****										
1520000	uhtopvol	branch					1870000	core7	sngljun								
1520001	2	1					1870101	124070005	126070006	0.0	0.0	0.0	0.003				
1520101	0.0	0.504	0.1475	0.0	90.0	0.504	4.57e-5	1870201	1	0.1	0.1	0.0					
1520102	0.0	00					*****										
1520200	004	101300.0	331.0	1.0			1880000	core8	sngljun								
1521101	148010000	152000000	0.0	0.0	0.0	0000	1880101	124080005	126080006	0.0	0.0	0.0	0.003				
1522101	152000000	156000000	0.00199	1.472	1.472	0000	1880201	1	0.1	0.1	0.0						

1890201	1	0.1	0.1	0.0			2120101	0.0	0.706	0.125	0.0	90.0	0.706	4.57e-5
*							2120102	0.377	0000000					
1900000	core10	sngljun					2120200	004	101500.0	334.0	1.0			
1900101	124100005	126100006	0.0	0.0	0.0	0003	*							
1900201	1	0.1	0.1	0.0			*****							
*							2130000	npsgfbj	sngljun					
1910000	core11	sngljun					2130101	212010000	214000000	0.2093	0.0	0.0	0000	
1910101	124110005	126110006	0.0	0.0	0.0	0003	2130201	1	0.0	0.0	0.0			
1910201	1	0.1	0.1	0.0			*							
*							*****							
1920000	core12	sngljun					2140000	npsgfb1	snglvol					
1920101	124120005	126120006	0.0	0.0	0.0	0003	2140101	0.0	0.55175	0.11615	0.0	90.0	0.55175	4.57e-5
1920201	1	0.1	0.1	0.0			2140102	0.4474	0000000					
*							2140200	004	101500.0	332.0	1.0			
*****							*							
*	Broken Loop without pressurizer						*****							
*****							2150000	npsgfbj	sngljun					
*							2150101	214010000	216000000	0.2105	0.0	0.0	0000	
2000000	nphotleg	snglvol					2150201	1	0.0	0.0	0.0			
2000101	0.0337	1.3246	0.0	0.0	0.0	0.0	*							
2000200	004	102100.0	334.0	0.0010			*****							
*							2160000	npsgfb2	snglvol					
2060000	nphotleg	branch					2160101	0.0	0.55175	0.11615	0.0	90.0	0.55175	4.57e-5
2060001	2	1					2160102	0.4474	0000000					
2060101	0.0337	1.3843	0.0	0.0	0.0	0.0	2160200	004	101500.0	325.0	1.0			
2060200	004	102100.0	334.0	0.00100			*							
2061101	200010000	206000000	0.0337	0.0	0.0	0000	*****							
2062101	206010000	208000000	0.0337	0.0	0.0	0000	2170000	npsgin	sngljun					
2061201	0.1	0.0	0.0				2170101	216010000	220000000	0.0425	0.0	0.0	100100	
2062201	0.1	0.0	0.0				2170110	0.0	0.0	0.725	1.0			
*							2170201	1	0.0	0.0	0.0			
*****							*							
2080000	wphotleg	pipe					2200000	npsgtube	pipe					
2080001	2						2200001	12						
2080101	0.0337	2					2200101	0.0425	12					
2080301	0.7043	1					2200301	0.7181	4					
2080302	0.5278	2					2200302	1.2827	6					
2080601	0.0	1					2200303	2.5654	7					
2080602	50.0	2					2200304	2.1728	9					
2080701	0.0	1					2200305	2.5654	11					
2080702	0.4043	2					2200306	2.8724	12					
2080801	4.57e-5	0.207	2				2200601	90.0	8					
2080901	0.05	0.05	1				2200604	-90.0	12					
2081001	0000000	2					2200701	0.7181	4					
2081101	100000	1					2200702	1.2827	6					
2081201	004	102000.0	334.0	0.00100	0.	0.	2	2200703	2.5654	7				
2081202	004	101500.0	334.0	0.1	0.	0.	2	2200704	2.0980	8				
2081300	1						2200705	-2.0980	9					
2081301	0.1	0.0	0.0	1			2200706	-2.5654	11					
2081401	0.	0.	0.55	0.785	1		2200707	-2.8724	12					
*							2200801	1.524-6	0.0196	12				
*****							2200901	0.0	0.0	7				
2090000	nphotleg	sngljun					2200902	0.006	0.0	8				
2090101	208010000	212000000	0.0337	0.0	0.0	0100	2200903	0.006	0.006	9				
2090201	1	0.0	0.0	0.0			2200904	0.0	0.006	10				
*							2200905	0.0	0.0	11				
*****							2201001	0000000	12					
2120000	npsgin	snglvol					2201101	0000	11					

2201201	004	101480.0	317.0	1.	0.	0.	1	2320601	-50.0	1					
2201202	004	101480.0	317.8	1.	0.	0.	2	2320602	-90.0	4					
2201203	004	101470.0	317.7	1.	0.	0.	3	2320603	0.0	5					
2201204	004	101460.0	317.6	1.	0.	0.	4	2320701	-0.3953	1					
2201205	004	101450.0	317.5	1.	0.	0.	5	2320702	-1.2422	4					
2201206	004	101440.0	317.4	1.	0.	0.	6	2320703	0.0	5					
2201207	004	101420.0	317.3	1.	0.	0.	7	2320801	4.57e-5	0.1682	5				
2201208	004	101420.0	317.3	1.	0.	0.	8	2320901	0.036	0.036	1				
2201209	004	101390.0	317.3	1.	0.	0.	9	2320902	0.0	0.0	3				
2201210	004	101420.0	317.4	1.	0.	0.	10	2320903	0.065	0.065	4				
2201211	004	101440.0	317.6	1.	0.	0.	11	2321001	0000000	5					
2201212	004	101470.0	317.0	1.	0.	0.	12	2321101	0000	4					
2201300	1							2321201	004	101500.0	320.0	0.01	0.	0.	1
2201301	0.0	0.0	0.0	1				2321202	003	107500.0	320.0	0.	0.	0.	2
2201302	0.0	0.0	0.0	2				2321203	003	119600.0	320.0	0.	0.	0.	3
2201303	0.0	0.0	0.0	3				2321204	003	131600.0	320.0	0.	0.	0.	4
2201304	0.0	0.0	0.0	4				2321205	003	137600.0	320.0	0.	0.	0.	5
2201305	0.0	0.0	0.0	5				2321300	1						
2201306	0.0	0.0	0.0	6				2321301	0.1	0.0	0.0		1		
2201307	0.0	0.0	0.0	7				2321302	0.1	0.0	0.0		2		
2201308	0.0	0.0	0.0	8				2321303	0.1	0.0	0.0		3		
2201309	0.0	0.0	0.0	9				2321304	0.1	0.0	0.0		4		
2201310	0.0	0.0	0.0	10				*							
2201311	0.0	0.0	0.0	11				*****							
*								2330000	npfcv	valve					
*****								2330101	232010000	236000000	0.0222	0.0	0.0	0.0	0100
2210000	npsgout	sngljun						2330201	1	0.0	0.0				
2210101	220010000	224000000	0.0425	0.0	0.0	0.0		2330300	mtrvlv						
2210201	1	0.0	0.0	0.0				2330301	536	537	1.42	1.0	0		
*								*							
*****								*****							
2240000	npsgfb0	snglvol						2360000	npcrslgu	pipe					
2240101	0.0	1.1035	0.2323	0.0	-90.0	-1.1035	4.57e-5	2360001	4						
2240102	0.4474	0000000						2360101	0.0222	4					
2240200	004	101400.0	320.0	1.0				2360301	1.3202	1					
*								2360302	1.1222	2					
*****								2360303	1.1417	3					
2250000	npsgfbj	sngljun						2360304	1.1222	4					
2250101	224010000	228000000	0.2093	0.0	0.0	0.0		2360601	0.0	1					
2250201	1	0.0	0.0	0.0				2360602	90.0	4					
*								2360701	0.0	1					
*****								2360702	1.1222	4					
2280000	npsgout	snglvol						2360801	4.57e-5	0.1682	4				
2280101	0.0	0.706	0.125	0.0	-90.0	-0.706	4.57e-5	2360901	0.065	0.065	1				
2280102	0.377	0000000						2360902	0.0	0.0	3				
2280200	004	101500.0	321.0	1.0				2361001	0000000	4					
*								2361101	0000	3					
*****								2361201	003	137100.0	320.0	0.	0.	0.	1
2290000	npcrsleg	sngljun						2361202	003	132700.0	319.0	0.	0.	0.	2
2290101	228010000	232000000	0.0222	0.0	0.0	0.0		2361203	003	121800.0	319.0	0.	0.	0.	3
2290201	1	0.0	0.0	0.0				2361204	003	110300.0	319.0	0.	0.	0.	4
*								2361300	1						
*****								2361301	0.1	0.0	0.0		1		
2320000	npcrsleg	pipe						2361302	0.1	0.0	0.0		2		
2320001	5							2361303	0.1	0.0	0.0		3		
2320101	0.0222	5						*							
2320301	0.516	1						*****							
2320302	1.2422	4						2400000	nprcpump	pump					
2320303	1.1919	5						2400101	0.0	0.802	0.0235	0.0	90.0	0.351	0

2400108 236010000 0.0222 0.0 0.0 0000 \* two-phase diff curves from r5 built-in data  
 2400109 244000000 0.0337 0.0525 0.0525 0000 \* head difference curves  
 2400200 004 103200.0 319.0 0.0003 \*  
 2400201 1 0.0 0.0 0.0 2404100 1 1 0.00 0.00 0.10 0.83 0.20 1.09 0.50 1.02  
 2400202 1 0.0 0.0 0.0 2404101 0.70 1.01 0.90 0.94 1.00 1.00  
 2400301 0 0 0 -1 -1 500 0 2404200 1 2 0.00 0.00 0.10 -0.40 0.20 0.00 0.30 0.10  
 2400302 188.50 0.0 0.054 10.0 55.2 2404201 0.40 0.21 0.80 0.67 0.90 0.80 1.00 1.00  
 2400303 0.54 750.0 0.0 0.0 0.0 0.0 0.0 2404300 1 3 -1.0 -1.16 -0.90 -1.24 -0.80 -1.77 -0.70 -2.36  
 \* 2404301 -0.60 -2.79 -0.50 -2.91 -0.40 -2.67 -0.25 -1.69  
 \* 2404302 -0.10 -0.50 0.00 0.00  
 \* single phase head and torque data from lstf sys. 2404400 1 4 -1.0 -1.16 -0.90 -0.78 -0.80 -0.50 -0.70 -0.31  
 \* description 2404401 -0.60 -0.17 -0.50 -0.08 -0.35 0.00 -0.20 0.05  
 \* 2404402 -0.10 0.08 0.00 0.11  
 2401100 1 1 0.00 1.36 0.10 1.38 0.24 1.42 0.40 1.41 2404500 1 5 0.00 0.00 1.00 0.00  
 2401101 0.60 1.32 0.80 1.19 1.00 1.00 2404600 1 6 0.00 0.00 1.00 0.00  
 2401200 1 2 0.00 -0.97 0.20 -0.68 0.50 -0.20 0.65 0.07 2404700 1 7 -1.00 0.00 0.00 0.00  
 2401201 0.80 0.40 1.00 1.00 2404800 1 8 -1.00 0.00 0.00 0.00  
 2401300 1 3 -1.0 3.20 -0.90 2.80 -0.80 2.46 -0.60 1.94 \*  
 2401301 -0.40 1.57 -0.20 1.41 0.00 1.36 \* torque difference curves  
 2401400 1 4 -1.00 3.20 -0.80 2.76 -0.60 2.41 -0.40 2.09 2404900 2 1 0.0 0.0 0.0 0.0 0.0  
 2401401 -0.20 1.81 0.00 1.58 2405000 2 2 0.0 0.0 0.0 0.0 0.0  
 2401500 1 5 0.00 0.00 1.00 0.00 2405100 2 3 0.0 0.0 0.0 0.0 0.0  
 2401600 1 6 0.00 0.00 1.00 0.00 2405200 2 4 0.0 0.0 0.0 0.0 0.0  
 2401700 1 7 -1.00 0.00 0.00 0.00 2405300 2 5 0.0 0.0 0.0 0.0 0.0  
 2401800 1 8 -1.00 0.00 0.00 0.00 2405400 2 6 0.0 0.0 0.0 0.0 0.0  
 \* 2405500 2 7 0.0 0.0 0.0 0.0 0.0  
 \* 2405600 2 8 0.0 0.0 0.0 0.0 0.0  
 \*  
 \* torque data  
 \*  
 2401900 2 1 0.00 0.36 0.12 0.38 0.20 0.44 0.30 0.58 2440000 npcollg branch  
 2401901 0.50 0.73 0.70 0.81 1.00 1.00 2440001 1 1  
 2402000 2 2 0.00 -1.26 0.10 -0.88 0.30 -0.31 0.50 0.09 2440101 0.0337 0.7348 0.0 0.0 0.0 0.0 4.57e-5 0.207 00  
 2402001 0.65 0.30 0.86 0.63 1.00 1.00 2440200 004 101500.0 319.0 0.00040  
 2402100 2 3 -1.00 2.40 -0.85 1.70 -0.65 1.12 -0.50 0.84 2441101 244010000 248000000 0.0337 0.0 0.0 0000  
 2402101 -0.40 0.69 -0.20 0.59 0.00 0.36 2441201 3.0 0.0 0.0  
 2402200 2 4 -1.00 2.40 -0.80 2.12 -0.60 1.80 -0.30 1.32 \*  
 2402201 0.00 0.80 2480000 npcollg branch  
 2402300 2 5 0.00 0.00 1.00 0.00 2480001 1 1  
 2402400 2 6 0.00 0.00 1.00 0.00 2480101 0.0337 0.9429 0.0 0.0 0.0 0.0 4.57e-5 0.207 00  
 2402500 2 7 -1.00 0.00 0.00 0.00 2480200 004 101500.0 319.0 0.0004  
 2402600 2 8 -1.00 0.00 0.00 0.00 2481101 248010000 252000000 0.0337 0.0 0.0 0000  
 \* 2481201 3.0 0.0 0.0  
 \*  
 \* two phase multiplier tables for head of rc pump 240 2520000 npcollg pipe  
 \*  
 2403000 0 0.0 0.0 2520001 2  
 2403001 0.10 0.0 2520101 0.0337 2  
 2403002 0.15 0.05 2520301 0.9752 2  
 2403003 0.24 0.80 2520601 0.0 2  
 2403004 0.30 0.96 2520701 0.0 2  
 2403005 0.40 0.98 2520801 4.57e-5 0.207 2  
 2403006 0.60 0.97 2521001 0.0 2  
 2403007 0.80 0.90 2521101 0000 1  
 2403008 0.90 0.80 2521201 004 101500.0 318.0 0.0004 0. 0. 1  
 2403009 0.96 0.50 2521202 004 101500.0 318.0 0.0004 0. 0. 2  
 2403010 1.00 0.0 2521300 1  
 \* 2521301 3.0 0.0 0.0 1



```

* blsg steam line
*****
3200000 blstmln1 branch
3200001 2 1
3200101 0.0286 5.286 0.0 0.0 0.0 0.0 4.57e-5
3200102 0.1909 00
3200200 004 101300.0 317.0 1.0
3201101 316010000 320000000 0.0286 0.0 0.0 0100
3202101 320010000 324000000 0.0286 0.0 0.0 0000
3202101 0.0 0.0 0.0
3202201 0.0 0.0 0.0
*
*****
3240000 blstmln2 snglvol
3240101 0.0286 9.9213 0.0 0.0 0.0 0.0 4.57e-5
3240102 0.1909 00
3240200 004 101300.0 317.0 1.0
*
*****
* secondary relief and safety valves, intact loop
*****
*
3690000 blsgrv valve
3690101 320010000 370000000 2.96e-4 0.0149 0.0 0120
3690201 0 0.0 0.0 0.0
3690300 trpvlv
3690301 501
*
*****
3700000 contain tmdpvol
3700101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 00
3700200 004
3700201 0.0 1.01325e+5 300.0 1.0
*
*****
3790000 blsgsv valve
3790101 324010000 380000000 0.00195 0.00055 0.0 0120
3790201 0 0.0 0.0 0.0
3790300 trpvlv
3790301 501
*
*****
3800000 contain tmdpvol
3800101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 00
3800200 004
3800201 0.0 1.01325e+5 300.0 1.0
*
*****
* Intact Loop with pressurizer
*****
*
4000000 wphotleg snglvol
4000101 0.0337 1.3246 0.0 0.0 0.0 4.57e-5 0.207 00
4000200 004 102100.0 334.0 0.00100
*
*****
4060000 wphotleg branch
4060001 3 1
4060101 0.0337 1.3843 0.0 0.0 0.0 4.57e-5 0.207 00
4060200 004 102100.0 334.0 0.00100
4061101 400010000 406000000 0.0337 0.0 0.0 0.0 0000
4062101 406010000 408000000 0.0337 0.0 0.0 0.0 0000
4063101 600030002 406010003 0.00352 1.0 0.5 0001
4061201 0.01 0.0 0.0
4062201 0.01 0.0 0.0
4063201 0.0 0.0 0.0
*
*****
4080000 wphotleg pipe
4080001 2
4080101 0.0337 2
4080301 0.7043 1
4080302 0.5278 2
4080601 0.0 1
4080602 50.0 2
4080701 0.0 1
4080702 0.4043 2
4080801 4.57e-5 0.207 2
4080901 0.05 0.05 1
4081001 0000000 2
4081101 100000 1
*
*****
4090000 wphotleg sngljun
4090101 408010000 412000000 0.0337 0.0 0.0 0.0 0100
4090201 1 0.0 0.0 0.0
*
*****
4120000 wpsgin snglvol
4120101 0.0 0.706 0.125 0.0 90.0 0.706 4.57e-5
4120102 0.377 0000000
4120200 004 101500.0 334.0 1.0
*
*****
4130000 wpsgfbj sngljun
4130101 412010000 414000000 0.2093 0.0 0.0 0000
4130201 1 0.0 0.0 0.0
*
*****
4140000 wpsgfb1 snglvol
4140101 0.0 0.55175 0.11615 0.0 90.0 0.55175 4.57e-5
4140102 0.4474 0000000
4140200 004 101500.0 330.0 1.0
*
*****
4150000 wpsgfbj sngljun
4150101 414010000 416000000 0.2105 0.0 0.0 0000
4150201 1 0.0 0.0 0.0
*
*****
4160000 wpsgfb2 snglvol
4160101 0.0 0.55175 0.11615 0.0 90.0 0.55175 4.57e-5
4160102 0.4474 0000000

```

4160200	004	101500.0	325.0	1.0		*	
*							
4170000	npsgin	sngljun					*****
4170101	416010000	420000000	0.0425	0.0 0.0	100100	4210000	wpsgout sngljun
4170110	0. 0.	0.725	1.			4210101	420010000 424000000 0.0425 0.0 0.0 0100
4170201	1 0.0	0.0 0.0				4210201	1 0.0 0.0 0.0
*						*	
4200000	wpsgtube	pipe				4240000	wpsgfb0 snglvol
4200001	12					4240101	0.0 1.1035 0.2323 0.0 -90.0 -1.1035 4.57e-5
4200101	0.0425	12				4240102	0.4474 0000000
4200301	0.7181	4				4240200	004 101500.0 320.0 1.0
4200302	1.2827	6				*	
4200303	2.5654	7				4250000	wpsgfbj sngljun
4200304	2.1728	9				4250101	424010000 428000000 0.2093 0.0 0.0 0000
4200305	2.5654	11				4250201	1 0.0 0.0 0.0
4200306	2.8724	12				*	
4200601	90.0	8				4280000	wpsgout snglvol
4200604	-90.0	12				4280101	0.0 0.706 0.125 0.0 -90.0 -0.706 4.57e-5
4200701	0.7181	4				4280102	0.377 0000000
4200702	1.2827	6				4280200	004 101500.0 320.0 1.0
4200703	2.5654	7				*	
4200704	2.0980	8				4290000	wpcrsleg sngljun
4200705	-2.0980	9				4290101	428010000 432000000 0.0222 0.0 0.0 0100
4200706	-2.5654	11				4290201	1 0.0 0.0 0.0
4200707	-2.8724	12				*	
4200801	1.524-6	0.0196	12			4320000	wpcrsleg pipe
4200901	0.0	0.0	7			4320001	5
4200902	0.006	0.0	8			4320101	0.0222 5
4200903	0.006	0.006	9			4320301	0.516 1
4200904	0.0	0.006	10			4320302	1.2422 4
4200905	0.0	0.0	11			4320303	1.1919 5
4201001	0000000	12				4320601	-50.0 1
4201101	0000	11				4320602	-90.0 4
4201201	004	101490.0	317.0	1. 0. 0. 1		4320603	0.0 5
4201202	004	101480.0	317.8	1. 0. 0. 2		4320701	-0.3953 1
4201203	004	101470.0	317.7	1. 0. 0. 3		4320702	-1.2422 4
4201204	004	101470.0	317.6	1. 0. 0. 4		4320703	0.0 5
4201205	004	101460.0	317.5	1. 0. 0. 5		4320801	4.57e-5 0.1682 5
4201206	004	101450.0	317.4	1. 0. 0. 6		4320901	0.036 0.036 1
4201207	004	101420.0	317.3	1. 0. 0. 7		4320902	0.0 0.0 3
4201208	004	101400.0	317.3	1. 0. 0. 8		4320903	0.065 0.065 4
4201209	004	101400.0	317.3	1. 0. 0. 9		4321001	0000000 5
4201210	004	101420.0	317.4	1. 0. 0. 10		4321101	0000 4
4201211	004	101450.0	317.6	1. 0. 0. 11		4321201	004 101500.0 320.0 0.01 0. 0. 1
4201212	004	101490.0	317.0	1. 0. 0. 12		4321202	003 107500.0 320.0 0. 0. 0. 2
4201300	1					4321203	003 119200.0 320.0 0. 0. 0. 3
4201301	0.0	0.0	1			4321204	003 131600.0 320.0 0. 0. 0. 4
4201302	0.0	0.0	2			4321205	003 137600.0 320.0 0. 0. 0. 5
4201303	0.0	0.0	3			4321300	1
4201304	0.0	0.0	4			4321301	0.1 0.0 0.0 1
4201305	0.0	0.0	5			4321302	0.1 0.0 0.0 2
4201306	0.0	0.0	6			4321303	0.1 0.0 0.0 3
4201307	0.0	0.0	7			4321304	0.1 0.0 0.0 4
4201308	0.0	0.0	8			*	
4201309	0.0	0.0	9			*****	
4201310	0.0	0.0	10				
4201311	0.0	0.0	11				

```

4330000 wpfcv    valve
4330101 432010000 436000000 0.0222  0.0  0.0  0100
4330201 1          0.0      0.0      0.0
4330300 mtrvlv
4330301 536      537      1.42     1.0   0
*
*****
4360000 wpcrslgu pipe
4360001 4
4360101 0.0222  4
4360301 1.3202  1
4360302 1.1222  2
4360303 1.1417  3
4360304 1.1222  4
4360601 0.0      1
4360602 90.0     4
4360701 0.0      1
4360702 1.1222  4
4360801 4.57e-5  0.1682  4
4360901 0.065    0.065   1
4360902 0.0      0.0      3
4361001 0000000 4
4361101 0000      3
4361201 003      137200.0 319.6  0.  0.  0.  1
4361202 003      132600.0 319.4  0.  0.  0.  2
4361203 003      121900.0 319.0  0.  0.  0.  3
4361204 003      110000.0 319.0  0.  0.  0.  4
4361300 1
4361301 0.1      0.0      0.0      1
4361302 0.1      0.0      0.0      2
4361303 0.1      0.0      0.0      3
*
*****
4400000 wprcpump pump
4400101 0.0      0.802   0.0235  0.0  90.0  0.351  0
4400108 436010000 0.0222  0.0      0.0      0.0      0000
4400109 444000000 0.0337  0.0525  0.0525  0.0000
4400200 004      103200.0 319.0  0.000300
4400201 1          0.0      0.0      0.0
4400202 1          0.0      0.0      0.0
4400301 240      240      240      -1      -1      500   0
4400302 188.5   0.0      .054    10.0   55.2
4400303 0.54     750.0   0.0      0.0      0.0      0.0   0.0
*
*****
4440000 wpcolleg snglvol
4440101 0.0337  1.1211  0.0  0.0  0.0  0.0  4.57e-5  0.207  00
4440200 004      101500.0 319.0  0.0004
*
*****
4480000 wpcollecg branch
4480001 2          1
4480101 0.0337  1.1945  0.0  0.0  0.0  0.0  4.57e-5  0.207  00
4480200 004      101500.0 318.0  0.0004
4481101 444010000 448000000 0.0337  0.0  0.0  0.0000
4482101 448010000 452000000 0.0337  0.0  0.0  0.0000
4481201 0.1      0.0      0.0
4482201 3.0      0.0      0.0
*
*****
```

5040202	0.2323	3		5160101	0.0	3.7778	2.0288	0.0	90.0	3.7778	4.57e-5
5040203	0.3138	4		5160102	0.7696	00					
5040301	2.5464	1		5160200	004	101300.0	317.0	1.0			
5040302	2.5654	3		*							
5040303	2.0980	4		*****							
5040304	2.0223	5		* wpsg steam line							
5040401	0.0	3		*****							
5040402	0.4951	4		5200000	ilstmin1	branch					
5040403	0.7979	5		5200001	2	1					
5040501	0.0	5		5200101	0.0286	5.286	0.0	0.0	0.0	0.0	4.57e-5
5040601	90.0	5		5200102	0.1909	00					
5040701	2.5464	1		5200200	004	101300.0	317.0	1.0			
5040702	2.5654	3		5201101	516010000	520000000	0.0286	0.0	0.0	0100	
5040703	2.0980	4		5202101	520010000	524000000	0.0286	0.0	0.0	0000	
5040704	2.0223	5		5201201	0.0	0.0	0.0				
5040801	4.57e-5	0.036	4	5202201	0.0	0.0	0.0				
5040802	4.57e-5	0.219	5	*							
5040901	1.435	1.435	4	*****							
5041001	0000000	5		5240000	ilstmln2	snglvol					
5041101	0000	4		5240101	0.0286	9.9213	0.0	0.0	0.0	0.0	4.57e-5
5041201	003	187000.0	317.0	0.0	0.0	0.0	1				
5041202	003	162100.0	317.0	0.0	0.0	0.0	2				
5041203	003	137200.0	317.0	0.0	0.0	0.0	3				
5041204	003	114500.0	317.0	0.0	0.0	0.0	4				
5041205	004	102800.0	317.0	0.1	0.0	0.0	5				
5041300	1			*							
5041301	0.0	0.0	0.0	1	*****						
5041302	0.0	0.0	0.0	2	5690000	ilsgrv	valve				
5041303	0.0	0.0	0.0	3	5690101	520010000	570000000	2.96e-4	0.0149	0.0	0120
5041304	0.0	0.0	0.0	4	5690201	0	0.0	0.0	0.0		
5041401	0.036	1.0	1.0	1.0	3	5690300	trpvlv				
5041402	0.1258	1.0	1.0	1.0	4	5690301	501				
*				*							
*****				*****							
5080000	npsepar	separatr		5700000	contain	tmdpvol					
5080001	3	1		5700101	1.0e+8	10.0	0.0	0.0	0.0	0.0	00
5080101	0.0	2.120	0.572	0.0	90.0	2.120	4.57e-5				
5080102	0.2134	00		5700200	004						
5080200	004	101400.0	317.0	0.5	5700201	0.0	1.01325e+5	300.0	1.0		
5081101	508010002	516010001	0.0615	0.0	0.0	0100	0.2				
5082101	508010001	500010001	0.03964	100.	100.	0000	0.15				
5083101	504050002	508010001	0.1986	0.0	0.0	0000					
5081201	0.0	0.0	0.0		5790000	bisgsv	valve				
5082201	0.0	0.0	0.0		5790101	524010000	580000000	0.00195	0.00055	0.0	0120
5083201	0.0	0.0	0.0		5790201	0	0.0	0.0	0.0		
*				5790300	trpvlv						
*****				5790301	501						
*				*							
*****				*****							
5120000	npsgspbp	branch		5800000	contain	tmdpvol					
5120001	2	1		5800101	1.0e+8	10.0	0.0	0.0	0.0	0.0	00
5120101	0.0	2.120	0.6288	0.0	90.0	2.120	4.57e-5				
5120102	0.1242	00		5800200	004						
5120200	004	101400.0	317.0	0.5	5800201	0.0	1.01325e+5	300.0	1.0		
5121101	500000000	512000000	0.3164	0.0	0.0	0000					
5122101	512010000	516000000	0.0392	1.5	1.5	0000					
5121201	0.0	0.0	0.0		*						
5122201	0.0	0.0	0.0		*****						
*				6000000	prssurgl	pipe					
*****				6000001	3						
5160000	stmdome	snglvol		6000101	3.515e-3	3					

6000301	6.7788	1		*	
6000302	9.245	2		*****	
6000303	5.4221	3		6190000	spryin sngljun
6000401	0.0	3		6190101	444010003 620010001 0.0 0.0 0.0 00102
6000601	-90.0	3		6190201	1 0.0 0.0 0.0
6000701	-4.4077	1		*	
6000702	-4.995	2		*****	
6000703	-2.5768	3		6200000	prsspryl pipe
6000801	4.57e-5	0.0669	3	6200001	2
6001001	00	3		6200101	3.53e-4 2
6001101	0000	2		6200301	22.43 2
6001201	004 101400.0	332.0	1.0 0.0 0.0 1	6200601	90.0 2
6001202	004 101500.0	333.0	1.0 0.0 0.0 2	6200701	8.07975 2
6001203	004 101700.0	334.0	1.0 0.0 0.0 3	6200801	4.57e-5 0.0 2
6001300	1			6201001	00 2
6001301	0.0 0.0 0.0 1			6201101	0000 1
6001302	0.0 0.0 0.0 2			6201201	004 101500.0 318.0 1.0 0.0 0.0 1
*				6201202	004 101500.0 318.0 1.0 0.0 0.0 2
*****				6201300	1
6030000	prssurgl sngljun			6201301	0.0 0.0 0.0 1
6030101	610010000 600000000 3.515e-3	0.0 0.0 0100		*	
6030201	1 0.0 0.0 0.0			*****	
*				6210000	prsspryl sngljun
6100000	prsrizer pipe			6210101	620010000 610000000 5.0e-5 0.0 0.0 0100
6100001	8			6210201	1 0.0 0.0 0.0
6100101	0.0 1			*	
6100102	0.2827 6			*6210000	prsspryl tm dpjun
6100103	0.2731 8			*6210101	620010000 610000000 0.0
6100201	0.0 7			*6210200	1 524 p 610010000
6100301	0.201 1			*6210201	0.0 0.0 0.0 0.0
6100302	0.470 3			*6210202	15.68e6 0.0 0.0 0.0
6100303	0.600 4			*6210203	16.03e6 0.98 0.0 0.0
6100304	0.682 6			*	
6100305	0.5375 8			*****	
6100401	0.0325 1			6500000	porvout tm dpvol
6100402	0.0 8			6500101	1.0e+1 10.0 0.0 0.0 0.0 0.0 0 00
6100501	0.0 8			6500200	004
6100601	-90.0 8			6500201	0.0 1.01325e+5 317.0 1.0
6100701	-0.201 1			*	
6100702	-0.470 3			*****	
6100703	-0.6 4			6510000	porv valve
6100704	-0.682 6			6510101	610000000 650000000 3.66e-5 0.0251 0.0 0120
6100705	-0.5375 8			6510201	0 0.0 0.0 0.0
6100801	4.57e-5 0.3187 1			6510300	trpvlv
6100802	4.57e-5 0.600 6			6510301	501
6100803	4.57e-5 0.2949 8			*	
6101001	00 8			*****	
6101101	0000 7			6600000	prsfvout tm dpvol
6101201	004 101330.0 317.0 1.0 0.0 0.0 1			6600101	1.0e+8 10.0 0.0 0.0 0.0 0.0 0 00
6101202	004 101330.0 317.0 1.0 0.0 0.0 2			6600200	004
6101203	004 101330.0 318.0 1.0 0.0 0.0 3			6600201	0.0 1.01325e+5 317.0 1.0
6101204	004 101330.0 322.0 1.0 0.0 0.0 4			*	
6101205	004 101330.0 326.0 1.0 0.0 0.0 5			*****	
6101206	004 101400.0 329.0 1.0 0.0 0.0 6			6610000	prsfvalv valve
6101207	004 101400.0 330.0 1.0 0.0 0.0 7			6610101	610000000 660000000 1.54e-4 0.2052 0.0 0120
6101208	004 101400.0 331.0 1.0 0.0 0.0 8			6610201	0 0.0 0.0 0.0
6101300	1			6610300	trpvlv
6101301	0.0 0.0 0.0 7			6610301	501
			*		

```

*****
* rhr system
*****
7800000    rhrscl    tmndpvol
7800101    0. 10. 1000. 0. 0. 0. 0. 0. 0. 00000
7800200    3
7800201    0.0 101325.0 334.0
*
7810000    rsuln11   tmndpjun
7810101    200010005 780010001 0.006
7810200    1 0
7810201    0.0 3.2 0.0 0.0
7810202    1000.0 3.2 0.0 0.0
*
7850000    rhrsol    tmndpvol
7850101    0. 10. 1000. 0. 0. 0. 0. 0. 0. 0. 00000
7850200    3
7850201    0.0 101325.0 318.0
*
7860000    rsoln11   tmndpjun
7860101    785010001 244010005 0.006
7860200    1 0
7860201    0.0 3.2 0.0 0.0
7860202    1000.0 3.2 0.0 0.0
*
7400000    rhrsc2    tmndpvol
7400101    0. 10. 1000. 0. 0. 0. 0. 0. 0. 0. 00000
7400200    3
7400201    0.0 101325.0 334.0
*
7410000    rsuln12   tmndpjun
7410101    400010005 740010001 0.006
7410200    1 0
7410201    0.0 3.2 0.0 0.0
7410202    1000.0 3.2 0.0 0.0
*
7450000    rhrso2    tmndpvol
7450101    0. 10. 1000. 0. 0. 0. 0. 0. 0. 0. 00000
7450200    3
7450201    0.0 101325.0 318.0
*
7460000    rsoln12   tmndpjun
7460101    745010001 448010005 0.006
7460200    1 0
7460201    0.0 3.2 0.0 0.0
7460202    1000.0 3.2 0.0 0.0
*
*****
* containment volume for environmental heat losses
*****
9000000    envsink   snglvol
9000101    2000. 100. 0.0 0.0 0.0 0.0 0. 0 10
9000200    004 1.01325e+5 317.15 1.0
*
9030000    dummy     tmndpvol
9030101    0.0 1.0 10.0 0.0 0.0 0.0 0.0 0.0 00
9030200    004
9030201    0.0 1.01325e+5 317.15 1.0
*
9040000    dumjun   sngljun
9040101    900000000 903000000 0.05 0.0 0.0 1100
9040201    1 0.0 0.0 0.0
*
*****
* break point - 5% break area
*****
9150000    npcolbrv  valve
9150101    248010006 920010001 1.685e-3 0.0.0 0100 1. 1.
9150201    0 0.0 0.0 0.0
9150300    trpvlv
9150301    500
*
*****
9200000    npcolleg  tmndpvol
9200101    1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0 00
9200200    004
9200201    0.0 1.01325e+5 317.0 1.0
*
*****
* Reactor Vessel Heat Structures
*****
* 100-1; vessel wall above nozzles, below upper head
* flange
*****
11001000   1 7 2 1 0.320
11001100   0 1
11001101   1 0.323
11001102   4 0.476
11001103   1 0.601
11001201   5 1
11001202   6 5
11001203   9 6
11001301   0.0 6
11001400   0
11001401   317.0 7
11001501   100010000 0 101 1 0.823 1
11001601   900010000 0 101 1 0.823 1
11001701   0 0 0 0 1
11001801   0.10.0 10.0 0.0 0.0 0.1. 1
11001901   0.10.0 10.0 0.0 0.0 0.1. 1
*
*****
* 104-1; reactor vessel wall below nozzles
*****
11041000   12 7 2 1 0.320
11041100   0 1
11041101   1 0.323
11041102   4 0.381
11041103   1 0.506
11041201   5 1
11041202   6 5
11041203   9 6
11041301   0.0 6
11041400   0
11041401   317.0 7
11041501   104010000 0 101 1 0.600 1

```

11041502	108010000	0	101	1	0.677	2	11122701	0	0	0	0	0	3		
11041503	108020000	0	101	1	0.867	3	11122901	0.	10.0	10.0	0.0	0.0	1.	3	
11041504	108030000	10000	101	1	0.610	9	*								
11041510	108090000	0	101	1	1.2588	10	*****	*****	*****	*****	*****	*****	*****	*****	
11041511	112010000	0	101	1	0.445	11	* 120-1: core barrel, channel								
11041512	116010000	0	101	1	0.4762	12	*****	*****	*****	*****	*****	*****	*****	*****	
11041601	900010000	0	101	1	0.600	1	*								
11041602	900010000	0	101	1	0.677	2	11201000	18	5	2	1	0.257			
11041603	900010000	0	101	1	0.867	3	11201100	0	1						
11041604	900010000	0	101	1	0.610	9	11201101	4	0.267						
11041610	900010000	0	101	1	1.2588	10	11201201	5	4						
11041611	900010000	0	101	1	0.445	11	11201301	0.0	4						
11041612	900010000	0	101	1	0.4762	12	11201400	0							
11041701	0	0	0	0	12		11201401	317.0	5						
11041801	0.	10.0	10.0	0.0	0.0	0.1.	12	11201501	120010000	0	101	1	1.2588	1	
11041901	0.	10.0	10.0	0.0	0.0	0.1.	12	11201502	124010000	10000	101	1	0.305	13	
*							11201503	128010000	0	101	1	0.867	14		
*****	*****	*****	*****	*****	*****	*****	11201504	132010000	0	101	1	0.677	15		
* 112-1: vessel bottom and flange							11201505	136010000	0	101	1	0.600	16		
*****	*****	*****	*****	*****	*****	*****	11201506	140010000	0	101	1	0.3674	17		
*							11201507	144010000	0	101	1	0.897	18		
11121000	1	7	1	1	0.0		11201601	108090000	0	101	1	1.2588	1		
11121100	0	1					11201602	108080000	0	101	1	0.305	2		
11121101	1	0.003					11201603	108080000	0	101	1	0.305	3		
11121102	4	0.724					11201604	108070000	0	101	1	0.305	4		
11121103	1	0.849					11201605	108070000	0	101	1	0.305	5		
11121201	5	1					11201606	108060000	0	101	1	0.305	6		
11121202	6	5					11201607	108060000	0	101	1	0.305	7		
11121203	9	6					11201608	108050000	0	101	1	0.305	8		
11121301	0.0	6					11201609	108050000	0	101	1	0.305	9		
11121400	0						11201610	108040000	0	101	1	0.305	10		
11121401	317.0	7					11201611	108040000	0	101	1	0.305	11		
11121501	112010000	0	101	0	0.686	1	11201612	108030000	0	101	1	0.305	12		
11121601	900010000	0	101	1	0.686	1	11201613	108030000	0	101	1	0.305	13		
11121701	0	0	0	0	1		11201614	108020000	0	101	1	0.867	14		
11121801	0.	10.0	10.0	0.0	0.0	0.1.0	1	11201615	108010000	0	101	1	0.677	15	
11121901	0.	10.0	10.0	0.0	0.0	0.1.0	1	11201616	104010000	0	101	1	0.600	16	
*							11201617	100010000	0	101	1	0.3674	17		
*****	*****	*****	*****	*****	*****	*****	11201618	100010000	0	101	1	0.897	18		
* 112-2: heater rods, below heated section							11201701	0	0	0	0	18			
*****	*****	*****	*****	*****	*****	*****	11201801	0.	10.0	10.0	0.0	0.	0.0	1.0	18
*							11201901	0.	10.0	10.0	0.0	0.	0.0	1.0	18
11122000	3	4	2	1	0.0		*								
11122100	0	1					*****	*****	*****	*****	*****	*****	*****	*****	
11122101	1	0.002					* 124-1: heated section of heater rods in channel								
11122102	1	0.00295					*****	*****	*****	*****	*****	*****	*****	*****	
11122103	1	0.00375					*								
11122201	3	1					11241000	12	9	2	1	0.0			
11122202	1	2					11241100	0	1						
11122203	4	3					11241101	2	0.00200						
11122301	0.0	3					11241102	2	0.00260						
11122400	0						11241103	2	0.00375						
11122401	317.0	4					11241104	2	0.00475						
11122501	0	0	0	1	731.2	1	11241201	7	2						
11122502	0	0	0	1	556.2	2	11241202	2	4						
11122503	0	0	0	1	1470.3	3	11241203	1	6						
11122601	112010000	0	101	1	731.2	1	11241204	4	8						
11122602	116010000	0	101	1	556.2	2	11241301	0.0	2						
11122603	120010000	0	101	1	1470.3	3	11241302	1.0	4						



11321000 5 4 2 1 0.04405

11321100 0 1  
11321101 3 0.04655  
11321201 5 3  
11321301 0.0 3

11321400 0  
11321401 317.0 4  
11321501 156020000 0 101 1 5.406 1  
11321502 156020000 0 101 1 4.800 2  
11321503 156010000 0 101 1 2.939 3  
11321504 156010000 0 101 1 7.176 4  
11321505 156010000 0 101 1 5.800 5  
11321601 132010000 0 101 1 5.406 1  
11321602 136010000 0 101 1 4.800 2  
11321603 140010000 0 101 1 2.939 3  
11321604 144010000 0 101 1 7.176 4  
11321605 148010000 0 101 1 5.800 5  
11321701 0 0 0 0 5  
11321801 0. 10.0 10.0 0. 0. 0.0 0. 1. 5  
11321901 0. 10.0 10.0 0. 0. 0.0 0. 1. 5

\*

\* 144-1: upper core support plate

11441000 1 9 1 1 0.0

11441100 0 1

11441101 8 0.304

11441201 5 8

11441301 0.0 8

11441400 0

11441401 317.0 9

11441501 144010000 0 101 0 0.156 1

11441601 140010000 0 101 0 0.156 1

11441701 0 0 0 0 1

11441801 0. 10.0 10.0 0. 0. 0. 0. 1. 1

11441901 0. 10.0 10.0 0. 0. 0. 0. 1. 1

\*

\* 148-1: reactor vessel wall above upper plenum flange

11481000 1 7 2 1 0.320

11481100 0 1

11481101 1 0.323

11481102 4 0.522

11481103 1 0.647

11481201 5 1

11481202 6 5

11481203 9 6

11481301 0.0 6

11481400 0

11481401 317.0 7

11481501 148010000 0 101 1 0.404 1

11481601 900010000 0 101 1 0.404 1

11481701 0 0 0 0 1

11481801 0. 10.0 10.0 0. 0. 0. 0. 1. 1

11481901 0. 10.0 10.0 0. 0. 0. 0. 1. 1

\*

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\* 152-1; reactor vessel upper head

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\*

11521000 1 7 3 1 0.320

11521100 0 1

11521101 1 0.324

11521102 4 0.354

11521103 1 0.479

11521201 5 1

11521202 6 5

11521203 9 6

11521301 0.0 6

11521400 0

11521401 317.0 7

11521501 152010000 0 101 1 0.5 1

11521601 900010000 0 101 1 0.5 1

11521701 0 0 0 0 1

11521801 0. 10.0 10.0 0. 0. 0. 0. 1. 1

11521901 0. 10.0 10.0 0. 0. 0. 0. 1. 1

\*

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\* ht str no. 212-1 Loop Heat Structures

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\*

12121000 2 6 3 1 0.377 0

12121100 0 1

12121101 1 0.380

12121102 2 0.430

12121103 2 0.555

12121201 5 1

12121202 6 3

12121203 9 5

12121301 0.0 5

12121400 0

12121401 317.0 6

12121501 212010000 0 101 1 0.1872 1

12121502 228010000 0 101 1 0.1872 2

12121601 900010000 0 101 1 0.1872 2

12121701 0 0 0 0 2

12121801 0. 10.0 10.0 0. 0. 0. 0. 1. 2

12121901 0. 10.0 10.0 0. 0. 0. 0. 1. 2

\*

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\* ht str no. 212-2 blsg inlet/outlet plnm walls

\*\*\*\*\*

12122000 5 6 2 1 0.365 0

12122100 0 1

12122101 1 0.368

12122102 2 0.434

12122103 2 0.559

12122201 5 1

12122202 6 3

12122203 9 5

12122301 0.0 5

12122400 0

12122401 317.0 6

12122501 212010000 0 101 1 0.4237 1

12122502	228010000	0	101	1	0.4237	2	13001101	2	0.0572						
12122503	214010000	0	101	1	0.55175	3	13001102	2	0.1572						
12122504	216010000	0	101	1	0.55175	4	13001201	5	2						
12122505	224010000	0	101	1	1.1035	5	13001202	9	4						
12122601	900010000	0	101	1	0.4237	2	13001301	0.0	4						
12122602	900010000	0	101	1	0.55175	4	13001401	317.0	5						
12122603	900010000	0	101	1	1.1035	5	13001501	300010000	0	101	1	9.0016	1		
12122701	0	0	0	0	0	5	13001502	300020000	0	101	1	8.3920	2		
12122801	0.	10.0	10.0	0.	0.	0.	1.5	13001503	300030000	10000	101	1	10.2616	4	
12122901	0.	10.0	10.0	0.	0.	0.	0.	1.5	13001504	300050000	0	101	1	10.2380	5
*							13001601	900010000	0	101	1	9.0016	1		
*****	*****	*****	*****	*****	*****	*****	13001602	900010000	0	101	1	8.3920	2		
*	ht str no. 220-2 blsg inlet/outlet tube sheet						13001603	900010000	0	101	1	10.2616	4		
*****	*****	*****	*****	*****	*****	*****	13001604	900010000	0	101	1	10.2380	5		
12202000	2	4	2	1	0.0098	0	13001701	0	0	0	0	0	5		
12202100	0	1					13001801	0.	10.0	10.0	0.	0.	0.	1.5	
12202101	3	0.0163					13001901	0.	10.0	10.0	0.	0.	0.	1.5	
12202201	5	3					*								
12202301	0.0	3					*****	*****	*****	*****	*****	*****			
12202400	0						*	ht str no. 300-2 blsg upper dc to separator							
12202401	317.0	4					*****	*****	*****	*****	*****	*****			
12202501	220010000	0	101	1	45.40	1	13002000	2	2	2	1	0.2514	0		
12202502	220080000	0	101	1	45.40	2	13002100	0		1					
12202601	0	0	0	1	45.40	2	13002101	1		0.2554					
12202701	0	0	0	0	0	2	13002201	5		1					
12202801	0.	10.0	10.0	0.	0.	0.	13002301	0.0		1					
*****	*****	*****	*****	*****	*****	*****	13002400	0							
*	ht str no. 220-1 sg in the loop without pressurizer						13002401	317.0	2						
*****	*****	*****	*****	*****	*****	*****	13002501	304050000	0	101	1	0.6461	1		
*							13002502	308010000	0	101	1	2.120	2		
12201000	12	8	2	1	0.00980		13002601	300010000	0	101	1	0.6461	1		
12201100	0	1					13002602	308010000	0	101	1	2.120	2		
12201101	7	0.0127					13002701	0	0	0	0	0	2		
12201201	5	7					13002801	0.	10.0	10.0	0.	0.	0.	1.2	
12201301	0.0	7					13002901	0.	10.0	10.0	0.	0.	0.	1.1	
12201400	0						13002902	0.	10.0	10.0	0.	0.	0.	1.2	
12201401	317.0	8					*								
12201501	220010000	10000	101	1	89.76	4	*****	*****	*****	*****	*****	*****			
12201502	220050000	10000	101	1	180.86	6	*	ht str no. 300-3 blsg upper sg shell to environ							
12201503	220070000	0	101	1	361.72	7	*****	*****	*****	*****	*****	*****			
12201504	220080000	10000	101	1	306.36	9	*								
12201505	220100000	10000	101	1	361.72	11	13003000	4	6	2	1	0.4375	0		
12201506	220120000	0	101	1	359.04	12	13003100	0		1					
12201601	304010000	0	110	1	89.76	4	13003101	1		0.4405					
12201602	304020000	0	110	1	180.86	6	13003102	2		0.4785					
12201603	304030000	0	110	1	361.72	7	13003103	2		0.6035					
12201604	304040000	0	110	1	306.36	9	13003201	5		1					
12201605	304030000	-10000	110	1	361.72	11	13003202	6		3					
12201606	304010000	0	110	1	359.04	12	13003203	9		5					
12201701	0	0	0	0	12		13003301	0.0		5					
12201801	0.	10.0	10.0	0.	0.	0.	12	13003400	0						
12201900	1						13003401	317.0	6						
12201901	0.	10.	10.	0.	0.	0.	1.	10.2	1.1	1.0	12	1	0.6461	1	
*							13003501	300010000	0	101	1	1	1.0104	2	
*****	*****	*****	*****	*****	*****	*****	13003502	304050000	0	101	1	1	2.120	3	
*	ht str no. 300-1 blsg external dc pipe to environ						13003503	312010000	0	101	1	1	3.4278	4	
*****	*****	*****	*****	*****	*****	*****	13003504	316010000	0	101	1	1	0.6461	1	
13001000	5	5	2	1	0.0486	0	13003601	900010000	0	101	1	1	1.0104	2	
13001100	0	1					13003602	900010000	0	101	1	1	2.120	3	
							13003603	900010000	0	101	1	1			

13003604	900010000	0	101	1	3.4278	4	13041502	304020000	10000	101	1	2.5654	3			
13003701	0	0	0	0	0	4	13041503	304040000	0	101	1	2.098	4			
13003801	0.	10.0	10.0	0.	0.	0.	1.	1	13041504	304050000	0	101	1	0.3658	5	
13003802	0.	10.0	10.0	0.	0.	0.	0.	1.	2	13041601	900010000	0	101	1	1.2827	1
13003803	0.	10.0	10.0	0.	0.	0.	0.	1.	3	13041602	900010000	0	101	1	2.5654	3
13003804	0.	10.0	10.0	0.	0.	0.	0.	1.	4	13041603	900010000	0	101	1	2.098	4
13003901	0.	10.0	10.0	0.	0.	0.	0.	1.	4	13041604	900010000	0	101	1	0.3658	5
*							13041701	0	0	0	0	0	5			
*****																
* ht str no. 300-4 blsg lower sg dc to boiler																
*****																
13004000	1	2	2	1	0.345	0	*									
13004100	0		1				13041801	0.	10.0	10.0	0.	0.	0.			
13004101	1		0.351				13041802	0.	10.0	10.0	0.	0.	0.			
13004201	5		1				13041901	0.	10.0	10.0	0.	0.	0.			
13004301	0.0		1				*									
13004400	0						13121000	1	2	2	1	0.2982	0			
13004401	317.0		2				13121100	0			1					
13004501	304010000	0	101	1	1.0637	1	13121101	1			0.3012					
13004601	300050000	0	101	1	1.0637	1	13121201	5			1					
13004701	0	0	0	0	0	1	13121301	0.0			1					
13004801	0.	10.0	10.0	0.	0.	0.	1.	13121400	0							
13004901	0.	10.0	10.0	0.	0.	0.	0.	13121401	317.0		2					
*							13121501	308010000	0	101	1	1.7886	1			
*****																
* ht str no. 300-5 blsg lower sg dc wall to environ																
*****																
13005000	1	6	2	1	0.370	0	13121601	312010000	0	101	1	1.7886	1			
13005100	0		1				13121701	0	0	0	0	0	1			
13005101	1		0.373				13121801	0.	10.0	10.0	0.	0.	0.			
13005102	2		0.405				13121901	0.	10.0	10.0	0.	0.	0.			
13005103	2		0.530				*									
13005201	5		1				13161000	1	6	3	1	0.447	0			
13005202	6		3				13161100	0			1					
13005203	9		5				13161101	1			0.451					
13005301	0.0		5				13161102	2			0.473					
13005400	0						13161103	2			0.598					
13005401	317.0		6				13161201	5			1					
13005501	300050000	0	101	1	1.2637	1	13161202	6			3					
13005601	900010000	0	101	1	1.2637	1	13161203	9			5					
13005701	0	0	0	0	0	1	13161301	0.0			5					
13005801	0.	10.0	10.0	0.	0.	0.	1.	13161400	0							
13005901	0.	10.0	10.0	0.	0.	0.	0.	13161401	317.0		6					
*							13161501	316010000	0	101	1	0.391	1			
*****																
* ht str no. 304-1 blsg boiler wall to environ																
*****																
13041000	5	6	2	1	0.347	0	13161601	900010000	0	101	1	0.391	1			
13041100	0		1				13161701	0	0	0	0	0	1			
13041101	1		0.350				13161801	0.	10.0	10.0	0.	0.	0.			
13041102	2		0.380				13161901	0.	10.0	10.0	0.	0.	0.			
13041103	2		0.505				*									
13041201	5		1				13161100	0			1					
13041202	6		3				14001000	6	5	2	1	0.1035	0			
13041203	9		5				14001100	0			1					
13041301	0.0		5				14001101	2			0.1981					
13041400	0						14001102	2			0.3231					
13041401	317.0		6				14001201	5			2					
13041501	304010000	0	101	1	1.2827	1	14001202	9			4					
							14001301	0.0			4					



14122504	416010000	0	101	1	0.55175	4	15001102	2	0.1572										
14122505	424010000	0	101	1	1.1035	5	15001201	5	2										
14122601	900010000	0	101	1	0.4237	2	15001202	9	4										
14122602	900010000	0	101	1	0.55175	4	15001301	0.0	4										
14122603	900010000	0	101	1	1.1035	5	15001401	317.0	5										
14122701	0	0	0	0	0	5	15001501	500010000	0	101	1	9.0016	1						
14122801	0.	10.0	10.0	0.	0.	0.	1.	5	15001502	500020000	0	101	1	8.3920	2				
14122901	0.	10.0	10.0	0.	0.	0.	0.	1.	5	15001503	500030000	10000	101	1	10.2616	4			
*							15001504	500050000	0	101	1	10.2380	5						
*****																			
*	ht str no. 420-1 intact loop sg tubes																		
*****																			
*							15001601	900010000	0	101	1	9.0016	1						
							15001602	900010000	0	101	1	8.3920	2						
							15001603	900010000	0	101	1	10.2616	4						
*							15001604	900010000	0	101	1	10.2380	5						
14201000	12	8	2	1	0.00980		15001701	0	0	0	0	0	5						
14201100	0	1					15001801	0.	10.0	10.0	0.	0.	0.	1.	5				
14201101	7	0.0127					15001901	0.	10.0	10.0	0.	0.	0.	0.	1.	5			
14201201	5	7					*												
14201301	0.0	7					*****												
14201400	0						*	ht str no. 500-2 ilsg upper dc to separator											
14201401	317.0	8					*****												
14201501	420010000	10000	101	1	89.76	4	15002000	2	2	2	1	0.2514	0						
14201502	420050000	10000	101	1	180.86	6	15002100	0			1								
14201503	420070000	0	101	1	361.72	7	15002101	1			0.2554								
14201504	420080000	10000	101	1	306.36	9	15002201	5			1								
14201505	420100000	10000	101	1	361.72	11	15002301	0.0			1								
14201506	420120000	0	101	1	359.04	12	15002400	0											
14201601	504010000	0	110	1	89.76	4	15002401	317.0			2								
14201602	504020000	0	110	1	180.86	6	15002501	504050000	0	101	1	0.6461	1						
14201603	504030000	0	110	1	361.72	7	15002502	508010000	0	101	1	2.120	2						
14201604	504040000	0	110	1	306.36	9	15002601	500010000	0	101	1	0.6461	1						
14201605	504030000	-10000	110	1	361.72	11	15002602	508010000	0	101	1	2.120	2						
14201606	504010000	0	110	1	359.04	12	15002701	0	0	0	0	0	2						
14201701	0	0	0	0	12		15002801	0.	10.0	10.0	0.	0.	0.	1.	2				
14201801	0.	10.0	10.0	0.0	0.0	0.	1.	12	15002901	0.	10.0	10.0	0.	0.	0.	1.	1		
14201900	1						15002902	0.	10.0	10.0	0.	0.	0.	1.	2				
14201901	0.	10.0	10.0	0.0	0.	0.	1.	10.2	1.1	1.0	12	*							
*							*****												
*	ht str no. 420-2 ilsg inle/outlet tube sheet																		
*****																			
*							*	ht str no. 500-3 ilsg upper sg shell to environ											
							15003000	4	6	2	1	0.4375	0						
14202000	2	4	2	1	0.0098	0	15003100	0			1								
14202100	0		1				15003101	1			0.4405								
14202101	3		0.0163				15003102	2			0.4785								
14202201	5		3				15003103	2			0.6035								
14202301	0.0		3				15003201	5			1								
14202400	0						15003202	6			3								
14202401	317.0	4					15003203	9			5								
14202501	420010000	0	101	1	45.40	1	15003301	0.0			5								
14202502	420080000	0	101	1	45.40	2	15003400	0											
14202601	0	0	0	1	45.40	2	15003401	317.0			6								
14202701	0	0	0	0	0	2	15003501	500010000	0	101	1	0.6461	1						
14202801	0.	10.0	10.0	0.	0.	0.	1.	2	15003502	504050000	0	101	1	1.0104	2				
*							15003503	512010000	0	101	1	2.120	3						
*	ht str no. 500-1 ilsg external dc pipe to environ																		
*****																			
15001000	5	5	2	1	0.0486	0	15003504	516010000	0	101	1	3.4278	4						
15001100	0		1				15003601	900010000	0	101	1	0.6461	1						
15001101	2		0.0572				15003602	900010000	0	101	1	1.0104	2						
							15003603	900010000	0	101	1	2.120	3						
							15003604	900010000	0	101	1	3.4278	4						
							15003701	0	0	0	0	0	4						

15003801	0.	10.0	10.0	0.	0.	0.	0.	1.	1	15041504	504050000	0	101	1	0.3658	5
15003802	0.	10.0	10.0	0.	0.	0.	0.	1.	2	15041601	900010000	0	101	1	1.2827	1
15003803	0.	10.0	10.0	0.	0.	0.	0.	1.	3	15041602	900010000	0	101	1	2.5654	3
15003804	0.	10.0	10.0	0.	0.	0.	0.	1.	4	15041603	900010000	0	101	1	2.098	4
15003901	0.	10.0	10.0	0.	0.	0.	0.	1.	4	15041604	900010000	0	101	1	0.3658	5
*										15041701	0	0	0	0	0	5
*****																
* ht str no. 500-4 ilsg lower sg dc to boiler																
*****																
15004000	1	2	2	1	0.345	0	*									
15004100	0		1													
15004101	1		0.351													
15004201	5		1													
15004301	0.0		1													
15004400	0															
15004401	317.0		2													
15004501	504010000	0	101	1	1.0637	1	15121000	1	2	2	1	0.2982	0			
15004601	500050000	0	101	1	1.0637	1	15121100	0								
15004701	0		0	0	0	1	15121101	1								
15004801	0.	10.0	10.0	0.	0.	0.	0.	1.	1	15121201	5					
15004901	0.	10.0	10.0	0.	0.	0.	0.	1.	1	15121301	0.0					
*							15121400	0								
*****																
* ht str no. 500-5 ilsg lower sg dc wall to environ																
*****																
15005000	1	6	2	1	0.370	0	15121401	317.0								
15005100	0		1				15121501	508010000	0	101	1	1.7886	1			
15005101	1		0.373				15121601	512010000	0	101	1	1.7886	1			
15005102	2		0.405				15121701	0	0			0	0	1		
15005103	2		0.530				15121801	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15005201	5		1				15121901	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15005202	6		3				*									
15005203	9		5													
15005301	0.0		5													
15005400	0															
15005401	317.0		6													
15005501	500050000	0	101	1	1.2637	1	15161000	1	6	3	1	0.447	0			
15005601	900010000	0	101	1	1.2637	1	15161100	0								
15005701	0		0	0	0	1	15161101	1								
15005801	0.	10.0	10.0	0.	0.	0.	0.	1.	1	15161102	2					
15005901	0.	10.0	10.0	0.	0.	0.	0.	1.	1	15161103	2					
*							15161201	5								
*****																
* ht str no. 504-1 ilsg boiler wall to environ																
*****																
15041000	5	6	2	1	0.347	0	15161202	6								
15041100	0		1				15161203	9								
15041101	1		0.350				15161301	0.0								
15041102	2		0.380				15161400	0								
15041103	2		0.505				15161401	317.0								
15041201	5		1				15161501	516010000	0	101	1	0.391	1			
15041202	6		3				15161601	900010000	0	101	1	0.391	1			
15041203	9		5				15161701	0	0	0	0	0	1			
15041301	0.0		5				15161801	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15041400	0						15161901	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15041401	317.0		6				*									
15041501	504010000	0	101	1	1.2827	1										
15041502	504020000	10000	101	1	2.5654	3	16101000	7	6	2	1	0.300	0			
15041503	504040000	0	101	1	2.098	4	16101100	0								
							16101101	1								
							16101102	2								
							16101103	2								
							16101201	5								
							16101202	6								
							16101203	9								
							16101301	0.0								
							16101400	0								



\* nicr heater  
 \*  
 20100251 300.0 3.00e+6  
 20100252 373.15 3.23e+6 573.15 3.62e+6 773.15 4.10e+6  
 20100253 1073.15 4.61e+6 1173.15 4.73e+6 1273.15 4.95e+6  
 20100254 1473.15 5.29e+6 10000.0 5.29e+6  
 \*  
 \* copper  
 \*  
 20100351 3.43e6  
 \*  
 \* inconel 600  
 \*  
 20100451 300.0 3.50e6 323.0 3.76e6  
 20100452 373.15 3.94e+6 573.15 4.18e+6 873.15 4.71e+6  
 20100453 1173.15 5.17e+6  
 \*  
 \* stainless steel  
 \*  
 20100551 273.15 3.83e+6 366.5 3.83e+6 477.59 4.19e+6  
 20100552 588.59 4.336e+6 699.82 4.504e+6 810.93 4.639e+6  
 20100553 922.04 4.773e+6 1144.26 5.076e+6 1366.5 5.376e+6  
 20100554 1477.59 5.546e+6 10000.0 5.546e+6  
 \*  
 \* aluminum oxide  
 \*  
 20100751 300.0 3.00e6  
 20100752 373.15 3.015e+6 473.15 3.482e+6 573.15 3.796e+6  
 20100753 673.15 3.946e+6 773.15 4.093e+6 873.15 4.239e+6  
 20100754 973.15 4.384e+6 1073.16 4.373e+6 1173.16 4.529e+6  
 20100755 1373.16 4.529e+6 1473.16 4.685e+6  
 \*  
 \* rockwool  
 \*  
 20100951 1.36e-5  
 \*  
 \* core power  
 \*  
 \*  
 20288800 power 501  
 20288801 -1.0 0.430e+6  
 20288802 0.0 0.430e+6  
 \*  
 \*  
 \* Control Systems  
 \*  
 \* calculate core collapsed liquid level  
 \*  
 20512400 "core lvl" sum 1.0 3.66 1  
 20512401 0.0 0.305 voidf 124010000  
 20512402 0.305 voidf 124020000  
 20512403 0.305 voidf 124030000  
 20512404 0.305 voidf 124040000  
 20512405 0.305 voidf 124050000  
 20512406 0.305 voidf 124060000  
 20512407 0.305 voidf 124070000  
 20512408 0.305 voidf 124080000  
 20512409 0.305 voidf 124090000  
 20512410 0.305 voidf 124100000  
 20512411 0.305 voidf 124110000  
 20512412 0.305 voidf 124120000  
 \*\*\*\*  
 \* calculate core collapsed liquid level ---vessel---  
 \*  
 20512500 "core lvl" sum 1.0 5.8027 1  
 20512501 0.0 0.305 voidf 124010000  
 20512502 0.305 voidf 124020000  
 20512503 0.305 voidf 124030000  
 20512504 0.305 voidf 124040000  
 20512505 0.305 voidf 124050000  
 20512506 0.305 voidf 124060000  
 20512507 0.305 voidf 124070000  
 20512508 0.305 voidf 124080000  
 20512509 0.305 voidf 124090000  
 20512510 0.305 voidf 124100000  
 20512511 0.305 voidf 124110000  
 20512512 0.305 voidf 124120000  
 20512513 0.867 voidf 128010000  
 20512514 0.6757 voidf 132010000  
 20512515 0.6 voidf 136010000  
 \*  
 20575100 "dpdoup" sum 1.0 0.0 1  
 20575101 0.0 1.0 p 136010000  
 20575102 -1.0 p 104010000  
 \*  
 20575300 "dpe080" sum 1.0 266000. 1  
 20575301 0.0 1.0 p 436010000  
 20575302 -1.0 p 436040000  
 \*  
 20575700 "dpe220" sum 1.0 266000. 1  
 20575701 0.0 1.0 p 236010000  
 20575702 -1.0 p 236040000  
 \*  
 20575400 "updp" sum 1.0 0.0 1  
 20575401 0.0 1.0 p 128010000  
 20575402 -1.0 p 136010000  
 \*  
 20575500 "ildown" sum 1.0 0.0 1  
 20575501 0.0 -1.0 p 432010000  
 20575502 1.0 p 432050000  
 \*  
 20575600 "bldown" sum 1.0 0.0 1  
 20575601 0.0 -1.0 p 232010000  
 20575602 1.0 p 232050000  
 \*  
 20576000 "dpe290" sum 1.0 1200. 1  
 20576001 0.0 1.0 p 120010000  
 20576002 -1.0 p 124010000  
 \*  
 20576100 "dpe300" sum 1.0 32000. 1  
 20576101 0.0 1.0 p 124010000  
 20576102 -1.0 p 128010000  
 \*  
 20576300 "dpe320" sum 1.0 13000. 1  
 20576301 0.0 1.0 p 128010000

20576302		-1.0	p	140010000	20561900	"v-214"	mult	1.0	0.1	1	
*					20561901	tmassv		214010000			
*****	*****	*****	*****	*****	20561902	quals		214010000			
* calculate wide range sg liquid levels					20561903	quala		214010000			
*****	*****	*****	*****	*****	20562200	"v-216"	mult	1.0	0.1	1	
*					20562201	tmassv		216010000			
20531200	"blsglwde"	sum	1.0	8.9221049 1	20562202	quals		216010000			
20531201	0.0	2.5464	voidf	304010000	20562203	quala		216010000			
20531202		2.5654	voidf	304020000	*						
20531203		2.5654	voidf	304030000	20562300	"v-220-1"	mult	1.0	0.1	1	
20531204		2.0980	voidf	304040000	20562301	tmassv		220010000			
20531205		2.0223	voidf	304050000	20562302	quals		220010000			
20531206		2.1200	voidf	308010000	20562303	quala		220010000			
20531207		3.7778	voidf	316010000	20562400	"v-220-2"	mult	1.0	0.1	1	
*					20562401	tmassv		220020000			
20551200	"ilsglwde"	sum	1.0	8.8904978 1	20562402	quals		220020000			
20551201	0.0	2.5464	voidf	504010000	20562403	quala		220020000			
20551202		2.5654	voidf	504020000	20562500	"v-220-3"	mult	1.0	0.1	1	
20551203		2.5654	voidf	504030000	20562501	tmassv		220030000			
20551204		2.0980	voidf	504040000	20562502	quals		220030000			
20551205		2.0223	voidf	504050000	20562503	quala		220030000			
20551206		2.1200	voidf	508010000	20562600	"v-220-4"	mult	1.0	0.1	1	
20551207		3.7778	voidf	516010000	20562601	tmassv		220040000			
*					20562602	quals		220040000			
*****	*****	*****	*****	*****	20562603	quala		220040000			
* calculate the noncondensable mass in primary					20562700	"v-220-5"	mult	1.0	0.1	1	
* system-broken loop					20562701	tmassv		220050000			
*****	*****	*****	*****	*****	20562702	quals		220050000			
*					20562703	quala		220050000			
20561100	"v-200"	mult	1.0	0.1	1	20562800	"v-220-6"	mult	1.0	0.1	1
20561101	tmassv		200010000			20562801	tmassv		220060000		
20561102	quals		200010000			20562802	quals		220060000		
20561103	quala		200010000			20562803	quala		220060000		
*						20562900	"v-220-7"	mult	1.0	0.1	1
20561200	"v-206"	mult	1.0	0.1	1	20562901	tmassv		220070000		
20561201	tmassv		206010000			20562902	quals		220070000		
20561202	quals		206010000			20562903	quala		220070000		
20561203	quala		206010000			20563000	"v-220-8"	mult	1.0	0.1	1
*						20563001	tmassv		220080000		
20561300	"v-208-1"	mult	1.0	0.1	1	20563002	quals		220080000		
20561301	tmassv		208010000			20563003	quala		220080000		
20561302	quals		208010000			20563100	"v-220-9"	mult	1.0	0.1	1
20561303	quala		208010000			20563101	tmassv		220090000		
20561400	"v-208-2"	mult	1.0	0.1	1	20563102	quals		220090000		
20561401	tmassv		208020000			20563103	quala		220090000		
20561402	quals		208020000			20563200	"v-220-10"	mult	1.0	0.1	1
20561403	quala		208020000			20563201	tmassv		220100000		
*						20563202	quals		220100000		
20562000	"hl-b-nc"	sum	1.0	0.1	1	20563203	quala		220100000		
20562001	0.0	1.0	cntrivar	611		20563300	"v-220-11"	mult	1.0	0.1	1
20562002		1.0	cntrivar	612		20563301	tmassv		220110000		
20562003		1.0	cntrivar	613		20563302	quals		220110000		
20562004		1.0	cntrivar	614		20563303	quala		220110000		
***						20563400	"v-220-12"	mult	1.0	0.1	1
20562100	"v-212"	mult	1.0	0.1	1	20563401	tmassv		220120000		
20562101	tmassv		212010000			20563402	quals		220120000		
20562102	quals		212010000			20563403	quala		220120000		
20562103	quala		212010000			*					
*						20563500	"v-224"	mult	1.0	0.1	1

20563501	tmassv	224010000		20564703	quala	236020000					
20563502	quals	224010000		20564800	"v-236-3"	mult 1.0	0.1	0.1	1		
20563503	quala	224010000		20564801	tmassv	236030000					
*				20564802	quals	236030000					
20563600	"v-228"	mult 1.0	0.1	1	20564803	quala	236030000				
20563601	tmassv	228010000		20564900	"v-236-4"	mult 1.0	0.1	0.1	1		
20563602	quals	228010000		20564901	tmassv	236040000					
20563603	quala	228010000		20564902	quals	236040000					
*				20564903	quala	236040000					
20563900	"sg-b-t"	sum 1.0	0.1	1	*						
20563901	0.0	1.0 cntrivar	623	20565000	"ol-b-nc"	sum 1.0	0.1	0.1	1		
20563902		1.0 cntrivar	624	20565001	0.0	1.0 cntrivar	641				
20563903		1.0 cntrivar	625	20565002		1.0 cntrivar	642				
20563904		1.0 cntrivar	626	20565003		1.0 cntrivar	643				
20563905		1.0 cntrivar	627	20565004		1.0 cntrivar	644				
20563906		1.0 cntrivar	628	20565005		1.0 cntrivar	645				
20563907		1.0 cntrivar	629	20565006		1.0 cntrivar	646				
20563908		1.0 cntrivar	630	20565007		1.0 cntrivar	647				
20563909		1.0 cntrivar	631	20565008		1.0 cntrivar	648				
20563910		1.0 cntrivar	632	20565009		1.0 cntrivar	649				
20563911		1.0 cntrivar	633	*							
20563912		1.0 cntrivar	634	20565100	"v-240"	mult 1.0	0.1	0.1	1		
*				20565101	tmassv	240010000					
20564000	"sg-b-nc"	sum 1.0	0.1	1	20565102	quals	240010000				
20564001	0.0	1.0 cntrivar	621	20565103	quala	240010000					
20564002		1.0 cntrivar	619	*							
20564003		1.0 cntrivar	622	20565200	"v-244"	mult 1.0	0.1	0.1	1		
20564004		1.0 cntrivar	639	20565201	tmassv	244010000					
20564005		1.0 cntrivar	635	20565202	quals	244010000					
20564006		1.0 cntrivar	636	20565203	quala	244010000					
***				*							
20564100	"v-232-1"	mult 1.0	0.1	1	20565300	"v-248"	mult 1.0	0.1	0.1	1	
20564101	tmassv	232010000		20565301	tmassv	248010000					
20564102	quals	232010000		20565302	quals	248010000					
20564103	quala	232010000		20565303	quala	248010000					
20564200	"v-232-2"	mult 1.0	0.1	1	*						
20564201	tmassv	232020000		20565400	"v-252-1"	mult 1.0	0.1	0.1	1		
20564202	quals	232020000		20565401	tmassv	252010000					
20564203	quala	232020000		20565402	quals	252010000					
20564300	"v-232-3"	mult 1.0	0.1	1	20565403	quala	252010000				
20564301	tmassv	232030000		20565500	"v-252-2"	mult 1.0	0.1	0.1	1		
20564302	quals	232030000		20565501	tmassv	252020000					
20564303	quala	232030000		20565502	quals	252020000					
20564400	"v-232-4"	mult 1.0	0.1	1	20565503	quala	252020000				
20564401	tmassv	232040000		*							
20564402	quals	232040000		20566000	"cl-b-nc"	sum 1.0	0.1	0.1	1		
20564403	quala	232040000		20566001	0.0	1.0 cntrivar	651				
20564500	"v-232-5"	mult 1.0	0.1	1	20566002		1.0 cntrivar	652			
20564501	tmassv	232050000		20566003		1.0 cntrivar	653				
20564502	quals	232050000		20566004		1.0 cntrivar	654				
20564503	quala	232050000		20566005		1.0 cntrivar	655				
*				*							
20564600	"v-236-1"	mult 1.0	0.1	1	*****						
20564601	tmassv	236010000		*	calculate the noncondensable mass in primary						
20564602	quals	236010000		*	system-Intact loop						
20564603	quala	236010000		*****							
20564700	"v-236-2"	mult 1.0	0.1	1	*						
20564701	tmassv	236020000		20581100	"v-400"	mult 1.0	0.1	0.1	1		
20564702	quals	236020000		20581101	tmassv	400010000					

20581102	quals	400010000					20582802	quals	420060000			
20581103	quala	400010000					20582803	quala	420060000			
*							20582900	"v-420-7"	mult 1.0	0.1	1	
20581200	"v-406"	mult 1.0	0.1	1			20582901	tmassv	420070000			
20581201	tmassv	406010000					20582902	quals	420070000			
20581202	quals	406010000					20582903	quala	420070000			
20581203	quala	406010000					20583000	"v-420-8"	mult 1.0	0.1	1	
*							20583001	tmassv	420080000			
20581300	"v-408-1"	mult 1.0	0.1	1			20583002	quals	420080000			
20581301	tmassv	408010000					20583003	quala	420080000			
20581302	quals	408010000					20583100	"v-420-9"	mult 1.0	0.1	1	
20581303	quala	408010000					20583101	tmassv	420090000			
20581400	"v-408-2"	mult 1.0	0.1	1			20583102	quals	420090000			
20581401	tmassv	408020000					20583103	quala	420090000			
20581402	quals	408020000					20583200	"v-420-10"	mult 1.0	0.1	1	
20581403	quala	408020000					20583201	tmassv	420100000			
*							20583202	quals	420100000			
20582000	"hl-i-nc"	sum 1.0	0.1	1			20583203	quala	420100000			
20582001	0.0	1.0 cntrlvar	811				20583300	"v-420-11"	mult 1.0	0.1	1	
20582002		1.0 cntrlvar	812				20583301	tmassv	420110000			
20582003		1.0 cntrlvar	813				20583302	quals	420110000			
20582004		1.0 cntrlvar	814				20583303	quala	420110000			
***							20583400	"v-420-12"	mult 1.0	0.1	1	
20582100	"v-412"	mult 1.0	0.1	1			20583401	tmassv	420120000			
20582101	tmassv	412010000					20583402	quals	420120000			
20582102	quals	412010000					20583403	quala	420120000			
20582103	quala	412010000				*						
*							20583500	"v-424"	mult 1.0	0.1	1	
20581900	"v-414"	mult 1.0	0.1	1			20583501	tmassv	424010000			
20581901	tmassv	414010000					20583502	quals	424010000			
20581902	quals	414010000					20583503	quala	424010000			
20581903	quala	414010000				*						
20582200	"v-416"	mult 1.0	0.1	1			20583600	"v-428"	mult 1.0	0.1	1	
20582201	tmassv	416010000					20583601	tmassv	428010000			
20582202	quals	416010000					20583602	quals	428010000			
20582203	quala	416010000					20583603	quala	428010000			
*						*						
20582300	"v-420-1"	mult 1.0	0.1	1			20583900	"sg-b-tb"	sum 1.0	0.1	1	
20582301	tmassv	420010000					20583901	0.0	1.0 cntrlvar	823		
20582302	quals	420010000					20583902		1.0 cntrlvar	824		
20582303	quala	420010000					20583903		1.0 cntrlvar	825		
20582400	"v-420-2"	mult 1.0	0.1	1			20583904		1.0 cntrlvar	826		
20582401	tmassv	420020000					20583905		1.0 cntrlvar	827		
20582402	quals	420020000					20583906		1.0 cntrlvar	828		
20582403	quala	420020000					20583907		1.0 cntrlvar	829		
20582500	"v-420-3"	mult 1.0	0.1	1			20583908		1.0 cntrlvar	830		
20582501	tmassv	420030000					20583909		1.0 cntrlvar	831		
20582502	quals	420030000					20583910		1.0 cntrlvar	832		
20582503	quala	420030000					20583911		1.0 cntrlvar	833		
20582600	"v-420-4"	mult 1.0	0.1	1			20583912		1.0 cntrlvar	834		
20582601	tmassv	420040000				*						
20582602	quals	420040000					20584000	"sg-i-nc"	sum 1.0	0.1	1	
20582603	quala	420040000					20584001	0.0	1.0 cntrlvar	821		
20582700	"v-420-5"	mult 1.0	0.1	1			20584002		1.0 cntrlvar	819		
20582701	tmassv	420050000					20584003		1.0 cntrlvar	822		
20582702	quals	420050000					20584004		1.0 cntrlvar	839		
20582703	quala	420050000					20584005		1.0 cntrlvar	835		
20582800	"v-420-6"	mult 1.0	0.1	1			20584006		1.0 cntrlvar	836		
20582801	tmassv	420060000				***						

20584100	"v-432-1"	mult	1.0	0.1	1	20585300	"v-448"	mult	1.0	0.1	1
20584101	tmassv	432010000				20585301	tmassv	448010000			
20584102	quals	432010000				20585302	quals	448010000			
20584103	quala	432010000				20585303	quala	448010000			
20584200	"v-432-2"	mult	1.0	0.1	1	*					
20584201	tmassv	432020000				20585400	"v-452"	mult	1.0	0.1	1
20584202	quals	432020000				20585401	tmassv	452010000			
20584203	quala	432020000				20585402	quals	452010000			
20584300	"v-432-3"	mult	1.0	0.1	1	20585403	quala	452010000			
20584301	tmassv	432030000				*					
20584302	quals	432030000				20586000	"cl-i-nc"	sum	1.0	0.1	1
20584303	quala	432030000				20586001	0.0	1.0	cntrivar	851	
20584400	"v-432-4"	mult	1.0	0.1	1	20586002		1.0	cntrivar	852	
20584401	tmassv	432040000				20586003		1.0	cntrivar	853	
20584402	quals	432040000				20586004		1.0	cntrivar	854	
20584403	quala	432040000				*					
20584500	"v-432-5"	mult	1.0	0.1	1	*****	*****	*****	*****	*****	
20584501	tmassv	432050000				* calculate the noncondensable mass in primary					
20584502	quals	432050000				* system-pressurizer					
20584503	quala	432050000				*****	*****	*****	*****	*****	
*						*					
20584600	"v-436-1"	mult	1.0	0.1	1	20566100	"v-600-1"	mult	1.0	0.1	1
20584601	tmassv	436010000				20566101	tmassv	600010000			
20584602	quals	436010000				20566102	quals	600010000			
20584603	quala	436010000				20566103	quala	600010000			
20584700	"v-436-2"	mult	1.0	0.1	1	20566200	"v-600-2"	mult	1.0	0.1	1
20584701	tmassv	436020000				20566201	tmassv	600020000			
20584702	quals	436020000				20566202	quals	600020000			
20584703	quala	436020000				20566203	quala	600020000			
20584800	"v-436-3"	mult	1.0	0.1	1	20566300	"v-600-3"	mult	1.0	0.1	1
20584801	tmassv	436030000				20566301	tmassv	600030000			
20584802	quals	436030000				20566302	quals	600030000			
20584803	quala	436030000				20566303	quala	600030000			
20584900	"v-436-4"	mult	1.0	0.1	1	*					
20584901	tmassv	436040000				20566600	"v-610-1"	mult	1.0	0.1	1
20584902	quals	436040000				20566601	tmassv	610010000			
20584903	quala	436040000				20566602	quals	610010000			
*						20566603	quala	610010000			
20585000	"ol-i-nc"	sum	1.0	0.1	1	20566700	"v-610-2"	mult	1.0	0.1	1
20585001	0.0	1.0	cntrivar	841		20566701	tmassv	610020000			
20585002		1.0	cntrivar	842		20566702	quals	610020000			
20585003		1.0	cntrivar	843		20566703	quala	610020000			
20585004		1.0	cntrivar	844		20566800	"v-610-3"	mult	1.0	0.1	1
20585005		1.0	cntrivar	845		20566801	tmassv	610030000			
20585006		1.0	cntrivar	846		20566802	quals	610030000			
20585007		1.0	cntrivar	847		20566803	quala	610030000			
20585008		1.0	cntrivar	848		20566900	"v-610-4"	mult	1.0	0.1	1
20585009		1.0	cntrivar	849		20566901	tmassv	610040000			
***						20566902	quals	610040000			
20585100	"v-440"	mult	1.0	0.1	1	20566903	quala	610040000			
20585101	tmassv	440010000				20567000	"v-610-5"	mult	1.0	0.1	1
20585102	quals	440010000				20567001	tmassv	610050000			
20585103	quala	440010000				20567002	quals	610050000			
*						20567003	quala	610050000			
20585200	"v-444"	mult	1.0	0.1	1	20567100	"v-610-6"	mult	1.0	0.1	1
20585201	tmassv	444010000				20567101	tmassv	610060000			
20585202	quals	444010000				20567102	quals	610060000			
20585203	quala	444010000				20567103	quala	610060000			
*						20567200	"v-610-7"	mult	1.0	0.1	1

20567201	tmassv	610070000			*	20586500	"v-130"	mult	1.0	0.1	1
20567202	quals	610070000			20586501	tmassv	130010000				
20567203	quala	610070000			20586502	quals	130010000				
20567300	"v-610-8"	mult 1.0	0.1	1	20586503	quala	130010000				
20567301	tmassv	610080000			*						
20567302	quals	610080000			20586600	"v-132"	mult	1.0	0.1	1	
20567303	quala	610080000			20586601	tmassv	132010000				
*					20586602	quals	132010000				
20567400	"v-620-1"	mult 1.0	0.1	1	20586603	quala	132010000				
20567401	tmassv	620010000			*						
20567402	quals	620010000			20586700	"v-134"	mult	1.0	0.1	1	
20567403	quala	620010000			20586701	tmassv	134010000				
20567500	"v-620-2"	mult 1.0	0.1	1	20586702	quals	134010000				
20567501	tmassv	620020000			20586703	quala	134010000				
20567502	quals	620020000			*						
20567503	quala	620020000			20586800	"v-136"	mult	1.0	0.1	1	
*					20586801	tmassv	136010000				
20567900	"pqr-nc"	sum 1.0	0.1	1	20586802	quals	136010000				
20567901	0.0	1.0 cntrlvar	666		20586803	quala	136010000				
20567902		1.0 cntrlvar	667		*						
20567903		1.0 cntrlvar	668		20586900	"v-140"	mult	1.0	0.1	1	
20567904		1.0 cntrlvar	669		20586901	tmassv	140010000				
20567905		1.0 cntrlvar	670		20586902	quals	140010000				
20567906		1.0 cntrlvar	671		20586903	quala	140010000				
20567907		1.0 cntrlvar	672		*						
20567908		1.0 cntrlvar	673		20587000	"v-144"	mult	1.0	0.1	1	
*					20587001	tmassv	144010000				
20568000	"pqrsp-nc"	sum 1.0	0.1	1	20587002	quals	144010000				
20568001	0.0	1.0 cntrlvar	661		20587003	quala	144010000				
20568002		1.0 cntrlvar	662		*						
20568003		1.0 cntrlvar	663		20587100	"v-148"	mult	1.0	0.1	1	
20568004		1.0 cntrlvar	679		20587101	tmassv	148010000				
20568005		1.0 cntrlvar	674		20587102	quals	148010000				
20568006		1.0 cntrlvar	675		20587103	quala	148010000				
*					*						
*****											
* calculate the noncondensable mass in primary											
* system-reactor vessel											
*****											
*					*						
20586100	"v-100"	mult 1.0	0.1	1	20587200	"v-152"	mult	1.0	0.1	1	
20586101	tmassv	100010000			20587201	tmassv	152010000				
20586102	quals	100010000			20587202	quals	152010000				
20586103	quala	100010000			20587203	quala	152010000				
*					*						
20586200	"v-104"	mult 1.0	0.1	1	20587300	"v-156-1"	mult	1.0	0.1	1	
20586201	tmassv	104010000			20587301	tmassv	156010000				
20586202	quals	104010000			20587302	quals	156010000				
20586203	quala	104010000			20587303	quala	156010000				
*					*						
20586300	"v-108-1"	mult 1.0	0.1	1	20587400	"v-156-2"	mult	1.0	0.1	1	
20586301	tmassv	108010000			20587401	tmassv	156020000				
20586302	quals	108010000			20587402	quals	156020000				
20586303	quala	108010000			20587403	quala	156020000				
*					*						
20586400	"v-128"	mult 1.0	0.1	1	20588000	"vesel-nc"	sum 1.0	0.1	1		
20586401	tmassv	128010000			20588001	0.0	1.0 cntrlvar	861			
20586402	quals	128010000			20588002		1.0 cntrlvar	862			
20586403	quala	128010000			20588003		1.0 cntrlvar	863			
*					20588004		1.0 cntrlvar	864			
20588005							1.0 cntrlvar	865			
20588006							1.0 cntrlvar	866			
20588007							1.0 cntrlvar	867			
20588008							1.0 cntrlvar	868			

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20588009      1.0    cntrlvar   869
20588010      1.0    cntrlvar   870
20588011      1.0    cntrlvar   871
20588012      1.0    cntrlvar   872
20588013      1.0    cntrlvar   873
20588014      1.0    cntrlvar   874
*
*****
* total noncondeasable mass in primary system
*****
*
20593000 "t-nocd-m"    sum     1.0    0.1    1
20593001  0.0    1.0    cntrlvar   620
20593002      1.0    cntrlvar   640
20593003      1.0    cntrlvar   650
20593004      1.0    cntrlvar   660
20593005      1.0    cntrlvar   680
20593006      1.0    cntrlvar   820
20593007      1.0    cntrlvar   840
20593008      1.0    cntrlvar   850
20593009      1.0    cntrlvar   860
20593010      1.0    cntrlvar   880
*
20592900 "u-tubes"    sum     1.0    0.1    1
20592901  0.0    1.0    cntrlvar   639
20592902      1.0    cntrlvar   839
*
*****
* core power
*****
*
20588800 "core pow"    function   1.0    0.43e+6   1
20588801    time     0        888
*
*****
* calculate time-integrated break mass flow
*****
*
20591500 "int bflo"    integral   1.0    0.00    1
20591501    mflowj    915000000
*
. zzz

```

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*****
*          * 329 tempf    124030000 * core water temperature
*          * 330 tempf    124040000 *
*          * 331 tempf    124050000 *
*          * 332 sattemp  124060000 * core saturation temp.
*          * 333 voidg    124010000 *
*          * 334 voidg    124020000 *
*          * 335 voidg    124030000 *
*          * 336 voidg    124040000 * core void
*          * 337 voidg    124050000 *
*          * 338 voidg    124060000 *
*          * 339 voidf    104010000 * vessel inlet
*          * 340 voidf    136010000 * vessel outlet
*          * 341 voidf    200010000 * hot leg-b
*          * 342 voidf    206010000 *
*          * 343 voidf    208010000 *
*          * 344 voidf    212010000 * sg-b inlet
*          * 345 voidf    228010000 * sg-b outlet
*          * 346 voidf    232010000 * cross leg
*          * 347 voidf    232050000 *
*          * 348 voidf    236040000 * rcp suction
*          * 349 voidf    244010000 * rcp discharge
*          * 350 voidf    248010000 *
*          * 351 voidf    252010000 * cold leg-b
*          * 352 voidf    400010000 * hot leg-i
*          * 353 voidf    406010000 *
*          * 354 voidf    408010000 *
*          * 355 voidf    412010000 * sg-i inlet
*          * 356 voidf    428010000 * sg-i outlet
*          * 357 voidf    432010000 * cross leg
*          * 358 voidf    432050000 *
*          * 359 voidf    436040000 * rcp suction
*          * 360 voidf    444010000 * rcp discharge
*          *
*          * minor edits
*****
*          *
301 p      610010000 * pqr pressure
302 p      516010000 * sg-i steam dome pres.
303 p      316010000 * sg-b steam dome pres.
304 p      452010000 * cold leg-i
305 p      252010000 * cold leg-b
306 p      400010000 * hot leg-i
307 p      200010000 * hot leg-b
308 p      248010000 * cold leg-b
309 p      448010000 * cold leg-b
310 p      124010000 * mid-core pressure
311 p      124020000 *
312 p      124030000 *
313 p      124040000 *
314 p      124050000 *
315 mflowj 108040000 * core downcomer flowrate
316 mflowj 124030000 * core flowrate
317 mflowj 136010000 * upper plenum to hl-b
318 mflowj 136020000 * upper plenum to hl-i
319 mflowj 136030000 * upper plenum to up-132
320 mflowj 136040000 * upper plenum to up-140
322 mflowj 208010000 * sg-b inlet flowrate
323 mflowj 252010000 * cold leg-b flowrate
324 mflowj 408010000 * sg-i inlet flowrate
325 mflowj 651000000 * prz. porv flowrate
326 mflowj 915000000 * break flowrate
327 tempf   124010000 *
328 tempf   124020000 *

*****
*          * 500 time    0 lt    null 0 0.0 n  * false
*          * 501 time    0 ge    null 0 0.0 n  * true
*          * 536 time    0 ge    null 0 0.0 l  * true
*          * 537 time    0 lt    null 0 0.0 l  * false
*          * 555 time    0 ge    null 0 16000. l * eccs injection
*          * 570 time    0 ge    null 0 1000.0 l * rhr flow
*
*****
*          * hydrodynamic components
*****
*          *
3690000 blsgsv valve
3690101 320010000 370000000 2.96e-4 0.0149 0.0 0120
3690201 0 0.0 0.0 0.0
3690300 trpvlv
3690301 501
*          *

```

3790000	blsgsv	valve												
3790101	324010000	380000000	0.00195	0.00055	0.0	0.0120	7860101	785010001	244010005	0.006				
3790201	0	0.0	0.0	0.0			7860200	1	570					
3790300	trpvlv						7860201	0.0	3.2	0.0	0.0			
3790301	500						7860202	10.0	1.6	0.0	0.0			
							7860203	20.0	0.0	0.0	0.0			
*							*							
5690000	ilsgsv	valve					*							
5690101	520010000	570000000	2.96e-4	0.0149	0.0	0.0120	*							
5690201	0	0.0	0.0	0.0			*							
5690300	trpvlv						9150000	npcolbrv	sngljun					
5690301	501						9150101	248010004	920010001	1.685e-3	0. 0.	30100	1.0	1.0
*							9150201	0	0.0	0.0	0.0			
5790000	blsgsv	valve					*							
5790101	524010000	580000000	0.00195	0.00055	0.0	0.0120	9200000	npcolleg	tmdpvol					
5790201	0	0.0	0.0	0.0			9200101	1.0e+8	10.0	0.0	0.0	0.0	0.0	0 00
5790300	trpvlv						9200200	004						
5790301	500						9200201	0.0	1.01325e+5	310.0	1.0			
*							*							
6510000	porv	valve					*							
6510101	610000000	650000000	3.66e-5	0.0251	0.0	0.0120	.	zzz						
6510201	0	0.0	0.0	0.0			*							
6510300	trpvlv						*							
6510301	500						*							
*							*							
6610000	prsfvalv	valve					*							
6610101	610000000	660000000	1.54e-4	0.2052	0.0	0.0120	*							
6610201	0	0.0	0.0	0.0			*							
6610300	trpvlv						*							
6610301	500						*							
*							*							
6210000	prsspryl	delete					*							
*							*							
*							*							
7410000	rhou-i	tmdpjun					*							
7410101	400010005	740010001				0.006	*							
7410200	1	570					*							
7410201	0.0	3.2	0.0	0.0			*							
7410202	10.0	1.6	0.0	0.0			*							
7410203	20.0	0.0	0.0	0.0			*							
*							*							
7810000	rhou-b	tmdpjun					*							
7810101	200010005	780010001				0.006	*							
7810200	1	570					*							
7810201	0.0	3.2	0.0	0.0			*							
7810202	10.0	1.6	0.0	0.0			*							
7810203	20.0	0.0	0.0	0.0			*							
*							*							
7460000	rhrin-i	tmdpjun					*							
7460101	745010001	448010005				0.006	*							
7460200	1	570					*							
7460201	0.0	3.2	0.0	0.0			*							
7460202	10.0	1.6	0.0	0.0			*							
7460203	20.0	0.0	0.0	0.0			*							
*							*							
7860000	rhrin-b	tmdpjun					*							

## **Appendix B**

### **Input Deck for the Assessment of the Loss-of-RHR Event with the Pressurizer Manway Opening (Steady State and Transient Input Deck)**



```

*****
*          * 321 tempf 124020000 *
*          * 322 tempf 124030000 *
*          * 323 tempf 124040000 *
*          * 324 tempf 124050000 *
*          * 325 tempf 124060000 *
*          * 326 tempf 124070000 * mid-core temperature
*          * 327 tempf 124080000 *
*          * 328 tempf 124090000 *
*          * 329 tempf 124100000 *
*          * 330 tempf 124110000 *
*          * 331 tempf 124120000 * top-core temperature
*          * 332 tempf 136010000 * upper plenum
*          * 333 httemp 124100109 * bottom-cladding temp.
*          * 334 httemp 124100209 *
*          * 335 httemp 124100309 *
*          * 336 httemp 124100409 *
*          * 337 httemp 124100509 *
*          * 338 httemp 124100609 * mid-cladding temp.
*          * 339 httemp 124100709 *
*          * 340 httemp 124100809 *
*          * 341 httemp 124100909 *
*          * 342 httemp 124101009 *
*          * 343 httemp 124101109 *
*          * 344 httemp 124101209 * top-cladding temp.
*          * 345 tempf 200010000 * hot leg-b
*          * 346 tempf 206010000 * hot leg-b temperature
*          * 347 tempf 208010000 * hot leg-b temperature
*          * 348 tempf 216010000 * sg-b inlet plenum
*          * 349 tempf 220010000 * sg-b inlet
*          * 350 tempf 244010000 * cold leg-b temperature
*          * 351 tempf 248010000 * cold leg-b temperature
*          * 352 tempf 252010000 * cold leg-b
*          * 353 tempf 400010000 * hot leg-i
*          * 354 tempf 406010000 * hot leg-i temperature
*          * 355 tempf 408010000 * hot leg-i temperature
*          * 356 tempf 416010000 * sg-i inlet plenum
*          * 357 tempf 420010000 * sg-i inlet
*          * 358 tempf 444010000 * cold leg-i temperature
*          * 359 tempf 448010000 * cold leg-i temperature
*          * 360 tempf 452010000 * cold leg-i
*          * 361 tempf 610080000 * pwr bottom
*          * 362 tempf 610040000 * pwr middle
*          * 363 tempf 610010000 * pwr top
*          * 364 voidf 104010000 * vessel inlet void
*          * 365 voidf 136010000 * vessel outlet void
*          * 366 voidf 200010000 * hot leg void
*          * 367 voidf 206010000 *
*          * 368 voidf 208010000 *
*          * 369 voidf 212010000 * sg-b inlet void
*          * 370 voidf 228010000 * sg-b outlet void
*          * 371 voidf 232010000 * cross leg void
*          * 372 voidf 232050000 *
*          * 373 voidf 236040000 * rcp suction void
*          * 374 voidf 244010000 * rcp discharge void
*          * 375 voidf 248010000 * cold leg void
*          * 376 voidf 252010000 * cold leg void
*          * 377 voidf 400010000 * hot leg void
*          * 378 voidf 406010000 *
*          * 379 voidf 408010000 *

```

380	voidf	412010000	* sg-i inlet void	1080301	0.6757	1						
381	voidf	428010000	* sg-i outlet void	1080302	0.8670	2						
382	voidf	432010000	* cross leg void	1080303	0.610	8						
383	voidf	432050000	*	1080304	1.2588	9						
384	voidf	436040000	* rcp suction void	1080601	-90.0	9						
385	voidf	444010000	* rcp discharge void	1080701	-0.6757	1						
386	voidf	448010000	* cold leg void	1080702	-0.8670	2						
387	voidf	452010000	* cold leg void	1080703	-0.610	8						
388	mflowj	108040000	* core downcommer flow	1080704	-1.2588	9						
389	mflowj	124060000	* core flowrate	1080801	4.573e-5	0.106	9					
390	mflowj	208010000	* hot leg-b flowrate	1081001	0001000	9						
391	mflowj	217000000	* sg-b inlet flowrate	1081101	0000	8						
392	mflowj	252010000	* cold leg-b flowrate	1081201	003	109060.0	320.7	0.	0.	0.	1	
393	mflowj	408010000	* hot leg-i flowrate	1081202	003	116560.0	320.2	0.	0.	0.	2	
394	mflowj	417000000	* sg-i inlet flowrate	1081203	003	123740.0	320.4	0.	0.	0.	3	
395	mflowj	741000000	* hot leg-i si	1081204	003	129670.0	320.6	0.	0.	0.	4	
396	mflowj	746000000	* cold leg-i si	1081205	003	135600.0	320.7	0.	0.	0.	5	
397	mflowj	781000000	* hot leg-b si	1081206	003	141530.0	320.8	0.	0.	0.	6	
398	mflowj	786000000	* cold leg-b si	1081207	003	147458.0	320.8	0.	0.	0.	7	
399	mflowj	915000000	* break flowrate	1081208	003	153380.0	320.8	0.	0.	0.	8	
*				1081209	003	162460.0	321.0	0.	0.	0.	9	
*				1081300	1							
*	variable trips			1081301	6.0	0.0	0.0		1			
*				1081302	6.0	0.0	0.0		2			
*				1081303	6.0	0.0	0.0		3			
500	time	0	lt	null	0	0.0	n	* false				
501	time	0	ge	null	0	0.0	n	* true				
536	time	0	ge	null	0	0.0	l	* true				
537	time	0	lt	null	0	0.0	l	* false				
*				1081304	6.0	0.0	0.0		4			
*				1081305	6.0	0.0	0.0		5			
*				1081306	6.0	0.0	0.0		6			
*				1081307	6.0	0.0	0.0		7			
*				1081308	6.0	0.0	0.0		8			
*				*								
*	Hydrodynamic Components											
*	reactor vessel											
1000000	inannl	snglvol										
1000101	0.0	1.5684	0.13609	.0.0	-90.	-1.5684						
1000102	4.57e-5	0.106	00									
1000200	004	102885.0	321.0	1.0								
*												
1040000	inann	branch										
1040001	4	1										
1040101	0.0	0.600	0.05425	0.0	-90.0	-0.600	4.57e-5					
1040102	0.106	0001000										
1040200	004	104309.0	320.0	0.0006								
1041101	104000000	100010000	0.0	0.0	0.0	0.0000						
1042101	104010000	108000000	0.0	0.0	0.0	0.0000						
1043101	252020002	104010003	0.03365	0.345	0.345	0101						
1044101	452010002	104010004	0.03365	0.345	0.345	0101						
1041201	3.7e-3	3.7e-3	0.0									
1042201	6.0	0.0	0.0									
1043201	3.0	0.0	0.0									
1044201	3.0	0.0	0.0									
*												
1080000	downcmer	annulus										
1080001	9											
1080101	0.09774	9										
1120000	lpvolvol	snglvol										
1120101	0.0	0.626	0.1661	0.0	90.0	0.626	4.57e-5					
1120102	0.0104	0001000										
1120200	003	176240.0	320.0									
*												
1160000	lowrplnm	branch										
1160001	3	1										
1160101	0.0	0.4762	0.0943	0.0	90.0	0.4762	4.57e-5					
1160102	0.0104	0001000										
1160200	003	170890.0	320.7									
1161101	108010000	116010000	0.09774	1.0	1.0	0100						
1162101	112010000	116000000	0.23623	0.0	0.0	0000						
1163101	116010000	120000000	0.15931	8.34	8.34	0000						
1161201	6.0	0.0	0.0									
1162201	0.01	0.01	0.0									
1163201	6.0	0.0	0.0									
1162110	0.0104	1.0	1.0									
1163110	0.0104	1.0	1.0									
*												
1200000	corein	branch										
1200001	1	1										
1200101	0.0	1.2588	0.1821	0.0	90.0	1.2588	4.57e-5					
1200102	0.0104	0001000										
1200200	003	162470.0	321.1									
1201101	120010000	124000000	0.13657	0.85	0.85	0000						

1201201	6.0	0.0	0.0				1320101	0.0	0.6757	0.1060	0.0	90.0	0.6757	4.57e-5	
1201110	0.009721		1.0	1.0	1.0		1320102	0.321	0001000						
*							1320200	003	109480.0	337.0					
*****							*****								
1240000	core	pipe					*								
1240001	12						1340000	upplnm-1	branch						
1240101	0.0	12					1340001	1	1						
1240301	0.305	12					1340101	0.0	0.200	0.03130	0.0	90.0	0.200	4.57e-5	
1240401	0.03656	12					1340102	0.321	0001000						
1240601	90.0	12					1340200	003	105840.0	337.0					
1240701	0.305	12					1341101	132010000	134000000	0.15669	0.0	0.0	0.000		
1240801	4.57e-5	0.00832	12				1341201	6.0	0.0	0.0					
1240901	0.68	0.68	11				*								
1241001	0001100	12					1360000	upplnm-2	branch						
1241101	0000	11					1360001	4	1						
1241201	003	154890.0	321.0	0.	0.	0.	1	1360101	0.0	0.200	0.03130	0.0	90.0	0.200	4.57e-5
1241202	003	151940.0	322.0	0.	0.	0.	2	1360102	0.321	0001000					
1241203	003	148980.0	324.2	0.	0.	0.	3	1360200	004	103440.0	337.0	0.0007			
1241204	003	146030.0	326.6	0.	0.	0.	4	1361101	136010006	400010001	0.03370	.265	.265	0102	
1241205	003	143080.0	327.8	0.	0.	0.	5	1362101	136010005	200010001	0.03370	.265	.265	0102	
1241206	003	140130.0	330.0	0.	0.	0.	6	1363101	134010000	136000000	0.15669	0.0	0.0	0000	
1241207	003	137190.0	332.6	0.	0.	0.	7	1364101	136010000	138000000	0.14305	0.0	0.0	0000	
1241208	003	134250.0	334.0	0.	0.	0.	8	1361201	3.0	0.0	0.0				
1241209	003	131310.0	335.8	0.	0.	0.	9	1362201	3.0	0.0	0.0				
1241210	003	128370.0	337.6	0.	0.	0.	10	1363201	6.0	0.0	0.0				
1241211	003	125440.0	338.0	0.	0.	0.	11	1364201	0.01	0.01	0.0				
1241212	003	122510.0	338.7	0.	0.	0.	12	1363110	0.321	1.0	1.0	1.0			
1241300	1						1364110	0.321	1.0	1.0	1.0				
1241301	6.0	0.0	0.0	1			*								
1241302	6.0	0.0	0.0	2			1380000	upplnm-3	branch						
1241303	6.0	0.0	0.0	3			1380001	1	1						
1241304	6.0	0.0	0.0	4			1380101	0.0	0.200	0.03130	0.0	90.0	0.200	4.57e-5	
1241305	6.0	0.0	0.0	5			1380102	0.321	0001000						
1241306	6.0	0.0	0.0	6			1380200	004	103350.0	337.0	1.0				
1241307	6.0	0.0	0.0	7			1381101	138010000	140000000	0.14305	0.0	0.0	0000		
1241308	6.0	0.0	0.0	8			1381201	0.0	0.0	0.0					
1241309	6.0	0.0	0.0	9			*								
1241310	6.0	0.0	0.0	10			1400000	uptopvol	snglvl						
1241311	6.0	0.0	0.0	11			1400101	0.0	0.3674	0.0445	0.0	90.0	0.3674	4.57e-5	
1241401	0.00832	1.0	1.0	1.0	11		1400102	0.321	00						
*							1400200	004	103350.0	337.0	1.0				
*****							*****								
1280000	creoutl	branch					*								
1280001	3	1					1440000	tophat	snglvl						
1280101	0.0	0.867	0.1360	0.0	90.0	0.867	4.57e-5	1440101	0.0	0.897	0.1655	0.0	90.0	0.897	4.57e-5
1280102	0.0	0001000					1440102	0.95	00						
1280200	003	116880.0	337.				1440200	004	102910.0	328.0	1.0				
1281101	124010000	128000000	0.15255	1.272	1.272	0000	*								
1282101	128010000	132000000	0.16737	0.0	0.0	0000	1480000	uhmidvol	branch						
1283101	156010000	128010000	0.085679	420.	420.	0000	1480001	2	1						
1281201	6.0	0.0	0.0				1480101	0.0	0.725	0.1970	0.0	90.0	0.725	4.57e-5	
1282201	6.0	0.0	0.0				1480102	0.256	00						
1283201	0.1	0.1	0.0				1480200	004	102900.0	324.0	1.0				
1281110	0.28097	1.0	1.0	1.0			1481101	100000000	148000000	9.5e-5	0.0	0.0	0100		
1282110	0.4063	1.0	1.0	1.0			1482101	144010000	148000000	0.0	0.0	0.0	0000		
1283110	0.3078	1.0	1.0	1.0			1481201	0.01	0.01	0.0					
*							1482201	-0.01	-0.01	0.0					
*****							*****								
1320000	upplnm1	snglvl													

```

*
*****
1520000 uhtopvol branch
1520001 2 1
1520101 0.0 0.504 0.1475 0.0 90.0 0.504 4.57e-5
1520102 0.0 00
1520200 004 102890.0 327.0 1.0
1521101 148010000 152000000 0.0 0.0 0.0 0000
1522101 152000000 156000000 0.00199 1.472 1.472 0000
1521201 0.01 0.01 0.0
1522201 0.01 0.01 0.0
*
*****
1560000 gdetub pipe
1560001 2
1560101 0.0 2
1560201 0.0102 1
1560301 1.9260 1
1560302 1.6431 2
1560401 0.06209 1
1560402 0.06286 2
1560601 -90.0 2
1560701 -1.9260 1
1560702 -1.6431 2
1560801 4.57e-5 0.0 2
1560901 3.34 3.34 1
1561001 01000 2
1561101 0000 1
1561201 004 102910.0 326.0 1.0 0.0 0.0 1
1561202 004 107760.0 337.0 0.0006 0.0 0.0 2
1561300 1
1561301 0.01 0.01 0.0 1
*
*****
* Broken Loop without pressurizer
*****
2000000 nphotleg snglivol
2000101 0.0337 1.3246 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
2000200 004 103650.0 337.0 0.00040
*
*****
2060000 nphotleg branch
2060001 2 1
2060101 0.0337 1.3843 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
2060200 004 103690.0 338.0 0.00040
2061101 200010000 206000000 0.0337 0.0 0.0 0000
2062101 206010000 208000000 0.0337 0.0 0.0 0000
2061201 0.1 0.0 0.0
2062201 0.1 0.0 0.0
*
*****
2080000 wphotleg pipe
2080001 2
2080101 0.0337 2
2080301 0.7043 1
2080302 0.5278 2
2080601 0.0 1
2080602 50.0 2
2080701 0.0 1
2080702 0.4043 2
2080801 4.57e-5 0.207 2
2080901 0.05 0.05 1
2081001 0000000 2
2081101 100000 1
2081201 004 103740.0 336.0 0.0004 0. 0. 1
2081202 004 103530.0 336.0 0.1 0. 0. 2
2081300 1
2081301 0.1 0.0 0.0 1
2081401 0. 0. 0.55 0.785 1
*
*****
2090000 nphotleg sngljun
2090101 208010000 212000000 0.0337 0.0 0.0 0100
2090201 1 0.0 0.0 0.0
*
*****
2120000 npsgin snglivol
2120101 0.0 0.706 0.125 0.0 90.0 0.706 4.57e-5
2120102 0.377 0000000
2120200 004 103520.0 337.0 1.0
*
*****
2130000 npsgfbj sngljun
2130101 212010000 216000000 0.2093 0.0 0.0 0000
2130201 1 0.0 0.0 0.0
*
*****
2160000 npsgfb snglivol
2160101 0.0 1.1035 0.2323 0.0 90.0 1.1035 4.57e-5
2160102 0.4474 0000000
2160200 004 103510.0 330.0 1.0
*
*****
2170000 npsgin sngljun
2170101 216010000 220000000 0.0425 0.0 0.0 100100
2170110 0.0 0.0 0.725 1.0
2170201 1 0.0 0.0 0.0
*
*****
2200000 npsttube pipe
2200001 12
2200101 0.0425 12
2200301 0.7181 4
2200302 1.2827 6
2200303 2.5654 7
2200304 2.1728 9
2200305 2.5654 11
2200306 2.8724 12
2200601 90.0 8
2200604 -90.0 12
2200701 0.7181 4
2200702 1.2827 6
2200703 2.5654 7
2200704 2.0980 8
2200705 -2.0980 9
2200706 -2.5654 11
2200707 -2.8724 12

```

2200801	1.524-6	0.0196	12	*
2200901	0.0	0.0	7	*****
2200902	0.006	0.0	8	2320000 npcrsleg pipe
2200903	0.006	0.006	9	2320001 5
2200904	0.0	0.006	10	2320101 0.0222 5
2200905	0.0	0.0	11	2320301 0.516 1
2201001	0000000	12		2320302 1.2422 4
2201101	0000	11		2320303 1.1919 5
2201201	004	103500.0	317.0 1. 0. 0. 1	2320601 -50.0 1
2201202	004	103500.0	317.8 1. 0. 0. 2	2320602 -90.0 4
2201203	004	103490.0	317.7 1. 0. 0. 3	2320603 0.0 5
2201204	004	103480.0	317.6 1. 0. 0. 4	2320701 -0.3953 1
2201205	004	103470.0	317.5 1. 0. 0. 5	2320702 -1.2422 4
2201206	004	103460.0	317.4 1. 0. 0. 6	2320703 0.0 5
2201207	004	103440.0	317.3 1. 0. 0. 7	2320801 4.57e-5 0.1682 5
2201208	004	103410.0	317.3 1. 0. 0. 8	2320901 0.036 0.036 1
2201209	004	103410.0	317.3 1. 0. 0. 9	2320902 0.0 0.0 3
2201210	004	103440.0	317.4 1. 0. 0. 10	2320903 0.065 0.065 4
2201211	004	103460.0	317.6 1. 0. 0. 11	2321001 0000000 5
2201212	004	103490.0	317.0 1. 0. 0. 12	2321101 0000 4
2201300	1			2321201 004 103910.0 320.0 0.005 0. 0. 1
2201301	0.0	0.0	0.0 1	2321202 003 110380.0 320.0 0. 0. 0. 2
2201302	0.0	0.0	0.0 2	2321203 003 122460.0 320.0 0. 0. 0. 3
2201303	0.0	0.0	0.0 3	2321204 003 134540.0 320.0 0. 0. 0. 4
2201304	0.0	0.0	0.0 4	2321205 003 140600.0 320.0 0. 0. 0. 5
2201305	0.0	0.0	0.0 5	2321300 1
2201306	0.0	0.0	0.0 6	2321301 0.1 0.0 0.0 1
2201307	0.0	0.0	0.0 7	2321302 0.1 0.0 0.0 2
2201308	0.0	0.0	0.0 8	2321303 0.1 0.0 0.0 3
2201309	0.0	0.0	0.0 9	2321304 0.1 0.0 0.0 4
2201310	0.0	0.0	0.0 10	*
2201311	0.0	0.0	0.0 11	*****
*				2330000 npfcv valve
*****				2330101 232010000 236000000 0.0222 0.0 0.0 0100
2210000	npsgout	sngljun		2330201 1 0.0 0.0 0.0
2210101	220010000	224000000	0.0425 0.0 0.0 0100	2330300 mtrvlv
2210201	1	0.0 0.0 0.0		2330301 536 537 1.42 1.0 0
*				*
*****				*****
2240000	npsgfb0	snglvol		2360000 npcrslgu pipe
2240101	0.0 1.1035	0.2323 0.0 -90.0 -1.1035	4.57e-5	2360001 4
2240102	0.4474	0000000		2360101 0.0222 4
2240200	004 103510.0	320.0 1.0		2360301 1.3202 1
*				2360302 1.1222 2
*****				2360303 1.1417 3
2250000	npsgfbj	sngljun		2360304 1.1222 4
2250101	224010000	228000000	0.2093 0.0 0.0 0000	2360601 0.0 1
2250201	1 0.0 0.0 0.0			2360602 90.0 4
*				2360701 0.0 1
*****				2360702 1.1222 4
2280000	npsgout	snglvol		2360801 4.57e-5 0.1682 4
2280101	0.0 0.706	0.125 0.0 -90.0 -0.706	4.57e-5	2360901 0.065 0.065 1
2280102	0.377	0000000		2360902 0.0 0.0 3
2280200	004 103520.0	324.0 1.0		2361001 0000000 4
*				2361101 0000 3
*****				2361201 003 140630.0 320.0 0. 0. 0. 1
2290000	npcrsleg	sngljun		2361202 003 135220.0 320.0 0. 0. 0. 2
2290101	228010000	232000000	0.0222 0.0 0.0 0100	2361203 003 124350.0 320.0 0. 0. 0. 3
2290201	1 0.0 0.0 0.0			2361204 003 113490.0 320.0 0. 0. 0. 4

2361300 1  
 2361301 0.1 0.0 0.0 1  
 2361302 0.1 0.0 0.0 2  
 2361303 0.1 0.0 0.0 3  
 \*  
 \*\*\*\*=  
 2400000 nprcpump pump  
 2400101 0.0 0.802 0.0235 0.0 90.0 0.351 0  
 2400108 236010000 0.0222 0.0 0.0 0000  
 2400109 244000000 0.0337 0.0525 0.0525 0000  
 2400200 004 106360.0 320.0 00001  
 2400201 1 0.0 0.0 0.0  
 2400202 1 0.0 0.0 0.0  
 2400301 0 0 0 -1 -1 500 0  
 2400302 188.50 0.0 0.054 10.0 55.2  
 2400303 0.54 750.0 0.0 0.0 0.0 0.0 0.0  
 \*  
 \* single phase head and torque data from lstf sys.  
 \* description  
 \*  
 2401100 1 1 0.00 1.36 0.10 1.38 0.24 1.42 0.40 1.41  
 2401101 0.60 1.32 0.80 1.19 1.00 1.00  
 2401200 1 2 0.00 -0.97 0.20 -0.68 0.50 -0.20 0.65 0.07  
 2401201 0.80 0.40 1.00 1.00  
 2401300 1 3 -1.0 3.20 -0.90 2.80 -0.80 2.46 -0.60 1.94  
 2401301 -0.40 1.57 -0.20 1.41 0.00 1.36  
 2401400 1 4 -1.00 3.20 -0.80 2.76 -0.60 2.41 -0.40 2.09  
 2401401 -0.20 1.81 0.00 1.58  
 2401500 1 5 0.00 0.00 1.00 0.00  
 2401600 1 6 0.00 0.00 1.00 0.00  
 2401700 1 7 -1.00 0.00 0.00 0.00  
 2401800 1 8 -1.00 0.00 0.00 0.00  
 \*  
 \* torque data  
 \*  
 2401900 2 1 0.00 0.36 0.12 0.38 0.20 0.44 0.30 0.58  
 2401901 0.50 0.73 0.70 0.81 1.00 1.00  
 2402000 2 2 0.00 -1.26 0.10 -0.88 0.30 -0.31 0.50 0.09  
 2402001 0.65 0.30 0.86 0.63 1.00 1.00  
 2402100 2 3 -1.00 2.40 -0.85 1.70 -0.65 1.12 -0.50 0.84  
 2402101 -0.40 0.69 -0.20 0.59 0.00 0.36  
 2402200 2 4 -1.00 2.40 -0.80 2.12 -0.60 1.80 -0.30 1.32  
 2402201 0.00 0.80  
 2402300 2 5 0.00 0.00 1.00 0.00  
 2402400 2 6 0.00 0.00 1.00 0.00  
 2402500 2 7 -1.00 0.00 0.00 0.00  
 2402600 2 8 -1.00 0.00 0.00 0.00  
 \*  
 \* two phase multiplier tables for head of rc pump 240  
 \*  
 2403000 0 0.0 0.0  
 2403001 0.10 0.0  
 2403002 0.15 0.05  
 2403003 0.24 0.80  
 2403004 0.30 0.96  
 2403005 0.40 0.98  
 2403006 0.60 0.97  
 2403007 0.80 0.90  
 2403008 0.90 0.80  
 2403009 0.96 0.50  
 2403010 1.00 0.0  
 \*  
 \* two phase multiplier tables for torque of rc pump 240  
 \*  
 2403100 0 0.0 0.0  
 2403101 1.0 0.0  
 \*  
 \* two-phase diff curves from r5 built-in data  
 \* head difference curves  
 \*  
 2404100 1 1 0.00 0.00 0.10 0.83 0.20 1.09 0.50 1.02  
 2404101 0.70 1.01 0.90 0.94 1.00 1.00  
 2404200 1 2 0.00 0.00 0.10 -0.40 0.20 0.00 0.30 0.10  
 2404201 0.40 0.21 0.80 0.67 0.90 0.80 1.00 1.00  
 2404300 1 3 -1.00 -1.16 -0.9 -1.24 -0.80 -1.77 -0.70 -2.36  
 2404301 -0.60 -2.79 -0.50 -2.91 -0.40 -2.67 -0.25 -1.69  
 2404302 -0.10 -0.50 0.00 0.00  
 2404400 1 4 -1.0 -1.16 -0.90 -0.78 -0.80 -0.50 -0.70 -0.31  
 2404401 -0.60 -0.17 -0.50 -0.08 -0.35 0.00 -0.20 0.05  
 2404402 -0.10 0.08 0.00 0.11  
 2404500 1 5 0.00 0.00 1.00 0.00  
 2404600 1 6 0.00 0.00 1.00 0.00  
 2404700 1 7 -1.00 0.00 0.00 0.00  
 2404800 1 8 -1.00 0.00 0.00 0.00  
 \*  
 \* torque difference curves  
 \*  
 2404900 2 1 0.0 0.0 0.0 0.0 0.0  
 2405000 2 2 0.0 0.0 0.0 0.0 0.0  
 2405100 2 3 0.0 0.0 0.0 0.0 0.0  
 2405200 2 4 0.0 0.0 0.0 0.0 0.0  
 2405300 2 5 0.0 0.0 0.0 0.0 0.0  
 2405400 2 6 0.0 0.0 0.0 0.0 0.0  
 2405500 2 7 0.0 0.0 0.0 0.0 0.0  
 2405600 2 8 0.0 0.0 0.0 0.0 0.0  
 \*  
 \*\*\*\*=  
 2440000 npcolleg branch  
 2440001 1 1  
 2440101 0.0337 0.7348 0.0 0.0 0.0 0.0 4.57e-5 0.207 00  
 2440200 004 104670.0 320.0 000030  
 2441101 244010000 248000000 0.0337 0.0 0.0 0000  
 2441201 3.0 0.0 0.0  
 \*  
 \*\*\*\*=  
 2480000 npcolleg branch  
 2480001 1 1  
 2480101 0.0337 0.9429 0.0 0.0 0.0 0.0 4.57e-5 0.207 00  
 2480200 004 104670.0 320.0 00003  
 2481101 248010000 252000000 0.0337 0.0 0.0 0000  
 2481201 3.0 0.0 0.0  
 \*  
 \*\*\*\*=  
 2520000 npcolleg pipe  
 2520001 2  
 2520101 0.0337 2  
 2520301 0.9752 2  
 2520601 0.0 2

2520701	0.0	2		3040101	0.2293	3										
2520801	4.57e-5	0.207	2	3040102	0.0	5										
2521001	00	2		3040201	0.2293	2										
2521101	0000	1		3040202	0.2323	3										
2521201	004	104670.0	320.0	0.0003	0. 0. 1		3040203	0.3138	4							
2521202	004	104670.0	320.0	0.0003	0. 0. 2		3040301	2.5464	1							
2521300	1			3040302	2.5654	3										
2521301	3.0	0.0	0.0	1	3040303	2.0980	4									
*				3040304	2.0223	5										
*****							3040401	0.0	3							
* Secondary side for the broken loop							3040402	0.4951	4							
*****							3040403	0.7979	5							
*				3040501	0.0	5										
3000000	npstgdcn	annulus		3040601	90.0	5										
3000001	5			3040701	2.5464	1										
3000101	0.0	1		3040702	2.5654	3										
3000102	0.0296	4		3040703	2.0980	4										
3000103	0.0	5		3040704	2.0223	5										
3000201	0.0	3		3040801	4.57e-5	0.036	4									
3000202	0.005281	4		3040802	4.57e-5	0.219	5									
3000301	2.8965	1		3040901	1.435	1.435	4									
3000302	2.0980	2		3041001	0001000	5										
3000303	2.5654	4		3041101	0000	3										
3000304	3.4395	5		3041102	0000	4										
3000401	0.3228	1		3041201	004	101500.0	310.0	1.0	0.0	0.0	1					
3000402	0.0	4		3041202	004	101470.0	310.0	1.0	0.0	0.0	2					
3000403	0.1302	5		3041203	004	101440.0	310.0	1.0	0.0	0.0	3					
3000501	0.0	5		3041204	004	101420.0	310.0	1.0	0.0	0.0	4					
3000601	-90.0	5		3041205	004	101400.0	310.0	1.0	0.0	0.0	5					
3000701	-2.0223	1		3041300	1											
3000702	-2.0980	2		3041301	0.0	0.0	0.0	1								
3000703	-2.5654	4		3041302	0.0	0.0	0.0	2								
3000704	-2.5464	5		3041303	0.0	0.0	0.0	3								
3000801	4.57e-5	0.3689	1	3041304	0.0	0.0	0.0	4								
3000802	4.57e-5	0.0971	4	3041401	0.036	1.0	1.0	1.0	3							
3000803	4.57e-5	0.0801	5	3041402	0.1258	1.0	1.0	1.0	4							
3000901	0.0	0.0	4	*												
3001001	0001000	5		*****												
3001101	0000	3		3080000	npsepar	separatr										
3001102	0100	4		3080001	3	1										
3001201	004	101400.0	310.	1.0	0.	0.	1	3080101	0.0	2.120	0.572	0.0	90.0	2.120	4.57e-5	
3001202	004	101420.0	310.	1.0	0.	0.	2	3080102	0.2134	00						
3001203	004	101450.0	310.	1.0	0.	0.	3	3080200	004	101370.0	310.0	1.0				
3001204	004	101470.0	310.	1.0	0.	0.	4	3081101	308010002	316010001	0.0615	0.0	0.0	0100	0.2	
3001205	004	101500.0	310.	1.0	0.	0.	5	3082101	308010001	300010001	0.03964	100.	100.	0000	0.15	
3001300	1			3083101	304050002	308010001	0.1986	0.0	0.0	0.00						
3001301	0.0	0.0	0.0	1	3081201	0.0	0.0	0.0								
3001302	0.0	0.0	0.0	2	3082201	0.0	0.0	0.0								
3001303	0.0	0.0	0.0	3	3083201	0.0	0.0	0.0								
3001304	0.0	0.0	0.0	4	*											
*				*****												
*****							3120000	npsgspbp	branch							
3010000	npstgdcn	sngljun		3120001	2	1										
3010101	300010000	304000000	0.0	100.	100.	0000		3120101	0.0	2.120	0.6288	0.0	90.0	2.120	4.57e-5	
3010201	1	0.0	0.0		3120102	0.1242	00									
*				3120200	004	101370.0	310.0	1.0								
*****							3121101	300000000	312000000	0.3164	0.0	0.0	0.00			
3040000	blsteamg	pipe		3122101	312010000	316000000	0.0392	1.5	1.5	0.00						
3040001	5			3121201	0.0	0.0	0.0									

```

3122201 0.0    0.0    0.0
*
*****
3160000 stmdome snglvol
3160101 0.0    3.7778 2.0288 0.0    90.0   3.7778 4.57e-5
3160102 0.7696  00
3160200 004    101340.0 310.0 1.0
*
*****
* blsg steam line
*****
3200000 blstmln1 branch
3200001 2       1
3200101 0.0286 5.286  0.0    0.0    0.0    0.0    4.57e-5
3200102 0.1909  00
3200200 004    101320.0 310.0 1.0
3201101 316010000 320000000 0.0286 0.0    0.0    0100
3202101 320010000 324000000 0.0286 0.0    0.0    0000
3201201 0.0    0.0    0.0
3202201 0.0    0.0    0.0
*
*****
3240000 blstmln2 snglvol
3240101 0.0286 9.9213 0.0    0.0    0.0    0.0    4.57e-5
3240102 0.1909  00
3240200 004    101320.0 310.0 1.0
*
*****
* secondary relief and safety valves, intact loop
*****
* blsgrv valve
3690101 320010000 370000000 2.96e-4 0.0149 0.0    0100
3690201 0       0.0    0.0    0.0
3690300 trpvlv
3690301 501
*
*****
3700000 contain trndpvol
3700101 1.0e+8 10.0  0.0  0.0  0.0  0.0  0.0  00
3700200 004
3700201 0.0    1.01325e+5 305.0 1.0
*
*****
3790000 blsgsv valve
3790101 324010000 380000000 0.00195 0.00055 0.0    0100
3790201 0       0.0    0.0    0.0
3790300 trpvlv
3790301 501
*
*****
3800000 contain trndpvol
3800101 1.0e+8 10.0  0.0  0.0  0.0  0.0  0.0  00
3800200 004
3800201 0.0    1.01325e+5 305.0 1.0
*
* Intact Loop with pressurizer
*****
4000000 wphotleg snglvol
4000101 0.0337 1.3246 0.0    0.0    0.0    0.0    4.57e-5 0.207 00
4000200 004    103650.0 337.0 0.0004
*
*****
4060000 wphotleg branch
4060001 3       1
4060101 0.0337 1.3843 0.0    0.0    0.0    0.0    4.57e-5 0.207 00
4060200 004    103690.0 337.0 0.0004
4061101 400010000 406000000 0.0337 0.0    0.0    0.0    0.0000
4062101 406010000 408000000 0.0337 0.0    0.0    0.0    0.0000
4063101 600030002 406010006 0.00352 1.0    0.5    0.0001
4061201 0.1    0.0    0.0
4062201 0.1    0.0    0.0
4063201 0.0    0.0    0.0
*
*****
4080000 wphotleg pipe
4080001 2
4080101 0.0337 2
4080301 0.7043 1
4080302 0.5278 2
4080601 0.0    1
4080602 50.0   2
4080701 0.0    1
4080702 0.4043 2
4080801 4.57e-5 0.207 2
4080901 0.05   0.05  1
4081001 0000000 2
4081101 100000 1
4081201 004    103740.0 337.0 0.0004 0. 0. 1
4081202 004    103520.0 337.0 0.1    0. 0. 0. 2
4081300 1
4081301 0.1    0.0    0.0
4081401 0.     0.    0.55  0.785  1
*
*****
4090000 wphotleg sngljun
4090101 408010000 412000000 0.0337 0.0    0.0    0.0    0100
4090201 1       0.0    0.0    0.0
*
*****
4120000 wpsgin snglvol
4120101 0.0    0.706  0.125 0.0    90.0   0.706  4.57e-5
4120102 0.377  0000000
4120200 004    103520.0 337.0 1.0
*
*****
4130000 wpsgfbj sngljun
4130101 412010000 416000000 0.2093 0.0    0.0    0.0    0000
4130201 1       0.0    0.0    0.0
*
*****
4160000 wpsgfb snglvol
4160101 0.0    1.1035 0.2323 0.0    90.0   1.1035 4.57e-5
4160102 0.4474 0000000
4160200 004    103510.0 337.0 1.0
*
*****

```

4170000 npsgin sngljun  
 4170101 416010000 420000000 0.0425 0.0 0.0 100100  
 4170110 0. 0. 0.725 1.  
 4170201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 4200000 wpsgtube pipe  
 4200001 12  
 4200101 0.0425 12  
 4200301 0.7181 4  
 4200302 1.2827 6  
 4200303 2.5654 7  
 4200304 2.1728 9  
 4200305 2.5654 11  
 4200306 2.8724 12  
 4200601 90.0 8  
 4200604 -90.0 12  
 4200701 0.7181 4  
 4200702 1.2827 6  
 4200703 2.5654 7  
 4200704 2.0980 8  
 4200705 -2.0980 9  
 4200706 -2.5654 11  
 4200707 -2.8724 12  
 4200801 1.524-6 0.0196 12  
 4200901 0.0 0.0 7  
 4200902 0.006 0.0 8  
 4200903 0.006 0.006 9  
 4200904 0.0 0.006 10  
 4200905 0.0 0.0 11  
 4201001 0000000 12  
 4201101 0000 11  
 4201201 004 103500.0 317.0 1. 0. 0. 1  
 4201202 004 103490.0 317.0 1. 0. 0. 2  
 4201203 004 103480.0 317.0 1. 0. 0. 3  
 4201204 004 103480.0 317.0 1. 0. 0. 4  
 4201205 004 103470.0 317.0 1. 0. 0. 5  
 4201206 004 103450.0 317.4 1. 0. 0. 6  
 4201207 004 103430.0 317.3 1. 0. 0. 7  
 4201208 004 103410.0 317.3 1. 0. 0. 8  
 4201209 004 103410.0 317.3 1. 0. 0. 9  
 4201210 004 103430.0 317.4 1. 0. 0. 10  
 4201211 004 103460.0 317.6 1. 0. 0. 11  
 4201212 004 103490.0 317.0 1. 0. 0. 12  
 4201300 1  
 4201301 0.0 0.0 0.0 1  
 4201302 0.0 0.0 0.0 2  
 4201303 0.0 0.0 0.0 3  
 4201304 0.0 0.0 0.0 4  
 4201305 0.0 0.0 0.0 5  
 4201306 0.0 0.0 0.0 6  
 4201307 0.0 0.0 0.0 7  
 4201308 0.0 0.0 0.0 8  
 4201309 0.0 0.0 0.0 9  
 4201310 0.0 0.0 0.0 10  
 4201311 0.0 0.0 0.0 11  
 \*  
 \*\*\*\*  
 4210101 420010000 424000000 0.0425 0.0 0.0 0100  
 4210201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 4240000 wpsgfbo snglvol  
 4240101 0.0 1.1035 0.2323 0.0 -90.0 -1.1035 4.57e-5  
 4240102 0.4474 0000000  
 4240200 004 103510.0 320.0 1.0  
 \*  
 \*\*\*\*  
 4250000 wpsgfbj sngljun  
 4250101 424010000 428000000 0.2093 0.0 0.0 0000  
 4250201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 4280000 wpsgout snglvol  
 4280101 0.0 0.706 0.125 0.0 -90.0 -0.706 4.57e-5  
 4280102 0.377 0000000  
 4280200 004 103520.0 324.0 1.0  
 \*  
 \*\*\*\*  
 4290000 wpccrsleg sngljun  
 4290101 428010000 432000000 0.0222 0.0 0.0 0100  
 4290201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 4320000 wpccrsleg pipe  
 4320001 5  
 4320101 0.0222 5  
 4320301 0.516 1  
 4320302 1.2422 4  
 4320303 1.1919 5  
 4320601 -50.0 1  
 4320602 -90.0 4  
 4320603 0.0 5  
 4320701 -0.3953 1  
 4320702 -1.2422 4  
 4320703 0.0 5  
 4320801 4.57e-5 0.1682 5  
 4320901 0.036 0.036 1  
 4320902 0.0 0.0 3  
 4320903 0.065 0.065 4  
 4321001 0000000 5  
 4321101 0000 4  
 4321201 004 103760.0 320.0 0.005 0. 0. 1  
 4321202 003 110140.0 320.0 0. 0. 0. 2  
 4321203 003 122230.0 320.0 0. 0. 0. 3  
 4321204 003 134320.0 320.0 0. 0. 0. 4  
 4321205 003 140390.0 320.0 0. 0. 0. 5  
 4321300 1  
 4321301 0.1 0.0 0.0 1  
 4321302 0.1 0.0 0.0 2  
 4321303 0.1 0.0 0.0 3  
 4321304 0.1 0.0 0.0 4  
 \*  
 \*\*\*\*  
 4330000 wpfcv valve  
 4330101 432010000 436000000 0.0222 0.0 0.0 0100

4330201	1	0.0	0.0	0.0		4520101	0.0337	1.3125	0.0	0.0	0.0	0.0	4.57e-5	0.207	00
4330300	mtrvlv					4520200	004	104560.0	320.0	0.0003					
4330301	536	537	1.42	1.0	0	*									
*															
4360000	wpcrlgu	pipe													
4360001	4														
4360101	0.0222	4													
4360301	1.3202	1													
4360302	1.1222	2													
4360303	1.1417	3													
4360304	1.1222	4													
4360601	0.0	1													
4360602	90.0	4													
4360701	0.0	1													
4360702	1.1222	4													
4360801	4.57e-5	0.1682	4												
4360901	0.065	0.065	1												
4360902	0.0	0.0	3												
4361001	0000000	4													
4361101	0000	3													
4361201	003	140410.0	320.6	0.	0.	0.	1								
4361202	003	135000.0	320.4	0.	0.	0.	2								
4361203	003	124180.0	320.0	0.	0.	0.	3								
4361204	003	113320.0	320.0	0.	0.	0.	4								
4361300	1														
4361301	0.1	0.0	0.0	1											
4361302	0.1	0.0	0.0	2											
4361303	0.1	0.0	0.0	3											
*															
4400000	wprcpump	pump													
4400101	0.0	0.802	0.0235	0.0	90.0	0.351	0								
4400108	436010000	0.0222	0.0	0.0	0.0	0000									
4400109	444000000	0.0337	0.0525	0.0525	0000										
4400200	004	106220.0	320.0	0.00010											
4400201	1	0.0	0.0	0.0											
4400202	1	0.0	0.0	0.0											
4400301	240	240	240	-1	-1	500	0								
4400302	188.5	0.0	.054	10.0	55.2										
4400303	0.54	750.0	0.0	0.0	0.0	0.0	0.0								
*															
4440000	wpcleg	snglvol													
4440101	0.0337	1.1211	0.0	0.0	0.0	4.57e-5	0.207	00							
4440200	004	103200.0	319.0	0.0003											
*															
4480000	wpcleg	branch													
4480001	2	1													
4480101	0.0337	1.1945	0.0	0.0	0.0	0.0	4.57e-5	0.207	00						
4480200	004	104570.0	320.0	0.0003											
4481101	444010000	448000000	0.0337	0.0	0.0	0000									
4482101	448010000	452000000	0.0337	0.0	0.0	0000									
4481201	0.1	0.0	0.0												
4482201	3.0	0.0	0.0												
*															
4520000	wpcleg	snglvol													
4520101	0.0337	1.3125	0.0	0.0	0.0	0.0	4.57e-5	0.207	00						
4520200	004	104560.0	320.0	0.0003											
*															
*****															
* Secondary Loop for the intact loop															
*****															
*															
5000000	wpstgdcn	annulus													
5000001	5														
5000101	0.0	1													
5000102	0.0296	4													
5000103	0.0	5													
5000201	0.0	3													
5000202	0.005281	4													
5000301	2.8965	1													
5000302	2.0980	2													
5000303	2.5654	4													
5000304	3.4395	5													
5000401	0.3228	1													
5000402	0.0	4													
5000403	0.1302	5													
5000501	0.0	5													
5000601	-90.0	5													
5000701	-2.0223	1													
5000702	-2.0980	2													
5000703	-2.5654	4													
5000704	-2.5464	5													
5000801	4.57e-5	0.3689	1												
5000802	4.57e-5	0.0971	4												
5000803	4.57e-5	0.0801	5												
5000901	0.0	4													
5001001	0001000	5													
5001101	0000	3													
5001102	0100	4													
5001201	004	101400.0	310.	1.0	0.	0.	1								
5001202	004	101420.0	310.	1.0	0.	0.	2								
5001203	004	101440.0	310.	1.0	0.	0.	3								
5001204	004	101470.0	310.	1.0	0.	0.	4								
5001205	004	101500.0	310.	1.0	0.	0.	5								
5001300	1														
5001301	0.0	0.0	0.0	1											
5001302	0.0	0.0	0.0	2											
5001303	0.0	0.0	0.0	3											
5001304	0.0	0.0	0.0	4											
*															
5010000	wpstgdcn	sngljun													
5010101	500010000	504000000	0.0	100.	100.	0000									
5010201	1	0.0	0.0	0.0											
*															
5040000	wpsteamg	pipe													
5040001	5														
5040101	0.2293	3													
5040102	0.0	5													
5040201	0.2293	2													
5040202	0.2323	3													
5040203	0.3138	4													
5040301	2.5464	1													

5040302	2.5654	3		5160200	004	101340.0	310.0	1.0
5040303	2.0980	4		*				
5040304	2.0223	5		*****				
5040401	0.0	3		* wpsg steam line				
5040402	0.4951	4		*****				
5040403	0.7979	5		5200000 ilstmln1 branch				
5040501	0.0	5		5200001 2 1				
5040601	90.0	5		5200101 0.0286 5.286 0.0 0.0 0.0 0.0 4.57e-5				
5040701	2.5464	1		5200102 0.1909 00				
5040702	2.5654	3		5200200 004 101320.0 310.0 1.0				
5040703	2.0980	4		5201101 516010000 520000000 0.0286 0.0 0.0 0100				
5040704	2.0223	5		5202101 520010000 524000000 0.0286 0.0 0.0 0000				
5040801	4.57e-5	0.036	4	5201201 0.0 0.0 0.0				
5040802	4.57e-5	0.219	5	5202201 0.0 0.0 0.0				
5040901	1.435	1.435	4	*				
5041001	0001000	5		*****				
5041101	0000	3		5240000 ilstmln2 snglvol				
5041102	0000	4		5240101 0.0286 9.9213 0.0 0.0 0.0 0.0 4.57e-5				
5041201	004	101500.0	310.0	1.0 0.0 0.0 1	5240102 0.1909 00			
5041202	004	101470.0	310.0	1.0 0.0 0.0 2	5240200 004 101320.0 310.0 1.0			
5041203	004	101440.0	310.0	1.0 0.0 0.0 3	*			
5041204	004	101420.0	310.0	1.0 0.0 0.0 4	*****			
5041205	004	101400.0	310.0	1.0 0.0 0.0 5	* secondary relief and safety valves, intact loop			
5041300	1			*****				
5041301	0.0	0.0	0.0	1	*			
5041302	0.0	0.0	0.0	2	5690000 ilsgrv valve			
5041303	0.0	0.0	0.0	3	5690101 520010000 570000000 2.96e-4 0.0149 0.0 0100			
5041304	0.0	0.0	0.0	4	5690201 0 0.0 0.0 0.0			
5041401	0.036	1.0	1.0	1.0 3	5690300 trpvlv			
5041402	0.1258	1.0	1.0	1.0 4	5690301 501			
*				*				
*****				*****				
5080000	npspar	separatr		5700000 contain tmdpvol				
5080001	3	1		5700101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0				
5080101	0.0	2.120	0.572	0.0 90.0 2.120 4.57e-5	5700200 004			
5080102	0.2134	00		5700201 0.0 1.01325e-5 305.0 1.0	*			
5080200	004	101370.0	310.0	1.0	*****			
5081101	508010002	516010001	0.0615	0.0 0.0 0100 0.2	5790000 blsgsv valve			
5082101	508010001	500010001	0.03964	100. 100. 0000 0.15	5790101 524010000 580000000 0.00195 0.00055 0.0 0100			
5083101	504050002	508010001	0.1986	0.0 0.0 0000	5790201 0 0.0 0.0 0.0			
5081201	0.0	0.0	0.0		5790300 trpvlv			
5082201	0.0	0.0	0.0		5790301 501			
5083201	0.0	0.0	0.0	*	*****			
*****				*****				
5120000	npsgspbp	branch		5800000 contain tmdpvol				
5120001	2	1		5800101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0				
5120101	0.0	2.120	0.6288	0.0 90.0 2.120 4.57e-5	5800200 004			
5120102	0.1242	00		5800201 0.0 1.01325e+5 305.0 1.0	*			
5120200	004	101370.0	310.0	1.0	*****			
5121101	500000000	512000000	0.3164	0.0 0.0 0000	* pressurizer			
5122101	512010000	516000000	0.0392	1.5 1.5 0000	*****			
5121201	0.0	0.0	0.0	*	*			
5122201	0.0	0.0	0.0		6000000 prssurgl pipe			
*				6000001 3				
*****				6000101 3.515e-3 3				
5160000	stmdome	snglvol		6000301 6.7788 1				
5160101	0.0	3.7778	2.0288	0.0 90.0 3.7778 4.57e-5	6000302 9.245 2			
5160102	0.7696	00						

6000303 5.4221 3  
 6000401 0.0 3  
 6000601 -90.0 3  
 6000701 -4.4077 1  
 6000702 -4.995 2  
 6000703 -2.5768 3  
 6000801 4.57e-5 0.0669 3  
 6001001 0000 3  
 6001101 0000 2  
 6001201 004 103350.0 333.0 1.0 0.0 0.0 1  
 6001202 004 103400.0 336.0 1.0 0.0 0.0 2  
 6001203 004 103690.0 338.0 1.0 0.0 0.0 3  
 6001300 1  
 6001301 0.0 0.0 0.0 1  
 6001302 0.0 0.0 0.0 2  
 \*  
 \*\*\*\*  
 6030000 prssurgl sngljun  
 6030101 610010000 600000000 3.515e-3 0.0 0.0 100100  
 6030201 1 0.0 0.0 0.0  
 6030110 0.0669 0.0 0.725 1.0  
 \*  
 \*\*\*\*  
 6100000 prsrizer pipe  
 6100001 8  
 6100101 0.0 1  
 6100102 0.2827 6  
 6100103 0.2731 8  
 6100201 0.0 7  
 6100301 0.201 1  
 6100302 0.470 3  
 6100303 0.600 4  
 6100304 0.682 6  
 6100305 0.5375 8  
 6100401 0.0325 1  
 6100402 0.0 8  
 6100501 0.0 8  
 6100601 -90.0 8  
 6100701 -0.201 1  
 6100702 -0.470 3  
 6100703 -0.6 4  
 6100704 -0.682 6  
 6100705 -0.5375 8  
 6100801 4.57e-5 0.3187 1  
 6100802 4.57e-5 0.600 6  
 6100803 4.57e-5 0.2949 8  
 \*  
 6101001 00 8  
 6101101 0000 7  
 6101201 004 103290.0 320.0 1.0 0.0 0.0 1  
 6101202 004 103290.0 321.0 1.0 0.0 0.0 2  
 6101203 004 103300.0 324.0 1.0 0.0 0.0 3  
 6101204 004 103300.0 326.0 1.0 0.0 0.0 4  
 6101205 004 103310.0 327.0 1.0 0.0 0.0 5  
 6101206 004 103310.0 328.0 1.0 0.0 0.0 6  
 6101207 004 103320.0 329.0 1.0 0.0 0.0 7  
 6101208 004 103330.0 330.0 1.0 0.0 0.0 8  
 6101300 1  
 6101301 0.0 0.0 0.0 7  
 \*  
 \*\*\*\*  
 6190000 spryin sngljun  
 6190101 444010003 620010001 0.0 0.0 0.0 10102  
 6190201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 6200000 prsspryl pipe  
 6200001 2  
 6200101 3.53e-4 2  
 6200301 22.43 2  
 6200601 90.0 2  
 6200701 8.131536 2  
 6200801 4.57e-5 0.0 2  
 6201001 00 2  
 6201101 0000 1  
 6201201 004 103610.0 320.0 1.0 0.0 0.0 1  
 6201202 004 103450.0 322.0 1.0 0.0 0.0 2  
 6201300 1  
 6201301 0.0 0.0 0.0 1  
 \*  
 \*\*\*\*  
 6210000 prsspryl sngljun  
 6210101 620010000 610000000 1.0e-6 0.0 0.0 0100  
 6210201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*  
 6210000 prsspryl tmddpjun  
 \*6210101 620010000 610000000 0.0  
 \*6210200 1 524 p 610010000  
 \*6210201 0.0 0.0 0.0 0.0  
 \*6210202 15.68e6 0.0 0.0 0.0  
 \*6210203 16.03e6 0.98 0.0 0.0  
 \*  
 \*\*\*\*  
 6300000 porvout tmddpvvol  
 6300101 1.0e+1 10.0 0.0 0.0 0.0 0.0 0.0 0 0 00  
 6300200 004  
 6300201 0.0 1.01325e+5 300.0 1.0  
 \*  
 \*\*\*\*  
 6310000 porv valve  
 6310101 610000000 650000000 3.66e-5 0.0251 0.0 0100  
 6310201 0 0.0 0.0 0.0  
 6310300 trpvlv  
 6310301 501  
 \*  
 \*\*\*\*  
 6600000 prsfvout tmddpvvol  
 6600101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0 0 00  
 6600200 004  
 6600201 0.0 1.01325e+5 300.0 1.0  
 \*  
 \*\*\*\*  
 6610000 prsfvalv valve  
 6610101 610000000 660000000 1.54e-4 0.2052 0.0 0100  
 6610201 0 0.0 0.0 0.0  
 6610300 trpvlv  
 6610301 500  
 \*  
 \*\*\*\*

\* rhr system

\*\*\*\*\*

7800000 rhrscl tmndpvol  
 7800101 0. 10. 1000. 0. 0. 0. 0. 0. 0. 00000  
 7800200 3  
 7800201 0.0 101325.0 337.0  
 \*  
 7810000 rsuln11 tmndpjun  
 7810101 200010005 780010001 0.006  
 7810200 1 0  
 7810201 0.0 3.0 0.0 0.0  
 7810202 1000.0 3.0 0.0 0.0  
 \*  
 7850000 rhrsol tmndpvol  
 7850101 0. 10. 1000. 0. 0. 0. 0. 0. 0. 00000  
 7850200 3  
 7850201 0.0 101325.0 320.0  
 \*  
 7860000 rsoln11 tmndpjun  
 7860101 785010001 244010005 0.006  
 7860200 1 0  
 7860201 0.0 3.0 0.0 0.0  
 7860202 1000.0 3.0 0.0 0.0  
 \*  
 7400000 rhrcsc2 tmndpvol  
 7400101 0. 10. 1000. 0. 0. 0. 0. 0. 0. 00000  
 7400200 3  
 7400201 0.0 101325.0 337.0  
 \*  
 7410000 rsuln12 tmndpjun  
 7410101 400010005 740010001 0.006  
 7410200 1 0  
 7410201 0.0 3.0 0.0 0.0  
 7410202 1000.0 3.0 0.0 0.0  
 \*  
 7450000 rhrcso2 tmndpvol  
 7450101 0. 10. 1000. 0. 0. 0. 0. 0. 0. 00000  
 7450200 3  
 7450201 0.0 101325.0 320.0  
 \*  
 7460000 rsoln12 tmndpjun  
 7460101 745010001 448010005 0.006  
 7460200 1 0  
 7460201 0.0 3.0 0.0 0.0  
 7460202 1000.0 3.0 0.0 0.0  
 \*  
 \*\*\*\*\*  
 \* containment volume for environmental heat losses  
 \*\*\*\*\*

9000000 envsink snglvol  
 9000101 2000. 100. 0.0 0.0 0.0 0.0 0. 10  
 9000200 004 1.01325e+5 300.15 1.0  
 \*  
 9030000 dummy tmndpvol  
 9030101 0.0 1.0 10.0 0.0 0.0 0.0 0.0 0.0 00  
 9030200 004  
 9030201 0.0 1.01325e+5 300.15 1.0  
 \*  
 9040000 dumjun sngljun

9040101 900000000 903000000 0.05 0.0 0.0 1100  
 9040201 1 0.0 0.0 0.0  
 \*  
 \*\*\*\*\*  
 \* break point - 5% break area  
 \*\*\*\*\*

9150000 npcolbrv valve  
 9150101 610010001 920010001 1.129e-2 0. 0. 00100 1. 1.  
 9150201 0 0.0 0.0 0.0  
 9150300 trpvlv  
 9150301 500  
 \*  
 \*\*\*\*\*

9200000 npcolleg tmndpvol  
 9200101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0 00  
 9200200 004  
 9200201 0.0 1.01325e+5 300.15 1.0  
 \*  
 \*\*\*\*\*

\* Reactor Vessel Heat Structures  
 \*\*\*\*\*

\* 100-1; vessel wall above nozzles,  
 \* below upper head flange  
 \*\*\*\*\*

11001000 1 7 2 1 0.320  
 11001100 0 1  
 11001101 1 0.323  
 11001102 4 0.476  
 11001103 1 0.601  
 11001201 5 1  
 11001202 6 5  
 11001203 9 6  
 11001301 0.0 6  
 11001400 0  
 11001401 317.0 7  
 11001501 100010000 0 101 1 0.823 1  
 11001601 900010000 0 101 1 0.823 1  
 11001701 0 0 0 0 1  
 11001801 0. 10.0 10.0 0.0 0. 0. 1. 1  
 11001901 0. 10.0 10.0 0.0 0. 0. 1. 1  
 \*  
 \*\*\*\*\*

\* 104-1; reactor vessel wall below nozzles  
 \*\*\*\*\*

11041000 12 7 2 1 0.320  
 11041100 0 1  
 11041101 1 0.323  
 11041102 4 0.381  
 11041103 1 0.506  
 11041201 5 1  
 11041202 6 5  
 11041203 9 6  
 11041301 0.0 6  
 11041400 0  
 11041401 317.0 7  
 11041501 104010000 0 101 1 0.600 1  
 11041502 108010000 0 101 1 0.677 2

11041503	108020000	0	101	1	0.867	3	11122901	0.	10.0	10.0	0.0	0.0	0.1.	3	
11041504	108030000	10000	101	1	0.610	9	*								
11041510	108090000	0	101	1	1.2588	10	*****								
11041511	112010000	0	101	1	0.445	11	* 120-1: core barrel, channel								
11041512	116010000	0	101	1	0.4762	12	*****								
11041601	900010000	0	101	1	0.600	1	*								
11041602	900010000	0	101	1	0.677	2	11201000	18	5	2	1	0.257			
11041603	900010000	0	101	1	0.867	3	11201100	0	1						
11041604	900010000	0	101	1	0.610	9	11201101	4	0.267						
11041610	900010000	0	101	1	1.2588	10	11201201	5	4						
11041611	900010000	0	101	1	0.445	11	11201301	0.0	4						
11041612	900010000	0	101	1	0.4762	12	11201400	0							
11041701	0	0	0	0	12		11201401	317.0		5					
11041801	0.	10.0	10.0	0.0	0.	0.	1.	12							
11041901	0.	10.0	10.0	0.0	0.	0.	0.	1.	12						
*							11201501	120010000	0	101	1	1.2588	1		
*****							11201502	124010000	10000	101	1	0.305	13		
*****							11201503	128010000	0	101	1	0.867	14		
*							11201504	132010000	0	101	1	0.677	15		
*****							11201505	136010000	0	101	1	0.600	16		
*							11201506	140010000	0	101	1	0.3674	17		
*****							11201507	144010000	0	101	1	0.897	18		
*							11201601	108090000	0	101	1	1.2588	1		
11121000	1	7	1	1	0.0		11201602	108080000	0	101	1	0.305	2		
11121100	0	1					11201603	108080000	0	101	1	0.305	3		
11121101	1	0.003					11201604	108070000	0	101	1	0.305	4		
11121102	4	0.724					11201605	108070000	0	101	1	0.305	5		
11121103	1	0.849					11201606	108060000	0	101	1	0.305	6		
11121201	5	1					11201607	108060000	0	101	1	0.305	7		
11121202	6	5					11201608	108050000	0	101	1	0.305	8		
11121203	9	6					11201609	108050000	0	101	1	0.305	9		
11121301	0.0	6					11201610	108040000	0	101	1	0.305	10		
11121400	0						11201611	108040000	0	101	1	0.305	11		
11121401	317.0		7				11201612	108030000	0	101	1	0.305	12		
11121501	112010000	0	101	0	0.686	1	11201613	108030000	0	101	1	0.305	13		
11121601	900010000	0	101	1	0.686	1	11201614	108020000	0	101	1	0.867	14		
11121701	0	0	0	0	1		11201615	108010000	0	101	1	0.677	15		
11121801	0.	10.0	10.0	0.0	0.	0.	1.	1							
11121901	0.	10.0	10.0	0.0	0.	0.	0.	1.							
*							11201616	104010000	0	101	1	0.600	16		
*****							11201617	100010000	0	101	1	0.3674	17		
*							11201618	100010000	0	101	1	0.897	18		
*****							11201701	0	0	0	0	18			
*							11201801	0.	10.0	10.0	0.0	0.	0.	1.0	18
*							11201901	0.	10.0	10.0	0.0	0.	0.	1.0	18
11122000	3	4	2	1	0.0		*								
11122100	0	1					*****								
11122101	1	0.002					*	124-1: heated section of heater rods in channel							
11122102	1	0.00295					*****								
11122103	1	0.00375					*								
11122201	3	1					11241000	12	9	2	1	0.0			
11122202	1	2					11241100	0	1						
11122203	4	3					11241101	2	0.00200						
11122301	0.0	3					11241102	2	0.00260						
11122400	0						11241103	2	0.00375						
11122401	317.0		4				11241104	2	0.00475						
11122501	0	0	0	1	731.2	1	11241201	7	2						
11122502	0	0	0	1	556.2	2	11241202	2	4						
11122503	0	0	0	1	1470.3	3	11241203	1	6						
11122601	112010000	0	101	1	731.2	1	11241204	4	8						
11122602	116010000	0	101	1	556.2	2	11241301	0.0	2						
11122603	120010000	0	101	1	1470.3	3	11241302	1.0	4						
11122701	0	0	0	0	3		11241303	0.0	8						





12201701	0	0	0	0	12		13003400	0											
12201801	0.	10.0	10.0	0.0	0.	0.0	0.1.	12	13003401	317.0	6								
12201900	1						13003501	300010000	0	101	1	0.6461	1						
12201901	0.	10.0	10.0	0.0	0.	0.0	0.	1.	10.2	1.1	1.0	12	13003502	304050000	0	101	1	1.0104	2
*							13003503	312010000	0	101	1	2.120	3						
*****	*****	*****	*****	*****	*****	*****	13003504	316010000	0	101	1	3.4278	4						
* ht str no. 300-1 blsg external dc pipe to environ	*****	*****	*****	*****	*****	*****	13003601	900010000	0	101	1	0.6461	1						
*****	*****	*****	*****	*****	*****	*****	13003602	900010000	0	101	1	1.0104	2						
13001000	5	5	2	1	0.0486	0	13003603	900010000	0	101	1	2.120	3						
13001100	0	1					13003604	900010000	0	101	1	3.4278	4						
13001101	2	0.0572					13003701	0	0	0	0	0	4						
13001102	2	0.1572					13003801	0.	10.0	10.0	0.	0.	0.	1.	1				
13001201	5	2					13003802	0.	10.0	10.0	0.	0.	0.	1.	2				
13001202	9	4					13003803	0.	10.0	10.0	0.	0.	0.	1.	3				
13001301	0.0	4					13003804	0.	10.0	10.0	0.	0.	0.	1.	4				
13001401	317.0	5					13003901	0.	10.0	10.0	0.	0.	0.	1.	4				
13001501	300010000	0	101	1	9.0016	1	*												
13001502	300020000	0	101	1	8.3920	2	*****	*****	*****	*****	*****	*****	*****						
13001503	300030000	10000	101	1	10.2616	4	* ht str no. 300-4 blsg lower sg dc to boiler	*****	*****	*****	*****	*****	*****						
13001504	300050000	0	101	1	10.2380	5	*****	*****	*****	*****	*****	*****	*****						
13001601	900010000	0	101	1	9.0016	1	13004000	1	2	2	1	0.345	0						
13001602	900010000	0	101	1	8.3920	2	13004100	0	1										
13001603	900010000	0	101	1	10.2616	4	13004101	1	0.351										
13001604	900010000	0	101	1	10.2380	5	13004201	5	1										
13001701	0	0	0	0	0	5	13004301	0.0	1										
13001801	0.	10.0	10.0	0.	0.	0.	1.	13004400	0										
13001901	0.	10.0	10.0	0.	0.	0.	0.	13004401	317.0	2									
*							13004501	304010000	0	101	1	1.0637	1						
*****	*****	*****	*****	*****	*****	*****	13004601	300050000	0	101	1	1.0637	1						
* ht str no. 300-2 blsg upper dc to separator	*****	*****	*****	*****	*****	*****	13004701	0	0	0	0	0	1						
*****	*****	*****	*****	*****	*****	*****	13004801	0.	10.0	10.0	0.	0.	0.	1.	1				
13002000	2	2	2	1	0.2514	0	13004901	0.	10.0	10.0	0.	0.	0.	1.	1				
13002100	0	1					*												
13002101	1	0.2554					*****	*****	*****	*****	*****	*****	*****						
13002201	5	1					* ht str no. 300-5 blsg lower sg dc wall to environ	*****	*****	*****	*****	*****	*****						
13002301	0.0	1					*****	*****	*****	*****	*****	*****	*****						
13002400	0						13005000	1	6	2	1	0.370	0						
13002401	317.0	2					13005100	0	1										
13002501	304050000	0	101	1	0.6461	1	13005101	1	0.373										
13002502	308010000	0	101	1	2.120	2	13005102	2	0.405										
13002601	300010000	0	101	1	0.6461	1	13005103	2	0.530										
13002602	308010000	0	101	1	2.120	2	13005201	5	1										
13002701	0	0	0	0	0	2	13005202	6	3										
13002801	0.	10.0	10.0	0.	0.	0.	1.	13005203	9	5									
13002901	0.	10.0	10.0	0.	0.	0.	0.	13005301	0.0	5									
13002902	0.	10.0	10.0	0.	0.	0.	0.	13005400	0										
*							13005401	317.0	6										
*****	*****	*****	*****	*****	*****	*****	13005501	300050000	0	101	1	1.2637	1						
* ht str no. 300-3 blsg upper sg shell to environ	*****	*****	*****	*****	*****	*****	13005601	900010000	0	101	1	1.2637	1						
*****	*****	*****	*****	*****	*****	*****	13005701	0	0	0	0	1							
13003000	4	6	2	1	0.4375	0	13005801	0.	10.0	10.0	0.	0.	0.	1.	1				
13003100	0	1					13005901	0.	10.0	10.0	0.	0.	0.	1.	1				
13003101	1	0.4405					*												
13003102	2	0.4785					*****	*****	*****	*****	*****	*****	*****						
13003103	2	0.6035					* ht str no. 304-1 blsg boiler wall to environ	*****	*****	*****	*****	*****	*****						
13003201	5	1					*****	*****	*****	*****	*****	*****	*****						
13003202	6	3					13041000	5	6	2	1	0.347	0						
13003203	9	5					13041100	0	1										
13003301	0.0	5					13041101	1	0.350										



\*  
 \*\*\*\* ht str no. 400-3 il + bl cl heat struct  
 \*\*\*\*

14003000	7	5	2	1	0.1035	0	14122202	6	3									
14003100	0			1			14122203	9	5									
14003101	2				0.1937		14122301	0.0	5									
14003102	2				0.3187		14122400	0										
14003201	5			2			14122401	317.0	6									
14003202	9			4			14122501	412010000	0	101	1	0.4237	1					
14003301	0.0			4			14122502	428010000	0	101	1	0.4237	2					
14003400	0						14122503	416010000	0	101	1	1.1035	3					
14003401	317.0			5			14122504	424010000	0	101	1	1.1035	4					
14003501	444010000	0		101	1	1.0562	1	14122601	900010000	0	101	1	0.4237	2				
14003502	448010000	0		101	1	1.1067	2	14122602	900010000	0	101	1	1.1035	4				
14003503	452010000	0		101	1	1.3125	3	14122701	0	0	0	0	0	4				
14003504	244010000	0		101	1	0.647	4	14122801	0.	10.0	10.0	0.	0.	0.	1.	4		
14003505	248010000	0		101	1	0.878	5	14122901	0.	10.0	10.0	0.	0.	0.	0.	1.	4	
14003506	252010000	10000		101	1	0.9752	7	*										
14003601	900010000	0		101	1	1.0562	1	14201000	12	8	2	1	0.00980					
14003602	900010000	0		101	1	1.1067	2	14201100	0	1								
14003603	900010000	0		101	1	1.3125	3	14201101	7	0.0127								
14003604	900010000	0		101	1	0.647	4	14201201	5	7								
14003605	900010000	0		101	1	0.878	5	14201301	0.0	7								
14003606	900010000	0		101	1	0.9752	7	14201400	0									
14003701	0	0	0	0	0	7	14201401	317.0	8									
14003801	0.	10.0	10.0	0.	0.	0.	1.	14201501	420010000	10000	101	1	89.76	4				
14003901	0.	10.0	10.0	0.	0.	0.	0.	14201502	420050000	10000	101	1	180.86	6				
*							14201503	420070000	0	101	1	361.72	7					
* ht str no. 412-1 ilsg inlet/outlet plnm hemisph							14201504	420080000	10000	101	1	306.36	9					
*****							14201505	420100000	10000	101	1	361.72	11					
*****							14201506	420120000	0	101	1	359.04	12					
14121000	2	6	3	1	0.377	0	14201601	504010000	0	110	1	89.76	4					
14121100	0			1			14201602	504020000	0	110	1	180.86	6					
14121101	1				0.380		14201603	504030000	0	110	1	361.72	7					
14121102	2				0.430		14201604	504040000	0	110	1	306.36	9					
14121103	2				0.555		14201605	504030000	-10000	110	1	361.72	11					
14121201	5			1			14201606	504010000	0	110	1	359.04	12					
14121202	6			3			14201701	0	0	0	0	12						
14121203	9			5			14201801	0.	10.0	10.0	0.0	0.0	0.	1.	12			
14121301	0.0			5			14201900	1										
14121400	0						14201901	0.	10.0	10.0	0.0	0.0	0.	1.	10.2	1.1	1.0	12
14121401	317.0			6			*											
14121501	412010000	0		101	1	0.1872	1	*****										
14121502	428010000	0		101	1	0.1872	2	* ht str no. 420-2 ilsg inlet/outlet tube sheet										
14121601	900010000	0		101	1	0.1872	2	*****										
14121701	0	0	0	0	0	2	14202000	2	4	2	1	0.0098	0					
14121801	0.	10.0	10.0	0.	0.	0.	14202100	0		1								
14121901	0.	10.0	10.0	0.	0.	0.	14202101	3		0.0163								
*							14202201	5		3								
* ht str no. 412-2 ilsg inlet/outlet plnm walls							14202301	0.0		3								
*****							14202400	0										
14122000	4	6	2	1	0.365	0	14202401	317.0	4									
14122100	0			1			14202501	420010000	0	101	1	45.40	1					
14122101	1				0.368		14202502	420080000	0	101	1	45.40	2					
14122102	2				0.434		14202601	0	0	0	1	45.40	2					
14122103	2				0.559		14202701	0	0	0	0	0	2					
14122201	5			1			14202801	0.	10.0	10.0	0.	0.	0.	1.	2			
*							*****											

* ht str no. 500-1 ilsg external dc pipe to environ									
*****									
15001000	5	5	2	1	0.0486	0	15003601	900010000	
15001100	0			1			15003602	900010000	
15001101	2			0.0572			15003603	900010000	
15001102	2			0.1572			15003604	900010000	
15001201	5			2			15003701	0	
15001202	9			4			15003801	0.	
15001301	0.0			4			15003802	0.	
15001401	317.0			5			15003803	0.	
15001501	500010000	0		101	1	9.0016	1	15003804	0.
15001502	500020000	0		101	1	8.3920	2	15003901	0.
15001503	500030000	10000		101	1	10.2616	4		*
15001504	500050000	0		101	1	10.2380	5		*****
15001601	900010000	0		101	1	9.0016	1	* ht str no. 500-4 ilsg lower sg dc to boiler	
15001602	900010000	0		101	1	8.3920	2	*****	
15001603	900010000	0		101	1	10.2616	4	15004000	1
15001604	900010000	0		101	1	10.2380	5	15004100	0
15001701	0		Q		0	0	5	15004101	1
15001801	0.	10.0	10.0	0.	0.	0.	1.	15004201	0.351
15001901	0.	10.0	10.0	0.	0.	0.	1.	15004301	1
*								15004400	0
*								15004401	317.0
*								15004501	504010000
*								15004601	500050000
*	ht str no. 500-2 ilsg upper dc to separator								
*	*****								
15002000	2	2	2	1	0.2514	0	15004701	0	
15002100	0			1			15004801	0.	
15002101	1			0.2554			15004901	0.	
15002201	5			1				*	
15002301	0.0			1				*****	
15002400	0						* ht str no. 500-5 ilsg lower sg dc wall to environ		
15002401	317.0			2			*****		
15002501	504050000	0		101	1	0.6461	1	15005000	1
15002502	508010000	0		101	1	2.120	2	15005100	0
15002601	500010000	0		101	1	0.6461	1	15005101	1
15002602	508010000	0		101	1	2.120	2	15005102	2
15002701	0		0		0	0	2	15005103	2
15002801	0.	10.0	10.0	0.	0.	0.	1.	15005201	5
15002901	0.	10.0	10.0	0.	0.	0.	1.	15005202	6
15002902	0.	10.0	10.0	0.	0.	0.	1.	15005203	9
*								15005301	5
*								15005400	0
*								15005401	317.0
*	ht str no. 500-3 ilsg upper sg shell to environ								6
*	*****								
15003000	4	6	2	1	0.4375	0	15005501	500050000	
15003100	0			1			15005601	900010000	
15003101	1			0.4405			15005701	0	
15003102	2			0.4785			15005801	0.	
15003103	2			0.6035			15005901	0.	
15003201	5			1				*	
15003202	6			3				*****	
15003203	9			5			* ht str no. 504-1 ilsg boiler wall to environ		
15003301	0.0			5			*****		
15003400	0								
15003401	317.0			6					
15003501	500010000	0		101	1	0.6461	1	15041000	5
15003502	504050000	0		101	1	1.0104	2	15041100	0
15003503	512010000	0		101	1	2.120	3	15041101	1
15003504	516010000	0		101	1	3.4278	4	15041102	0.350
								15041103	2
								15041201	0.380
								15041202	2
								15041203	0.505
								15041301	5



\*  
 \*\*\*\* Thermal Properties \*\*\*\*  
 \*  
 20100100   tbl/fctn   1   1   \* mgo  
 20100200   tbl/fctn   1   1   \* nicr  
 20100300   tbl/fctn   1   1   \* copper  
 20100400   tbl/fctn   1   1   \* inconel  
 20100500   tbl/fctn   1   1   \* stainless steel  
 20100600   c-steel                          \* carbon steel  
 20100700   tbl/fctn   1   1   \* al2o3  
 20100900   tbl/fctn   1   1   \* rockwool insulation  
 \*  
 \*\*\*\* thermal conductivity \*\*\*\*  
 \*  
 \*         mgo  
 \*  
 20100101   293.2   0.814   1273.2   1.047  
 \*  
 \*         nicr heater  
 \*  
 20100201 293.15 8.78 573.15 11.3 773.15 13.81 1073.15 18.83  
 20100202 1273.15 22.18 1473.15 25.52 10000.0 25.52  
 \*  
 \*         copper  
 \*  
 20100301 300.0 383.0  
 20100302 373.15 379. 473.15 374. 573.15 369.  
 20100303 673.15 363. 873.15 353.  
 \*  
 \*         inconel 600  
 \*  
 20100401 200.0 13.0 323.0 14.9  
 20100402 373.15 15.8 573.15 18.9 873.15 23.8 1173.15 29.3  
 \*  
 \*  
 \*         stainless steel  
 \*  
 20100501 273.15 12.98 1199.82 25.1 10000.0 25.1  
 \*  
 \*         aluminum oxide  
 \*  
 20100701 300.0 28.0  
 20100702 373.15 25.122 473.15 20.935 573.15 16.748 773.15  
 12.561  
 20100703 1073.15 8.374 1473.15 8.374  
 \*  
 \*         rockwool insulation  
 \*  
 20100901 273.0 0.1192  
 20100902 311.15 0.1192 422.15 0.1681 533.15 0.2166  
 20100903 811.15 0.3448  
 \*  
 \*\*\*\* volumetric heat capacity \*\*\*\*  
 \*  
 \*         mgo  
 \*  
 20100151   293.15   2.88e6   373.15   3.04e6   473.15   3.15e6  
 20100152   573.15   3.20e6   673.15   3.25e6   773.15   3.29e6  
 20100153   873.15   3.34e6   973.15   3.44e6   1073.15   3.53e6  
 20100154   1173.15   3.63e6  
 \*  
 \*         nicr heater  
 \*  
 20100251   300.0   3.00e+6  
 20100252   373.15   3.23e+6 573.15   3.62e+6 773.15   4.10e+6  
 20100253   1073.15   4.61e+6 1173.15   4.73e+6 1273.15   4.95e+6  
 20100254   1473.15   5.29e+6 10000.0   5.29e+6  
 \*  
 \*         copper  
 \*  
 20100351   3.43e6  
 \*  
 \*         inconel 600  
 \*  
 20100451   300.0   3.50e6   323.0   3.76e6  
 20100452   373.15   3.94e+6 573.15   4.18e+6 873.15   4.71e+6  
 20100453   1173.15   5.17e+6  
 \*  
 \*         stainless steel  
 \*  
 20100551   273.15   3.83e+6 366.5   3.83e+6 477.59   4.19e+6  
 20100552   588.59   4.336e+6 699.82   4.504e+6 810.93   4.639e+6  
 20100553   922.04   4.773e+6 1144.26   5.076e+6 1366.5   5.376e+6  
 20100554   1477.59   5.546e+6 10000.0   5.546e+6  
 \*  
 \*         aluminum oxide  
 \*  
 20100751   300.0   3.00e6  
 20100752   373.15   3.015e+6 473.15   3.482e+6 573.15   3.796e+6  
 20100753   673.15   3.946e+6 773.15   4.093e+6 873.15   4.239e+6  
 20100754   973.15   4.384e+6 1073.16   4.373e+6 1173.16   4.529e+6  
 20100755   1373.16   4.529e+6 1473.16   4.685e+6  
 \*  
 \*         rockwool  
 \*  
 20100951   1.36e+5  
 \*  
 \*\*\*\* core power \*\*\*\*  
 \*  
 20288800   power   501  
 20288801   -1.0   0.430e+6  
 20288802   0.0   0.430e+6  
 \*  
 \*\*\*\* Control Systems \*\*\*\*  
 \*  
 \* calculate core collapsed liquid level  
 \*  
 20512400 "core lvl"                          sum                  1.0   3.66   1  
 20512401    0.0                   0.305                   voidf   124010000  
 20512402    0.305                   voidf   124020000

20512403	0.305	voidf	124030000	*							
20512404	0.305	voidf	124040000	20575500	"ildown"	sum	1.0	0.0	1		
20512405	0.305	voidf	124050000	20575501	0.0	-1.0	p	432010000			
20512406	0.305	voidf	124060000	20575502		1.0	p	432050000			
20512407	0.305	voidf	124070000	*							
20512408	0.305	voidf	124080000	20575600	"bldown"	sum	1.0	0.0	1		
20512409	0.305	voidf	124090000	20575601	0.0	-1.0	p	232010000			
20512410	0.305	voidf	124100000	20575602		1.0	p	232050000			
20512411	0.305	voidf	124110000	*							
20512412	0.305	voidf	124120000	20576000	"dpe290"	sum	1.0	1200.	1		
*****											
* calculate core collapsed liquid level ---vessel---											
*****											
*				20576001	0.0	1.0	p	120010000			
*				20576002		-1.0	p	124010000			
*				*							
20512500	"core lvl"	sum	1.0	5.8027	1	20576100	"dpe300"	sum	1.0	32000.	1
20512501	0.0	0.305	voidf	124010000		20576101	0.0	1.0	p	124010000	
20512502		0.305	voidf	124020000		20576102		-1.0	p	128010000	
20512503		0.305	voidf	124030000	20576300	"dpe320"	sum	1.0	13000.	1	
20512504		0.305	voidf	124040000	20576301	0.0	1.0	p	128010000		
20512505		0.305	voidf	124050000	20576302		-1.0	p	140010000		
20512506		0.305	voidf	124060000	*						
20512507		0.305	voidf	124070000	*****						
20512508		0.305	voidf	124080000	*						
20512509		0.305	voidf	124090000	*****						
20512510		0.305	voidf	124100000	*						
20512511		0.305	voidf	124110000	20531200	"blsglwde"	sum	1.0	8.9221049	1	
20512512		0.305	voidf	124120000	20531201	0.0	2.5464	voidf	304010000		
20512513		0.867	voidf	128010000	20531202		2.5654	voidf	304020000		
20512514		0.6757	voidf	132010000	20531203		2.5654	voidf	304030000		
20512515		0.6	voidf	136010000	20531204		2.0980	voidf	304040000		
*****											
* calculate pressurizer collapsed liquid level											
*****											
*				20531205		2.0223	voidf	304050000			
*				20531206		2.1200	voidf	308010000			
*				20531207		3.7778	voidf	316010000			
*				*							
20512600	"pqr lvl"	sum	1.0	0.0	1	20551200	"ilsglwde"	sum	1.0	8.8904978	1
20512601	0.0	0.201	voidf	610010000	20551201	0.0	2.5464	voidf	504010000		
20512602		0.470	voidf	610020000	20551202		2.5654	voidf	504020000		
20512603		0.470	voidf	610030000	20551203		2.5654	voidf	504030000		
20512604		0.60	voidf	610040000	20551204		2.0980	voidf	504040000		
20512605		0.682	voidf	610050000	20551205		2.0223	voidf	504050000		
20512606		0.682	voidf	610060000	20551206		2.1200	voidf	508010000		
20512607		0.5375	voidf	610070000	20551207		3.7778	voidf	516010000		
20512608		0.5375	voidf	610080000	*						
*				*****							
20575100	"dpdoup"	sum	1.0	0.0	1	*					
20575101	0.0	1.0	p	136010000	*****						
20575102		-1.0	p	104010000	*						
*				*****							
20575300	"dpe080"	sum	1.0	266000.	1	20561100	"v-200"	mult	1.0	0.1	1
20575301	0.0	1.0	p	436010000	20561101	tmassv		200010000			
20575302		-1.0	p	436040000	20561102	quals		200010000			
*				20561103	quala			200010000			
20575700	"dpe220"	sum	1.0	266000.	1	*					
20575701	0.0	1.0	p	236010000	20561200	"v-206"	mult	1.0	0.1	1	
20575702		-1.0	p	236040000	20561201	tmassv		206010000			
*				20561202	quals			206010000			
20575400	"updP"	sum	1.0	0.0	1	20561203	quala		206010000		
20575401	0.0	1.0	p	124010000	*						
20575402		-1.0	p	136010000	20561300	"v-208-1"	mult	1.0	0.1	1	

20561301	tmassv	208010000					20563103	quala	220090000				
20561302	quals	208010000					20563200	"v-220-10"	mult	1.0	0.1	1	
20561303	quala	208010000					20563201	tmassv	220100000				
20561400	"v-208-2"	mult	1.0	0.1	1		20563202	quals	220100000				
20561401	tmassv	208020000					20563203	quala	220100000				
20561402	quals	208020000					20563300	"v-220-11"	mult	1.0	0.1	1	
20561403	quala	208020000					20563301	tmassv	220110000				
*							20563302	quals	220110000				
20562000	"hl-b-nc"	sum	1.0	0.1	1		20563303	quala	220110000				
20562001	0.0	1.0	cntrivar	611			20563400	"v-220-12"	mult	1.0	0.1	1	
20562002		1.0	cntrivar	612			20563401	tmassv	220120000				
20562003		1.0	cntrivar	613			20563402	quals	220120000				
20562004		1.0	cntrivar	614			20563403	quala	220120000				
***							*						
20562100	"v-212"	mult	1.0	0.1	1		20563500	"v-224"	mult	1.0	0.1	1	
20562101	tmassv	212010000					20563501	tmassv	224010000				
20562102	quals	212010000					20563502	quals	224010000				
20562103	quala	212010000					20563503	quala	224010000				
*							*						
20562200	"v-216"	mult	1.0	0.1	1		20563600	"v-228"	mult	1.0	0.1	1	
20562201	tmassv	216010000					20563601	tmassv	228010000				
20562202	quals	216010000					20563602	quals	228010000				
20562203	quala	216010000					20563603	quala	228010000				
*							*						
20562300	"v-220-1"	mult	1.0	0.1	1		20563900	"sg-b-t"	sum	1.0	0.1	1	
20562301	tmassv	220010000					20563901	0.0	1.0	cntrivar	623		
20562302	quals	220010000					20563902		1.0	cntrivar	624		
20562303	quala	220010000					20563903		1.0	cntrivar	625		
20562400	"v-220-2"	mult	1.0	0.1	1		20563904		1.0	cntrivar	626		
20562401	tmassv	220020000					20563905		1.0	cntrivar	627		
20562402	quals	220020000					20563906		1.0	cntrivar	628		
20562403	quala	220020000					20563907		1.0	cntrivar	629		
20562500	"v-220-3"	mult	1.0	0.1	1		20563908		1.0	cntrivar	630		
20562501	tmassv	220030000					20563909		1.0	cntrivar	631		
20562502	quals	220030000					20563910		1.0	cntrivar	632		
20562503	quala	220030000					20563911		1.0	cntrivar	633		
20562600	"v-220-4"	mult	1.0	0.1	1		20563912		1.0	cntrivar	634		
20562601	tmassv	220040000					*						
20562602	quals	220040000					20564000	"sg-b-nc"	sum	1.0	0.1	1	
20562603	quala	220040000					20564001	0.0	1.0	cntrivar	621		
20562700	"v-220-5"	mult	1.0	0.1	1		20564002		1.0	cntrivar	622		
20562701	tmassv	220050000					20564003		1.0	cntrivar	639		
20562702	quals	220050000					20564004		1.0	cntrivar	635		
20562703	quala	220050000					20564005		1.0	cntrivar	636		
20562800	"v-220-6"	mult	1.0	0.1	1		*						
20562801	tmassv	220060000					20564100	"v-232-1"	mult	1.0	0.1	1	
20562802	quals	220060000					20564101	tmassv	232010000				
20562803	quala	220060000					20564102	quals	232010000				
20562900	"v-220-7"	mult	1.0	0.1	1		20564103	quala	232010000				
20562901	tmassv	220070000					20564200	"v-232-2"	mult	1.0	0.1	1	
20562902	quals	220070000					20564201	tmassv	232020000				
20562903	quala	220070000					20564202	quals	232020000				
20563000	"v-220-8"	mult	1.0	0.1	1		20564203	quala	232020000				
20563001	tmassv	220080000					20564300	"v-232-3"	mult	1.0	0.1	1	
20563002	quals	220080000					20564301	tmassv	232030000				
20563003	quala	220080000					20564302	quals	232030000				
20563100	"v-220-9"	mult	1.0	0.1	1		20564303	quala	232030000				
20563101	tmassv	220090000					20564400	"v-232-4"	mult	1.0	0.1	1	
20563102	quals	220090000					20564401	tmassv	232040000				

20564402	quals	232040000					20566000	"cl-b-nc"	sum	1.0	0.1	1
20564403	quala	232040000					20566001	0.0	1.0	cntrivar	651	
20564500	"v-232-5"	mult	1.0	0.1	1		20566002		1.0	cntrivar	652	
20564501	tmassv	232050000					20566003		1.0	cntrivar	653	
20564502	quals	232050000					20566004		1.0	cntrivar	654	
20564503	quala	232050000					20566005		1.0	cntrivar	655	
*							*					
20564600	"v-236-1"	mult	1.0	0.1	1		*****	*****	*****	*****	*****	
20564601	tmassv	236010000					* calculate the noncondensable mass in primary					
20564602	quals	236010000					* system-Intact loop					
20564603	quala	236010000					*****	*****	*****	*****	*****	
20564700	"v-236-2"	mult	1.0	0.1	1		*					
20564701	tmassv	236020000					20581100	"v-400"	mult	1.0	0.1	1
20564702	quals	236020000					20581101	tmassv	400010000			
20564703	quala	236020000					20581102	quals	400010000			
20564800	"v-236-3"	mult	1.0	0.1	1		20581103	quala	400010000			
20564801	tmassv	236030000					*					
20564802	quals	236030000					20581200	"v-406"	mult	1.0	0.1	1
20564803	quala	236030000					20581201	tmassv	406010000			
20564900	"v-236-4"	mult	1.0	0.1	1		20581202	quals	406010000			
20564901	tmassv	236040000					20581203	quala	406010000			
20564902	quals	236040000					*					
20564903	quala	236040000					20581300	"v-408-1"	mult	1.0	0.1	1
*							20581301	tmassv	408010000			
20565000	"ol-b-nc"	sum	1.0	0.1	1		20581302	quals	408010000			
20565001	0.0	1.0	cntrivar	641			20581303	quala	408010000			
20565002		1.0	cntrivar	642			20581400	"v-408-2"	mult	1.0	0.1	1
20565003		1.0	cntrivar	643			20581401	tmassv	408020000			
20565004		1.0	cntrivar	644			20581402	quals	408020000			
20565005		1.0	cntrivar	645			20581403	quala	408020000			
20565006		1.0	cntrivar	646			*					
20565007		1.0	cntrivar	647			20582000	"hl-i-nc"	sum	1.0	0.1	1
20565008		1.0	cntrivar	648			20582001	0.0	1.0	cntrivar	811	
20565009		1.0	cntrivar	649			20582002		1.0	cntrivar	812	
***							20582003		1.0	cntrivar	813	
20565100	"v-240"	mult	1.0	0.1	1		20582004		1.0	cntrivar	814	
20565101	tmassv	240010000					***					
20565102	quals	240010000					20582100	"v-412"	mult	1.0	0.1	1
20565103	quala	240010000					20582101	tmassv	412010000			
*							20582102	quals	412010000			
20565200	"v-244"	mult	1.0	0.1	1		20582103	quala	412010000			
20565201	tmassv	244010000					*					
20565202	quals	244010000					20582200	"v-416"	mult	1.0	0.1	1
20565203	quala	244010000					20582201	tmassv	416010000			
*							20582202	quals	416010000			
20565300	"v-248"	mult	1.0	0.1	1		20582203	quala	416010000			
20565301	tmassv	248010000					*					
20565302	quals	248010000					20582300	"v-420-1"	mult	1.0	0.1	1
20565303	quala	248010000					20582301	tmassv	420010000			
*							20582302	quals	420010000			
20565400	"v-252-1"	mult	1.0	0.1	1		20582303	quala	420010000			
20565401	tmassv	252010000					20582400	"v-420-2"	mult	1.0	0.1	1
20565402	quals	252010000					20582401	tmassv	420020000			
20565403	quala	252010000					20582402	quals	420020000			
20565500	"v-252-2"	mult	1.0	0.1	1		20582403	quala	420020000			
20565501	tmassv	252020000					20582500	"v-420-3"	mult	1.0	0.1	1
20565502	quals	252020000					20582501	tmassv	420030000			
20565503	quala	252020000					20582502	quals	420030000			
*							20582503	quala	420030000			

20582600	"v-420-4"	mult	1.0	0.1	1	20583912		1.0	cntrivar	834		
20582601	tmassv	420040000				*						
20582602	quals	420040000				20584000	"sg-i-nc"	sum	1.0	0.1	1	
20582603	quala	420040000				20584001	0.0	1.0	cntrivar	821		
20582700	"v-420-5"	mult	1.0	0.1	1	20584002		1.0	cntrivar	822		
20582701	tmassv	420050000				20584003		1.0	cntrivar	839		
20582702	quals	420050000				20584004		1.0	cntrivar	835		
20582703	quala	420050000				20584005		1.0	cntrivar	836		
20582800	"v-420-6"	mult	1.0	0.1	1	***						
20582801	tmassv	420060000				20584100	"v-432-1"	mult	1.0	0.1	1	
20582802	quals	420060000				20584101	tmassv	432010000				
20582803	quala	420060000				20584102	quals	432010000				
20582900	"v-420-7"	mult	1.0	0.1	1	20584103	quala	432010000				
20582901	tmassv	420070000				20584200	"v-432-2"	mult	1.0	0.1	1	
20582902	quals	420070000				20584201	tmassv	432020000				
20582903	quala	420070000				20584202	quals	432020000				
20583000	"v-420-8"	mult	1.0	0.1	1	20584203	quala	432020000				
20583001	tmassv	420080000				20584300	"v-432-3"	mult	1.0	0.1	1	
20583002	quals	420080000				20584301	tmassv	432030000				
20583003	quala	420080000				20584302	quals	432030000				
20583100	"v-420-9"	mult	1.0	0.1	1	20584303	quala	432030000				
20583101	tmassv	420090000				20584400	"v-432-4"	mult	1.0	0.1	1	
20583102	quals	420090000				20584401	tmassv	432040000				
20583103	quala	420090000				20584402	quals	432040000				
20583200	"v-420-10"	mult	1.0	0.1	1	20584403	quala	432040000				
20583201	tmassv	420100000				20584500	"v-432-5"	mult	1.0	0.1	1	
20583202	quals	420100000				20584501	tmassv	432050000				
20583203	quala	420100000				20584502	quals	432050000				
20583300	"v-420-11"	mult	1.0	0.1	1	20584503	quala	432050000				
20583301	tmassv	420110000				*						
20583302	quals	420110000				20584600	"v-436-1"	mult	1.0	0.1	1	
20583303	quala	420110000				20584601	tmassv	436010000				
20583400	"v-420-12"	mult	1.0	0.1	1	20584602	quals	436010000				
20583401	tmassv	420120000				20584603	quala	436010000				
20583402	quals	420120000				20584700	"v-436-2"	mult	1.0	0.1	1	
20583403	quala	420120000				20584701	tmassv	436020000				
*						20584702	quals	436020000				
20583500	"v-424"	mult	1.0	0.1	1	20584703	quala	436020000				
20583501	tmassv	424010000				20584800	"v-436-3"	mult	1.0	0.1	1	
20583502	quals	424010000				20584801	tmassv	436030000				
20583503	quala	424010000				20584802	quals	436030000				
*						20584803	quala	436030000				
20583600	"v-428"	mult	1.0	0.1	1	20584900	"v-436-4"	mult	1.0	0.1	1	
20583601	tmassv	428010000				20584901	tmassv	436040000				
20583602	quals	428010000				20584902	quals	436040000				
20583603	quala	428010000				20584903	quala	436040000				
*						*						
20583900	"sg-b-tb"	sum	1.0	0.1	1	20585000	"ol-i-nc"	sum	1.0	0.1	1	
20583901	0.0	1.0	cntrivar	823		20585001	0.0	1.0	cntrivar	841		
20583902		1.0	cntrivar	824		20585002		1.0	cntrivar	842		
20583903		1.0	cntrivar	825		20585003		1.0	cntrivar	843		
20583904		1.0	cntrivar	826		20585004		1.0	cntrivar	844		
20583905		1.0	cntrivar	827		20585005		1.0	cntrivar	845		
20583906		1.0	cntrivar	828		20585006		1.0	cntrivar	846		
20583907		1.0	cntrivar	829		20585007		1.0	cntrivar	847		
20583908		1.0	cntrivar	830		20585008		1.0	cntrivar	848		
20583909		1.0	cntrivar	831		20585009		1.0	cntrivar	849		
20583910		1.0	cntrivar	832		***						
20583911		1.0	cntrivar	833		20585100	"v-440"	mult	1.0	0.1	1	

20585101	tmassv	440010000				20567000	"v-610-5"	mult	1.0	0.1	1
20585102	quals	440010000				20567001	tmassv	610050000			
20585103	quala	440010000				20567002	quals	610050000			
*						20567003	quala	610050000			
20585200	"v-444"	mult	1.0	0.1	1	20567100	"v-610-6"	mult	1.0	0.1	1
20585201	tmassv	444010000				20567101	tmassv	610060000			
20585202	quals	444010000				20567102	quals	610060000			
20585203	quala	444010000				20567103	quala	610060000			
*						20567200	"v-610-7"	mult	1.0	0.1	1
20585300	"v-448"	mult	1.0	0.1	1	20567201	tmassv	610070000			
20585301	tmassv	448010000				20567202	quals	610070000			
20585302	quals	448010000				20567203	quala	610070000			
20585303	quala	448010000				20567300	"v-610-8"	mult	1.0	0.1	1
*						20567301	tmassv	610080000			
20585400	"v-452"	mult	1.0	0.1	1	20567302	quals	610080000			
20585401	tmassv	452010000				20567303	quala	610080000			
20585402	quals	452010000				*					
20585403	quala	452010000				20567400	"v-620-1"	mult	1.0	0.1	1
*						20567401	tmassv	620010000			
20586000	"cl-i-nc"	sum	1.0	0.1	1	20567402	quals	620010000			
20586001	0.0	1.0	cntrlvar	851		20567403	quala	620010000			
20586002		1.0	cntrlvar	852		20567500	"v-620-2"	mult	1.0	0.1	1
20586003		1.0	cntrlvar	853		20567501	tmassv	620020000			
20586004		1.0	cntrlvar	854		20567502	quals	620020000			
*						20567503	quala	620020000			
*****											
* calculate the noncondensable mass in primary											
* system-pressurizer											
*****											
*						20567900	"pqr-nc"	sum	1.0	0.1	1
						20567901	0.0	1.0	cntrlvar	666	
						20567902		1.0	cntrlvar	667	
						20567903		1.0	cntrlvar	668	
20566100	"v-600-1"	mult	1.0	0.1	1	20567904		1.0	cntrlvar	669	
20566101	tmassv	600010000				20567905		1.0	cntrlvar	670	
20566102	quals	600010000				20567906		1.0	cntrlvar	671	
20566103	quala	600010000				20567907		1.0	cntrlvar	672	
20566200	"v-600-2"	mult	1.0	0.1	1	20567908		1.0	cntrlvar	673	
20566201	tmassv	600020000				*					
20566202	quals	600020000				20568000	"pqrsp-nc"	sum	1.0	0.1	1
20566203	quala	600020000				20568001	0.0	1.0	cntrlvar	661	
20566300	"v-600-3"	mult	1.0	0.1	1	20568002		1.0	cntrlvar	662	
20566301	tmassv	600030000				20568003		1.0	cntrlvar	663	
20566302	quals	600030000				20568002		1.0	cntrlvar	679	
20566303	quala	600030000				20568003		1.0	cntrlvar	674	
*						20568004		1.0	cntrlvar	675	
20566600	"v-610-1"	mult	1.0	0.1	1	*					
20566601	tmassv	610010000				*****					
20566602	quals	610010000				* calculate the noncondensable mass in primary					
20566603	quala	610010000				* system-reactor vessel					
20566700	"v-610-2"	mult	1.0	0.1	1	*****					
20566701	tmassv	610020000									
20566702	quals	610020000				20586100	"v-100"	mult	1.0	0.1	1
20566703	quala	610020000				20586101	tmassv	100010000			
20566800	"v-610-3"	mult	1.0	0.1	1	20586102	quals	100010000			
20566801	tmassv	610030000				20586103	quala	100010000			
20566802	quals	610030000				*					
20566803	quala	610030000				20586200	"v-104"	mult	1.0	0.1	1
20566900	"v-610-4"	mult	1.0	0.1	1	20586201	tmassv	104010000			
20566901	tmassv	610040000				20586202	quals	104010000			
20566902	quals	610040000				20586203	quala	104010000			
20566903	quala	610040000				*					

20586300	"v-108-1"	mult	1.0	0.1	1	20588010		1.0	cntrivar	872
20586301	tmassv	108010000				20588011		1.0	cntrivar	873
20586302	quals	108010000				20588012		1.0	cntrivar	874
20586303	quala	108010000				*				
*						*****				
20586400	"v-128"	mult	1.0	0.1	1	* total noncondeasable mass in primary system				
20586401	tmassv	128010000				*****				
20586402	quals	128010000				*				
20586403	quala	128010000				20593000 "t-nocd-m"	sum	1.0	0.1	1
*						20593001 0.0	1.0	cntrivar	620	
20586600	"v-132"	mult	1.0	0.1	1	20593002		1.0	cntrivar	640
20586601	tmassv	132010000				20593003		1.0	cntrivar	650
20586602	quals	132010000				20593004		1.0	cntrivar	660
20586603	quala	132010000				20593005		1.0	cntrivar	680
*						20593006		1.0	cntrivar	820
20586800	"v-136"	mult	1.0	0.1	1	20593007		1.0	cntrivar	840
20586801	tmassv	136010000				20593008		1.0	cntrivar	850
20586802	quals	136010000				20593009		1.0	cntrivar	860
20586803	quala	136010000				20593010		1.0	cntrivar	880
*						*				
20586900	"v-140"	mult	1.0	0.1	1	20592900 "u-tubes"	sum	1.0	0.1	1
20586901	tmassv	140010000				20592901 0.0	1.0	cntrivar	639	
20586902	quals	140010000				20592902		1.0	cntrivar	839
20586903	quala	140010000				*				
*						*****				
20587000	"v-144"	mult	1.0	0.1	1	* core power				
20587001	tmassv	144010000				*****				
20587002	quals	144010000				*				
20587003	quala	144010000				20588800 "core pow"	function	1.0	0.43e-6	1
*						20588801 time 0		888		
20587100	"v-148"	mult	1.0	0.1	1	*				
20587101	tmassv	148010000				*****				
20587102	quals	148010000				* calculate time-integrated break mass flow				
20587103	quala	148010000				*****				
*						*				
20587200	"v-152"	mult	1.0	0.1	1	20591500 "int bflo"	integral	1.0	0.00	1
20587201	tmassv	152010000				20591501 mflowj		91500000		
20587202	quals	152010000				*				
20587203	quala	152010000				zzz				
*										
20587300	"v-156-1"	mult	1.0	0.1	1					
20587301	tmassv	156010000								
20587302	quals	156010000								
20587303	quala	156010000								
20587400	"v-156-2"	mult	1.0	0.1	1					
20587401	tmassv	156020000								
20587402	quals	156020000								
20587403	quala	156020000								
*										
20588000	"vesel-nc"	sum	1.0	0.1	1					
20588001	0.0	1.0	cntrivar	861						
20588002		1.0	cntrivar	862						
20588003		1.0	cntrivar	863						
20588004		1.0	cntrivar	864						
20588005		1.0	cntrivar	866						
20588006		1.0	cntrivar	868						
20588007		1.0	cntrivar	869						
20588008		1.0	cntrivar	870						
20588009		1.0	cntrivar	871						

```

*****
*                                     *
* = LSTF Mid-loop : Transient Input Deck   *
*          for relap5/mod3.2 Assessment      *
*                                     *
* = Pressurizer Manway Opening Case        *
*****                                     *
100    restart  transnt
101    run
102    si    si
103    10033
105    5.0   10.0
*
201    9000.0 1.0e-12  0.1   3   100   10000  10000
*
20800001  dt     0.0
20800002  dtcrnt 0.0
20800003  sysrms 1
20800004  sysmer 1
20800005  pps    610020000
20800006  pps    152010000
20800007  pps    136010000
20800008  pps    420010000
20800009  pps    220010000
20800010  gammaw 420010000
20800011  gammaw 220010000
20800012  gammaw 100010000
20800013  gammaw 610040000
*
*****                                     *
* minor edits
*****                                     *
301  p     610010000  * pwr pressure
302  p     516010000  * sg-i steam dome pres.
303  p     316010000  * sg-b steam dome pres.
304  p     452010000  * cold leg-i
305  p     252010000  * cold leg-b
306  p     400010000  * hot leg-i
307  p     200010000  * hot leg-b
308  p     248010000  * cold leg-b
309  p     448010000  * cold leg-b
310  p     124010000  * mid-core pressure
311  p     124020000  *
312  p     124030000  *
313  p     124040000  *
314  p     124050000  *
315  mflowj 108040000 * core downcomer flowrate
316  mflowj 124030000 * core flowrate
317  mflowj 136010000 * upper plenum to hl-b
318  mflowj 136020000 * upper plenum to hl-i
319  mflowj 136030000 * upper plenum to up-132
320  mflowj 208010000 * sg-b inlet flowrate
321  mflowj 252010000 * cold leg-b flowrate
322  mflowj 408010000 * sg-i inlet flowrate
323  mflowj 651000000 * prz. porv flowrate
324  mflowj 915000000 * break flowrate
325  tempf  124010000 *
326  tempf  124020000 *
327  tempf  124030000 *
328  tempf  124040000 *
329  tempf  124050000 *
330  tempf  124060000 *
331  tempf  124070000 *
332  sattemp 124080000 *
333  voidg  124090000 *
334  voidg  124010000 *
335  voidg  124020000 *
336  voidg  124030000 *
337  voidg  124040000 *
338  voidg  124050000 *
339  voidf  104010000 *
340  voidf  136010000 *
341  voidf  200010000 *
342  voidf  206010000 *
343  voidf  208010000 *
344  voidf  212010000 *
345  voidf  228010000 *
346  voidf  232010000 *
347  voidf  232050000 *
348  voidf  236040000 *
349  voidf  244010000 *
350  voidf  248010000 *
351  voidf  252010000 *
352  voidf  400010000 *
353  voidf  406010000 *
354  voidf  408010000 *
355  voidf  412010000 *
356  voidf  428010000 *
357  voidf  432010000 *
358  voidf  432050000 *
359  voidf  436040000 *
360  voidf  444010000 *
361  voidf  448010000 *
362  voidf  452010000 *
363  cputime 0
364  sysrms 1
365  sysmer 1
*
*****                                     *
* variable trips
*****                                     *
*
500  time   0   lt   null 0   0.0   n   * false
501  time   0   ge   null 0   0.0   n   * true
536  time   0   ge   null 0   0.0   l   * true
537  time   0   lt   null 0   0.0   l   * false
555  time   0   ge   null 0   10000. I * eccs injection
570  time   0   ge   null 0   1000.  l * rhr flow
*
*****                                     *
* hydrodynamic components
*****                                     *
*
3690000  blsgsv  valve
3690101  320010000 370000000 2.96e-4 0.0149 0.0 0.0
3690201  0       0.0   0.0   0.0
3690300  trpvlv
3690301  501

```

```

*
3790000 blsgsv valve
3790101 324010000 380000000 0.00195 0.00055 0.0 0100
3790201 0 0.0 0.0 0.0
3790300 trpvlv
3790301 500
*****
*
5690000 ilsgsv valve
5690101 520010000 570000000 2.96e-4 0.0149 0.0 0100
5690201 0 0.0 0.0 0.0
5690300 trpvlv
5690301 501
*
5790000 blsgsv valve
5790101 524010000 580000000 0.00195 0.00055 0.0 0100
5790201 0 0.0 0.0 0.0
5790300 trpvlv
5790301 500
*****
*
6510000 porv valve
6510101 610000000 650000000 3.66e-5 0.0251 0.0 0100
6510201 0 0.0 0.0 0.0
6510300 trpvlv
6510301 500
*
6610000 prsfvalv valve
6610101 610000000 660000000 1.54e-4 0.2052 0.0 0100
6610201 0 0.0 0.0 0.0
6610300 trpvlv
6610301 500
*
6210000 prsspryl delete
*
*****
* ecc system
*****
*
7410000 rhrou-i tmndpjun
7410101 400010005 740010001 0.006
7410200 1 570
7410201 0.0 3.0 0.0 0.0
7410202 10.0 1.5 0.0 0.0
7410203 20.0 0.0 0.0 0.0
*
7810000 rhrou-b tmndpjun
7810101 200010005 780010001 0.006
7810200 1 570
7810201 0.0 3.0 0.0 0.0
7810202 10.0 1.5 0.0 0.0
7810203 20.0 0.0 0.0 0.0
*
7460000 rhrin-i tmndpjun
7460101 745010001 448010005 0.006
7460200 1 570
7460201 0.0 3.0 0.0 0.0
7460202 10.0 1.5 0.0 0.0
7460203 20.0 0.0 0.0 0.0

```

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10. SUPPLEMENTARY NOTES

S. Smith, NRC Project Manager

11. ABSTRACT (200 words or less)

The potential for the RELAP5/MOD3.2 code was assessed for the loss of residual heat removal (RHR) event during the mid-loop operation. The predictability of major thermal hydraulic phenomena was evaluated for the long term transient. The results of two typical cases, cold leg opening (CLO) case with water-filled steam generators (SGs) and pressurizer opening (PRO) case with emptied SGs were compared with experimental data conducted at ROSA-IV/LSTF in Japan.

It was found that the code was capable of simulating the system responses to the loss-of-RHR event during the reduced inventory operation. The thermal hydraulic transport process including noncondensable gas behavior was reasonably predicted with an appropriate time setup and CPU time. Overall, the code well predicted the major thermal hydraulic phenomena during the transient.

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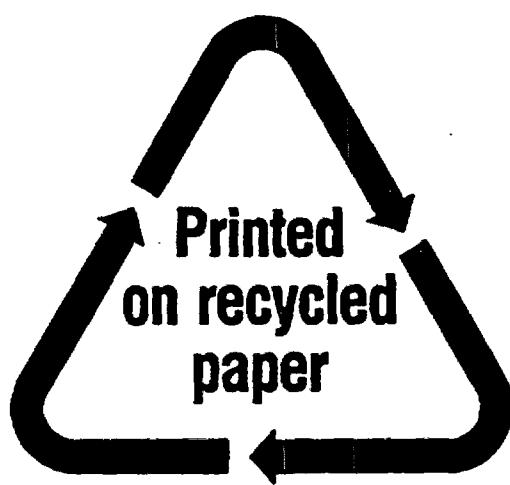
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