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International Agreement Report

Assessment of RELAP5/MOD3 With the LOFT L9-1/L3-3 Experiment Simulating an Anticipated Transient With Multiple Failures

Prepared by
Young Seok Bang, Kwang Won Seul, Hho Jung Kim

Korea Institute of Nuclear Safety
P. O. Box 16, Daeduk-Danji
Taejon, Korea

Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
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Assessment of RELAP5/MOD3 with the LOFT L9-1/L3-3 Experiment Simulating an Anticipated Transient with Multiple Failures

Abstract

The RELAP5/MOD3 5m5 code is assessed using the L9-1/L3-3 test carried out in the LOFT facility, a 1/60-scaled experimental reactor, simulating a loss of feedwater accident with multiple failures and the sequentially-induced small break loss-of-coolant accident. The code predictability is evaluated for the four separated sub-periods with respect to the system response; initial heatup phase, spray and power operated relief valve(PORV) cycling phase, blowdown phase and recovery phase. Based on the comparisons of the results from the calculation with the experiment data, it is shown that the overall thermal-hydraulic behavior important to the scenario such as a heat removal between the primary side and the secondary side and a system depressurization can be well-predicted and that the code could be applied to the full-scale nuclear power plant for an anticipated transient with multiple failures within a reasonable accuracy. The minor discrepancies between the prediction and the experiment are identified in reactor scram time, post-scrum behavior in the initial heatup phase, excessive heatup rate in the cycling phase, insufficient energy convected out the PORV under the hot leg stratified condition in the saturated blowdown phase and void distribution in secondary side in the recovery phase. This may come from the code uncertainties in predicting the spray mass flow rate, the associated condensation in pressurizer and junction fluid density under stratified condition.

Executive Summary

This report presents the RELAP5/MOD3 code assessment calculation using the test L9-1/L3-3 conducted in the loss of fluid test(LOFT) facility. The LOFT facility was a 1/60-scaled experimental reactor. The experiment L9-1/L3-3 simulated a loss of feedwater accident(LOFA) with multiple failures and a consequentially-induced small break loss of coolant accident(LOCA).

The full period of the test was separated with four sub-periods according to the thermal-hydraulic characteristics ; the initial heatup phase, the spray and power operated relief valve(PORV) cycling phase, the blowdown phase and the recovery phase.

RELAP5/MOD3 calculation successfully simulated the complex sequence of events associated with a LOFA and a consequential LOCA. Based on the comparisons between the calculation results and the experiment data, the overall behavior such as a subcooled heatup and a depressurization in the primary coolant system, and a heat removal after the dryout in steam generator secondary side was well-predicted throughout the four sub-periods. However, the calculation results show the reactor scram earlier than the experiment, resulting in the overestimation of the post-scram cooling, which may due to a code uncertainty in the spray mass flow rate and the associated condensation in the pressurizer. Due to this difference, the predicted initiation and completion times were somewhat delayed. The excessive heatup rate was also found in the spray cycling phase, which may come from the overprediction of discharged flow rate through the PORV during the blowdown phase. And the RELAP5/MOD3 predicted an inaccurate junction fluid density under the hot leg stratified, which resulted in an insufficient energy convected out the PORV. This caused an overprediction in primary system pressure and temperature during the saturated blowdown phase. In the recovery phase, the RELAP5/MOD3 calculation yields an inaccurate void distribution in the SG secondary side. It may be ascribed to the overprediction of the pressure and temperature drop in primary coolant system.

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1. Introduction

The RELAP5/MOD3 code [1] was developed by the Idaho National Engineering Laboratory (INEL) under the sponsorship of US Nuclear Regulatory Commission (NRC), and its frozen version, 5m5 was released at the end of 1990. Through the developmental assessments conducted [2], the code capability was investigated, however, the code predictability for such transients as an anticipated transient with multiple failures was not fully demonstrated. This report summarizes a code assessment using the typical experiment simulating this type of transient, the L9-1/L3-3 [3] conducted in the Loss-of-Fluid-Test (LOFT) facility [4]. The test L9-1/L3-3 composed of two sequential tests; L9-1 and L3-3, which simulated a loss of feedwater accident (LOFA) with multiple failures and a consequentially-induced small break loss of coolant accident (SBLOCA) in pressurized water reactor (PWR), respectively.

The major objective of this study was to identify the code capability of the RELAP5/MOD3 5m5 on the prediction of thermal-hydraulic (TH) behavior in primary coolant system (PCS) and secondary coolant system (SCS) during the LOFA with multiple failures and the consequentially-induced LOCA. To achieve this objective, the full period of the test L9-1/L3-3 was separated with four sub-periods with respect to the system response on the accident ; the initial heatup phase, the spray and power operated relief valve(PORV) cycling phase, the blowdown phase and the recovery phase. The programmatic objectives of this study are :

1. to provide RELAP5/MOD3 simulation of the test L9-1/L3-3 for demonstrating the code applicability to this kind of transient in full-scale PWR,
2. to evaluate the accuracy and the discrepancy of the code in predicting the following TH phenomena during the four sub-periods based on the comparison with the experiment,
 - Steam generator (SG) secondary side dry out after a LOFA
 - Post-scrum PCS cooling

- PCS heatup in subcooled state and pressurizer liquid level swell
- Pressurizer spray valve actuation and pressure control
- Pressurizer PORV cycling and pressure control
- PCS depressurization due to PCS mass depletion through PORV
- Two-phase break flow through PORV and hot leg stratification
- PCS depressurization due to the secondary side refill and secondary side feed and bleed

3. to identify reasons for the discrepancy evaluated in item 2.

The descriptions of the LOFT system and the test L9-1/L3-3 are given in Chapter 2. The code description, the input modeling and the initial and boundary conditions are given in Chapter 3. The results of the calculation are discussed in Chapter 4 and the run statistics given in Chapter 5. The conclusions obtained throughout the assessment are summarized in Chapter 6.

2. Facility and Test Description

2.1 Facility Description

The LOFT facility is an experimental 50 MWt PWR designed to simulate LOCA's and anticipated transients and to provide data on the thermal-hydraulic phenomena occurring throughout the system [4]. It is a scaled representation of a commercial PWR of Westinghouse type having 4 loops with a volume ratio of 1/60. The LOFT system consists of five major systems : reactor system, primary coolant system, blowdown suppression system, emergency core cooling system and secondary coolant system, and also includes instrumentations. The lengths of the core and reactor vessel are 1.68 and 7 m, respectively. The overall configuration is shown in Fig.1.

The break location for the test L9-1/L3-3 was the experiment PORV located in the pressurizer relief line at the top of the pressurizer. The experiment PORV was geometrically similar to the commercial PWR PORV's and was steam-scaled by 1.32×10^{-2} kg/s/MW. The detailed description was provided in reference [10].

2.2 Test Description

The experiment L9-1/L3-3 composed of two sequential tests. The test L9-1 simulated a LOFA with delayed scram and no auxiliary feedwater injection in PWR. The test L3-3 described the LOFA recovery modes initiated by tripping the PCP and depressurizing the PCS through the PORV in pressurizer. The experiment objectives were as follows [5];

1. For L9-1:

- a. To evaluate uncertainties in predicted primary and secondary thermal hydraulic response associated with steam generator dryout during delayed scram.
- b. To evaluate the adequacy of PORV to provide overpressure protection in a LOFA.

2. For L3-3

- a. To investigate uncertainties in system response during a PORV imposed small break with loss of heat sink.
- b. To assess the adequacy of modelling assumptions which are used in small break performance predictions such as those identified in NUREG-0623 [7].
- c. To assess the effectiveness of steam generator refill on LOFAs following reestablishment of auxiliary feedwater availability.
- d. To assess the relative magnitude of the change in reactor vessel mixture level as a result of primary coolant system shrink during steam generator refill.
- e. To contribute to the NRC relief and safety valve testing program by providing experimental data on PORV performance characteristics over a range of PORV inlet fluid conditions.

Prior to the experiment, the flow rate of the primary system was 479.1 ± 2.6 kg/sec under the pressure of 14.9 ± 0.10 MPa. Temperatures at the hot leg and the cold leg in the intact loop were 578.2 ± 1.8 K and 558.9 ± 1.3 K, respectively. The important initial conditions including pressure, temperature and liquid level in the intact loop steam generator (SG) secondary side were listed in

Table 1.

Experiment L9-1 was initiated by stopping the main feedwater pump. Due to decrease in heat removal capacity of SG secondary side, the PCS pressure increased and the pressurizer spray valve was open at its setpoint (15.338 MPa), which was observed at 30.0 seconds after initiation of LOFA. As the magnitude of the primary-secondary power mismatch grew, the PCS pressurization exceeded the spray cooling, which caused a delayed scram, simulating a failure of the SG low level trip, on the high pressure of hot leg (15.745 MPa) at 65.4 seconds. Auxiliary feedwater was not activated in order to simulate nonavailability of auxiliary feedwater. The main steam control valve (MSCV) started to close on the scram signal and completed to close at 77.2 seconds. The primary system pressure was decreased on reactor scram and then increased due to the decay heat and the complete loss of heat sink in SG secondary, which caused the pressurizer spray valve open and initiate cycling at 208.9 seconds to control PCS pressure. The open/close setpoints of spray valve were 15.338 and 15.05 MPa, respectively. Spray was allowed to cycle for 900 seconds approximately, whereupon it was manually overridden, allowing PCS pressure to rise to the PORV actuation setpoint (16.20 MPa) at 1468 seconds. Thereafter, the pressurizer came into the liquid-full state. The PORV was allowed to cycle relieving single phase liquid primary coolant as the PCS volume continued to heatup and expand at 1468 seconds. The PORV cycling was ended at the time which the PCS hot leg temperature reached 597 K, 3270 seconds. At that time, the PCPs were deenergized, the PORV was held open and the test L3-3 was initiated. The sequence of important events was presented in Table 2.

As the PORV latch open for 1580 seconds from the initiation of L3-3, the PCS pressure dropped rapidly to saturation and the hot regions of the core and upper plenum flashed. ECCS actuation was inhibited. The depressurization stabilized while the upper plenum and upper head voided whereupon the hot leg stratified. As hot leg voided a higher quality fluid was convected up the surge line, and the pressurizer liquid level receded as the cooler pressurizer fluid was entrained out the PORV. A transition to higher quality PORV mass flow decreased fluid density

flowing pressurizer relief line shortly after latching open PORV. This transition resulted in a higher specific energy fluid being discharged out the PORV and resulted in increased energy removal out the break. As break energy removal exceeded decay heat addition, PCS pressure declined steadily. PCS pressure stabilized as the PORV was closed. A steam generator refill was initiated 265 seconds after the PORV-closure. PCS pressure dropped rapidly as the secondary heat sink was restored. When the normal steam generator liquid level was regained at 5746.4 seconds, the SG refill was completed and then a 966 seconds equilibration period was observed to allow the primary and secondary to reach an equilibrium. Subsequently, a secondary steam and makeup operation was initiated at 6712.2 seconds to cool down the primary and recover plant. ECCS injection was not provided throughout the experiment. The experiment was terminated as PCS pressure reached 2.15 MPa. The major sequence was summarized in Table 2.

3. Code and Modeling Description

3.1 Code Description

RELAP5/MOD3 Cycle 5m5 version released by USNRC was used in the present assessment calculation of the test L9-1/L3-3. The changed features from the RELAP5/MOD2 were described in references [1, 2].

3.2 Input Modelling

The original RELAP5/MOD1 input data for simulating the LOFT system and the sequence specific to the test L9-1/L3-3 was received from INEL at January 1991. Based on the original RELAP5/MOD1 input data, some modifications was made during the assessment work. Major changes were as follows :

1. All geometric data except the U-tube heat transfer area and separator in the intact loop SG remain unchanged.
2. Modeling options related to volume, junction, heat structure were properly modified to work with RELAP5/MOD3 [1].
3. The options, 'new transnt' were changed to 'new stdy-st' in order to re-initialize the whole plant conditions under RELAP5/MOD3 models and correlations.
4. For steady state run, three steady state control systems were added ;
 - a. PCP speed controllers for controlling a intact loop mass flow rate,
 - b. a pressurizer heater controller and a pressurizer spray controller for controlling the PCS pressure, and
 - c. a main feedwater controller for controlling the S/G secondary side liquid level.
5. For steady state run, the test specific trips were set not to be activated.
6. A new transient input data was developed with deleting steady state controllers and changing the test specific trips to be activated.
7. The moderator density feedback table in a reactor kinetics input data was appropriately changed from the original one, based on the reference [8].

In the present calculation, the LOFT system was discretized by 125 volumes, 135 junctions and 136 heat structures after implementing the items stated above. Figure 2 shows a RELAP5 nodalization diagram for simulating the test L9-1/L3-3. Table 3 summarizes the nodalization and input modelling. A steady state input deck and a transient input deck were provided in Appendice A and B.

3.2.1 Primary Coolant System Modelling

The PCS composed of an intact loop and a broken loop, the former included a hot leg, a crossover leg, a pump suction tee, two PCPs and a cold leg. The intact loop was modelled by 25 hydrodynamic volumes. All piping metal structures exposed to environmental atmosphere were simulated by the heat structure to consider the associated heat loss. An overall information for the all heat structures was provided in table 4. The broken loop composed of a hot leg, a SG-pump simulator, a reflood assist bypass system (RABS), a cold leg and pipings front of the quick opening blowdown valves (QOBVs). The detailed information can be found in Fig.2, table 3 and table 4. The volume and junction modelling options were set with default options.

3.2.2 Reactor Vessel Modeling

The LOFT reactor vessel was modelled by a downcomer annulus, a lower plenum, an active core, a core-bypass flow path, an upper plenum, an upper head and a filler gap flow path. The filler gap flow path was especially modeled for simulating an upward flow during a natural circulation phase. The active core, the downcomer and the filler gap were modeled by 3 volumes, 6 volumes and 7 volumes stacked vertically, respectively. Totally 26 volumes and 50 heat structures were used. The rod bundle interphase friction model option was selected for the active core volumes. The fuel rods were modeled by 3 heat structures representing the central fuel assembly and 3 heat structures representing the peripheral fuel assemblies of LOFT core. The axial power shape was described according to the reference[8]. The reactor kinetics was used for simulating the moderator density and doppler temperature feedback and a scram curve was provided, which was

used in the posttest calculation [8]. The ANS-79 model was used for a decay heat simulation, which was changed from ANS-73 model in the posttest calculation [8].

3.2.3 Pressurizer Modeling

The pressurizer system was modeled by a surgeline, a pressurizer vessel, a spray line from cold leg, a spray valve and a experiment PORV. Two volumes for the surge line, nine volumes for the vessel and one volume for the spray line were used, respectively. The spray valve and the PORV were simulated by two trip valves. The associated trip logics were prepared according to the experimental specification [6]. To consider the environmental heat loss from the pressurizer vessel wall, the vessel wall was modeled by nine heat structures.

3.2.4 Steam Generator Modeling

The steam generator consisted of a SG inlet plenum, U-tubes, a outlet plenum, a main feedwater tank and feed line, a auxiliary feedwater tank and feed line, a feedwater inlet annulus, a SG secondary side downcomer, a boiler section, a separator inlet annulus, a separator, a steam dome, a steamline, a MSCV, a MSCV bypass flow path, a MSCV downstream piping and a air-cooled condenser. The numbers of volumes used for each flow path were provided in Table 3 and Fig.2. All of the SG metal wall and U-tubes were described by the proper heat structures. The detailed description can be found in Table 4. The rod bundle interphacial friction option was used for the volumes contacted with the U-tubes heat structures (Volumes 515-4, -5, -6). The separator section in SG was modeled by a branch component (Volume 520) and a SEPARATR component (Volume 500). The separator inlet junction was connected to the bottom of the volume 520, as show in Fig.2.

The heat transfer area of U-tube heat structure in the intact loop SG generally has an impact on the initial conditions in SG secondary side. According to the previous LOFT calculations using RELAP5/MOD2 [9, 10], the predicted pressure in SG secondary side were generally underpredicted by 0.3-0.4 MPa. This discrepancy was considered as a result of underestimation of heat transfer area

in the SG U-tube. In the present input data, an increase of heat transfer area by 110 % of the original heat transfer area [8] was made. The whole listing of steady state input data were provided in Appendix A.

3.2.5 Others

The emergency core cooling system (ECCS) in LOFT was also modeled, however, it is not used in the transient calculation. Table 3, Fig 2 and Appendix A provided a detailed information of it. And the containment was also modeled by time-dependent volume with a constant pressure.

3.3 Initial and Boundary conditions

To provide all initial conditions of the whole system prior to transient, a steady state run was carried out with three steady state controllers as stated above. The result obtained from the steady state run was compared with the measured initial conditions in Table 1. The RELAP5 calculated results generally agree with the experiment initial conditions.

Boundary conditions required to simulate the L9-1/L3-3 experiment including the pressures and temperatures at air-cooled condenser, makeup feed storage tank and reactor core power history were almost the same as those used in the posttest calculation [8]. The exact values can be found in the steady state input data.

Test specific sequence to be described are as follows: Main feedwater turned off, Reactor scram, SG MSCV closure, Pressurizer spray valve open/closure, Pressurizer PORV cycling, Pressurizer PORV latched open and closure, PCP coastdown initiation, SG secondary refill initiation/completion, and SG secondary bleed initiation/completion.

All of the sequence were as the same as the original input data [8] and were illustrated with some comments in the Figure 3-a through 3-g. The delay time in the trip logic describing the SG refill initiation (Variable trip 561) was corrected to '265 seconds' after PORV closure according to the reference [5]. The whole list of the transient input data was attached in Appendix B.

4. Calculation and Discussion

A transient calculation using the input modelings, initial conditions and boundary conditions stated above was conducted by RELAP5/MOD3 5m5 code. The transient calculation was terminated at 8106 seconds due to water property failure at the SG secondary side volume 515-06. Since the calculational result up to 8100 seconds contains all of the important phenomena in the L9-1/L3-3 experiment, any additional restart transient calculation was not executed. The foregoing description was, therefore, based on the calculational result up to 8100 seconds. This chapter was devoted to address results from the transient calculation, to compare them with the corresponded measurement data and to identify the code predictability. Table 2 shows a comparison of the predicted sequence of event with the measured chronology. The detailed discussion of the comparison was provided in following sub-chapters. From the test description above, it is shown that the full period of the LOFT L9-1/L3-3 experiment can be divided into four distinguishable sub-phases according to the TH characteristics as follows;

- 1) Initial heatup phase before spray cycling,
- 2) Spray and PORV cycling phase until PORV latched open,
- 3) Blowdown phase until PORV closure, and
- 4) Recovery phase

The following discussions contain the prediction and its comparison for the important thermal-hydraulic phenomena during these four period, respectively. Table 5 summarizes the comparison plots and their data channels.

The measurement uncertainties for each parameter were also listed in this table, which were from the reference [5].

4.1 Initial Heatup Phase

Figure 4 shows a comparison of the pressure at the intact loop hot leg in PCS with the measured data up to 300 seconds after the test initiation. Fig.5 shows a comparison of the coolant temperature at the intact loop hot leg with the measured data for the same period as in Fig.4. Due to LOFA the heat removal capacity in SG secondary side was degraded, the PCS pressure and temperature was increased. These figures show good agreements between the calculation and the experiment before reactor scram. The calculated reactor scram time (55.8 seconds) was earlier than the experiment (65.4 seconds). This discrepancy may come from a code uncertainty in predicting the mass flow rate through the spray valve and the associated condensation phenomena in the pressurizer. For an illustration of it, the calculation shows the PCS pressure was still increased inspite of the second spray actuation at 50 seconds approximately, while the experiment indicated the PCS pressure was slightly decreased at the almost same time and then re-increased. It can be also identified in the first activation of spray (30 seconds), in which the predicted slope of pressure decrease was slower than the predicted one. The underprediction of pressure and temperature after scram was due to the difference in scram time. Figure 6 shows a comparison of the calculated reactor power with the power measured by a neutron detector and with the decay heat reported in reference [5]. The difference in power during time period from 56 to 65 seconds lowered the PCS pressure below 14 MPa and delayed a pressure re-increase until 170 seconds, i.e, an excessive post-scram cooling. This discrepancy also delayed the spray valve activation time until 315 seconds, which was later than the experiment, 208 seconds.

Figures 7 and 8 show comparisons of the pressure and temperature in the SG steam dome and the top of the boiler section with the measured data, respectively. Before the reactor scram the predicted behavior was agreed to the measured one. Due to earlier scram in calculation, the starting time and completion time of MSCV closure predicted by RELAP5/MOD3 were earlier than those in experiment as shown in Table 2. According to the experiment, just after a LOFA, the SCS pressure and temperature were both increased from saturated state until

the complete dryout, and then decreased until the MSCV began to reduce the discharging steam flow on the response to the reactor scram. This reduction yields a decrease in heat rejection from the SCS, therefore, the SCS pressure and temperature were re-increased. Afterwards, the TH behavior of the SCS was dependent on the energy balance between the heat-rejection due to the MSCV leakage flow and the heat addition from the PCS generated by core decay heat. The result from the RELAP5/MOD3 calculation generally shows these TH behavior well, however, shows an overprediction in SCS pressure and temperature after scram. It must due to a difference in the scram time. In spite of this difference, the slope of increase in pressure after scram was almost the same as that in the experiment. Figure 9 shows a comparison of the collapsed liquid level with the measured data, which indicated a complete dryout in SG secondary side at 60 seconds after a LOFA, approximately and a good agreement between the calculation and the experiment. Figure 10 shows a comparison of the mass flow rate through MSCV. From these comparisons, it, therefore, can be stated that the consequent behavior after scram can be well-predicted if the scram time was correctly predicted.

4.2 Spray and PORV Cycling Phase

Figures 11 and 12 show comparisons of the pressure and temperature at the intact loop hot leg in PCS up to 10000 seconds. The starting time of the spray valve cycling predicted was, as previously mentioned, later than the that measured. The predicted duration of spray cycling was about 1055 seconds ($= 1370 - 315$), which was similar to the measured duration, 1037 seconds ($= 1246 - 209$). The slope of temperature increase, i.e, heatup rate was larger than the experiment, however, a saw-tooth behavior in pressure was well predicted during the spray cycling period. One of the reasons of higher heatup rate was also considered as an uncertainty in the spray mass flow rate.

The predicted starting time of PORV cycling was 1795 seconds and also later than the experiment, 1468 seconds. The duration of PORV cycling was about 1390 seconds ($= 3185 - 1795$) in calculation, which was shorter than the experiment, 1802 seconds ($= 3270 - 1468$). The heatup rate during the PORV cycling phase was almost same as the experiment. The cycling phase was ended at 3185 sec in calculation. During the spray and PORV cycling period the major contributor to the PCS heatup was considered as the core decay heat and the heat provided by PCP's.

Figures 13 and 14 show comparisons of the pressure and temperature at the same position as in Figures 7 and 8 up to 10000 seconds, respectively. The predicted pressure was monotonously decreased during the spray and PORV cycling phase, which was, however, higher than the experiment throughout the cycling phase. It was due to a difference in scram time, but the slope of pressure decrease was well agreed to the experiment. The secondary coolant temperature was also overpredicted as shown in Fig.14.

4.3 Blowdown Phase

After the PCS hot leg temperature reached 597 K, the PORV was held open for the consequent 1580 seconds. During this period the primary coolant was discharged through the PORV, which caused a rapid depressurization until the onset time of saturation in PCS. As shown in Fig.11, the calculated pressure drop was almost same as the experiment until the PCS saturation. After the saturation, the calculation shows that the PCS pressure was almost constant until the PORV closure time (4769 seconds), which was quite different from the experiment. The difference in the pressurizer liquid level can be regarded as one reason for the pressure increase during the saturated blowdown period as shown in Fig.15. The calculated liquid level in the pressurizer was almost constant until the SG refill initiation, while the measured level was slowly decreased from the PORV open time. It is also shown that the high heatup rate during the spray cycling period yielded an overprediction in the pressurizer liquid level swell and in the PCS pressure. The over-estimated liquid level also contributed to the overprediction of mass flow rate through the PORV during the two-phase blowdown phase as shown Fig.16.

During the same period, the PCS temperature was also overpredicted, which indicated that the insufficient energy convected out the PORV. According to the reference [8], the effective flow area of PORV was correctly chosen, the reason for the insufficient energy discharged out the PORV, therefore, was a code inaccuracy in calculating the fluid density convected from the hot leg to the pressurizer surge line under the hot leg stratified. As shown in Fig.17, the measured fluid density at the intact loop hot leg was different from the calculated one from 3500 seconds, approximately. The experiment indicated that the intact loop hot leg was stratified shortly after holding open PORV, that a higher quality fluid was convected out the break as pressurizer level receded and that the hot leg fluid density significantly decreased. However, RELAP5/MOD3 predicted this phenomena inaccurately, which due to a code weakness in calculating the junction density under the stratified condition.

During the blowdown period, the SCS experienced the similar depressurization

to the previous phase as shown in Figures 13 and 14.

4.4 Recovery Phase

After 265 seconds from the closure of PORV, the SG secondary side refill was initiated through the auxiliary feedwater line. The predicted hot leg pressure and temperature were rapidly decreased during the secondary refill period as shown in Figures 11 and 12. However, the magnitudes of drops in pressure and temperature were overpredicted. One of the reason for this overprediction was considered as an difference in the refill duration (1085 seconds in calculation versus 622 seconds in experiment). It is also shown in Fig.17, which presents a comparison of the SG liquid level in long term. The calculated liquid level indicated no jump which was found in the experiment and the predicted refill duration was longer than the experiment. Since the refill duration was strongly dependent on the SG secondary side liquid level, the inaccuracy of the level prediction may extend the refill duration, consequently increase the cooling effect. The major contributor to their accuracy of level prediction was a void distribution calculated by the code.

After restoring the SCS heat removal capacity, the predicted SCS pressure was increased more rapidly and the predicted peak pressure was higher than the experiment as shown in Fig.13. During the same period the predicted temperature at SG secondary side moved down as shown in Fig.14, which indicates the return from the superheated steam to the saturated state in SG secondary side at 5200 seconds, approximately. The reason for the overprediction of pressure was considered as a propagation from the previous phase. The descending behavior in pressure after saturation was almost similar to the experiment.

During the equilibration period of 966 seconds after the SG refill completion (6119 seconds in prediction), the PCS pressure and temperature were slightly increased. The calculation shows that the SG feed and bleed operation was initiated at 7085 seconds, that the PCS pressure and temperature were both decreased in stepwise manner and that the magnitudes of drops in the pressure and temperature were larger than those measured. It due to the continual feed operation from the auxiliary feedwater valve, which was different from the continuous feed operation in the experiment. Since the feed operation is also

strongly dependent on the SG secondary side liquid level, the reason for this larger drops than the experiment can be regarded as the inaccuracy of the SG secondary void distribution.

5. Run Statistics

The main frame computer used in the present calculation was a CRAY-2S in System Engineering Research Institute(SERI) in Taejon, Korea under UNICOS as a operating system. Figure 19 presents the plot of the required CPU time for the transient time in the calculation. And the time step size are also plotted in Fig.20. The user-specified maximum time step was 1.0 second up to 1000 seconds, 0.1 second up to 2000 seconds, 0.5 second up to 4000 seconds, 0.1 second up to 8000 seconds and 0.5 second up to 10000 seconds in real time. The grind time can be calculated as follows.

Computer time,	$CPU = 7981.4 - 1.9181 = 7979.48 \text{ (sec)}$
Number of time step,	$DT = 89332 - 220 = 89112$
Number of volume,	$C = 125$
Transient real time,	$RT = 8100 \text{ (sec)}$
Grind time =	$CPU \times 1000 / (C * DT) = 0.71635 \text{ CPU m sec/vol/step}$

6. Conclusions

The RELAP5/MOD3 5m5 code was assessed using the test L9-1/L3-3 simulating a LOFA with multiple failures and the consequentially-induced LOCA. The full period of the test was divided into four sub-periods according to the thermal-hydraulic characteristics ; the initial heatup phase, the spray and PORV cycling phase, the blowdown phase and the recovery phase. The calculation results were compared with the measured data and the evaluation of the code predictability for this type of transient was conducted. The following conclusions are obtained.

- 1) RELAP5/MOD3 code calculation was successfully executed for the L9-1/L3-3 test and the code applicability to an anticipated transient with multiple failures in PWR was demonstrated.
- 2) From the fact that the result from the calculation generally shows a good agreement with the experiment data, the overall predictability of the RELAP5/MOD3 was identified and the minor discrepancies were also identified.
- 3) In the initial heatup phase, the predicted scram time was earlier than the experiment due to a code uncertainty in predicting the spray mass flow rate and the associated condensation phenomena in pressurizer, which caused an excessive heatup rate in the spray cycling phase.
- 4) In the blowdown phase, the overprediction of PORV-discharged flow was found under the over-estimated pressurizer level, which may come from the excessive heatup in the previous phase. And a code inaccuracy was found in calculating the junction fluid density at the hot leg to the pressurizer surge line under the stratified condition.
- 5) In the recovery phase, an excessive cooling was predicted both in the steam generator secondary refill phase and in the secondary feed and bleed operation phase due to a poor prediction on void distribution in the SG secondary side.

References

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9. Y.S. Bang, et al, *Assessment of RELAP5/MOD2 Cycle 36.04 Using LOFT Large Break Experiment L2-5*, NUREG/IA-0032, April 1990.
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Table 1. Initial conditions for L9-1/L3-3

<u>Parameter</u>	<u>Measured</u>	<u>Simulated</u>
Primary Coolant System		
Mass flow rate (kg/s)	479.1 ± 2.6	479.34
Hot leg pressure (MPa)	14.9 ± 0.10	14.8905
Cold leg temperature (K)	558.9 ± 1.3	559.132
Hot leg temperature (K)	578.2 ± 1.8	578.327
Reactor		
Power level (MW)	49.6 ± 0.9	49.6
Maximum linear heat generation rate (kW/m)	50.8 ± 3.6	50.8
Steam Generator Secondary Side		
Water level (m)	0.14 ± 0.08	0.1475
Water temperature (K)	545.0 ± 0.8	542.377
Pressure (MPa)	5.67 ± 0.08	5.72
Mass flow rate (kg/s)	27.0 ± 1.0	26.728
Broken Loop		
Hot leg temperature (K)	563.3 ± 2.6	559.137
Cold leg temperature (K)	557.6 ± 2.6	558.381
Pressurizer		
Steam Volume (m ³)	0.43 ± 0.05	---
Liquid volume (m ³)	0.50 ± 0.05	---
Water temperature (K)	614.9 ± 1.3	610.4
Pressure (MPa)	14.93 ± 0.25	14.901
Liquid level (m)	0.92 ± 0.1	0.96

Table 2. Sequence of events in L9-1/L3-3

<u>Event</u>	<u>Description</u>	<u>Measured</u> (sec)	<u>Calculated</u> (sec)
<u>L9-1</u>			
Main feedwater pump off		0.0	0.0
Pressurizer spray activated	$P_{pzs} > 15.338^*$	30.0 ± 0.1	28.94
Reactor scram (15.67 MPa) t_{SCRAM}	$P_{ILHL} > 15.745$ $T_{ILHL} > 583.16^*$	65.4 ± 0.2	55.8
Steam generator main steam control valve closed	$t_{SCRAM} + \text{delay}^*$	77.2 ± 0.2	69.0
Steam generator liquid level reached bottom of range	$L_{S/G} = 0.25 \text{ m}$	190 ± 20	82.0
Pressurizer spray valve cycling initiated	$P_{pzs} > 15.338$	208.9 ± 0.1	315.0
Pressurizer liquid level reached top of the range	$L_{pzs} = 1.83 \text{ m}$	1089.7 ± 30	1840.0
Pressurizer spray valve cycling ended	$P_{pzs} > 16.2$	1246.0 ± 0.1	1370.0
PORV cycling initiated	$P_{pzs} > 16.2$	1467.9 ± 0.1	1795.0
<u>L3-3</u>			
PORV latched open (t_{LATCH})	$T_{ILHL} > 597$	3269.9 ± 0.1	3189.0
PCPs tripped off	$T_{ILHL} > 597$	3284.8 ± 0.2	3189.0

(continued)

<u>Event</u>	<u>Description</u>	<u>Measured</u> (sec)	<u>Calculated</u> (sec)
PCP coastdown completed		3304.2 $\pm$ 0.8	3220.0
Upper plenum fluid reached saturation pressure		3329.4 $\pm$ 0.2	3270.0
PORV closed ($t_{\text{PORV-CLOSE}}$)	$t_{\text{LATCH}} + 1580$	4849.7 $\pm$ 0.1	4769.0
Steam generator secondary refill initiated	$t_{\text{PORV-CLOSE}} + 265$	5114.6 $\pm$ 0.2	5034.0
Natural circulation initiated		5205 $\pm$ 10	---
Steam generator secondary refill completed ($t_{\text{REF-COM}}$)	$L_{\text{S/G}} = 2.9464$	5746.4 $\pm$ 0.2	6119.0
Pressurizer liquid level reached bottom of the range	$L_{\text{pZR}} = 0.06$	5915 $\pm$ 5	5460.0
Steam generator secondary feed and bleed initiated	$t_{\text{REF-COM}} + 966$	6712.2 $\pm$ 0.2	7822.2
Experiment completed		9517.4 $\pm$ 0.2	---

Note --- : not predicted

* : MPa in pressure, K in temperature, and m in level

Table 3. Summary of nodalization

<u>Component</u>	<u>Vol</u>	<u>Jun</u>	<u>H.S</u>
1.Reactor Vessel			
Filler Gap	7	7	14
Downcomer	6	6	18
Lower Plenum	3	5	5
Active Core	3	2	6
Core Bypass	3	2	---
Upper Plenum	3	4	5
Upper Head	1	1	2
2.Primary Coolant System (Intact Loop)			
Hot Leg (included S/G inlet plenum)	6	7	8
S/G U-tube	6	5	6
Loop Seal (included S/G outlet plenum)	4	4	3
Pump Suction Tee	5	6	5
Primary Coolant Pumps	2	4	---
Colg Leg (included pump discharge pipes)	8	12	7
3.Primary Coolant System (Broken Loop)			
Hot Leg	3	4	3
S/G-Pump Simulator	12	12	12
RABS	4	5	4
Cold Leg	5	6	5
QOBV/Line	2	2	---
4.Pressurizer System			
Surge Line/Valve	2	3	---
Pzr Vessel	9	8	10
Spray Line/Valve	1	3	---
Experiment PORV	---	1	---
Heater	---	---	1
5.Secondary Coolant System			
Feedwater Storage	2	2	---
S/G Downcomer	6	6	10
S/G Riser	5	4	12
Separator	1	3	1
Steam Dome/Line	3	2	2
MSCV/Bypass	---	2	---
6.ECCS	6	6	---
7.Others (Letdown/Charging, Containment)	3	1	---
Total	125	135	136

Table 4. Detailed information for heat structure

<u>No</u>	<u>NH</u>	<u>NA</u>	<u>Description</u>	<u>Left Bn.</u>	<u>Right Bn.</u>
60	6	8	SG U-tube	115-4:9	515-4:6
1151	2	4	SG Inlet/Outlet Plenum Wall	115-3,-10	Ambient
1152	2	20	S/G Tube Sheet Periphery Region	115-3,10	515-3
1001	12	11	Intact Loop Piping (Large Pipes)	100, 105, 110, 115-1 115-12,-13 120, 150 150, 175-1, 175-2, 180, 185	Ambient
1002	2	11	S/G Inlet-Cold Leg, Outlet-Hot Leg Connection	115-2, 11	Ambient
1003	7	11	Intact Loop Piping (0.216 m OD)	125, 130, 140, 145, 155, 160, 170	Ambient
1004	2	11	S/G Inlet/Outlet Plena	115-3,10,	Ambient
2000	1	21	Reactor Vessel Filler Block Inlet Annulus Top Volume	200	Insulated
2001	6	11	Core Support Barrel	Insulated 210-1:4	200, 205
2050	1	21	Filler Blocks Inlet Annulus Lower Volume	205-1	223-1
2100	6	21	Downcomer and Lower Plenum	210-1:4, 215, 220	223-2:7

(continued)

<u>No</u>	<u>NH</u>	<u>NA</u>	<u>Description</u>	<u>Left Bn.</u>	<u>Right Bn.</u>
2110	3	11	Reactor Vessel Wall (Mid-Part)	223-1:3	Ambient
2120	5	7	Reactor Vessel Wall (Lower-Part)	223-3:7	Ambient
2200	1	11	Reactor Vessel Bottom Wall	220	Ambient
2250	7	11	Core Flow Skirt-Core Filler Assembly	225, 230-1:3, 240, 245, 246	Insulated
2260	1	7	Lower Core Support Structure, Core Support Barrel Lips, Fuel Module Lower End Box	225	Insulated
2300	3	10	Active Core	230-1:3	Kinetics
2400	1	7	Upper Core Support Structure	240	Insulated
2460	1	5	Fuel Module Top	245	246
2500	1	11	Core Support Barrel-Upper Plenum Lower Volume	250	Insulated
2510	2	5	Upper Plenum Internals	250	Insulated
2501	1	21	Core Support Barrel-Upper Plenum Upper part	250	Insulated
2550	1	21	Upper Head Top Plate	250	Ambient
3150	2	11	Broken Loop S/G Simulator 1	315-1:2	Ambient
3151	1	11	Broken Loop S/G Simulator 2	315-9	Ambient

(continued)

<u>No</u>	<u>NH</u>	<u>NA</u>	<u>Description</u>	<u>Left Bn.</u>	<u>Right Bn.</u>
3152	1	11	Broken Loop S/G Simulator 3	315-11	Ambient
3153	6	11	Broken Loop S/G Simulator 4	315-3:8	Ambient
3154	1	11	Broken Loop S/G Simulator 5	315-12	Ambient
3155	1	11	Broken Loop S/G Simulator 6	315-10	Ambient
3000	3	11	Broken Loop Hot Leg	300, 305 310	Ambient
2250	3	11	Broken Loop Cold Leg	335, 340, 345	Ambient
3501	1	11	Broken Loop Cold Leg	350-1	Ambient
3502	1	11	Broken Loop Cold Leg	350-2	Ambient
3700	4	11	Reflood Assist Bypass Piping	370, 375, 380, 385	Ambient
4151	1	11	Pressurizer Vessel Bottom	415-1	Ambient
4152	7	11	Pressurizer Vessel (Large Dia.)	415-2:7	Ambient
4162	1	11	Pressurizer Vessel (Small Dia.)	415-8	Ambient
4172	12	9	Pressurizer Backup Heater	415-2	Table 417/8
4201	1	11	Pressurizer Top Wall	420	Ambient
5000	3	4	S/G Shroud Upper Part	500, 505, 510-1	520, 515-8:7
5150	4	4	S/G Shroud Lower Part	510-1:4	515-7:4
5300	8	10	S/G Secondary Vessel Wall	530-1, 525 500, 505 510, 515-1:3	Ambient

Table 5. Summary of data channels and uncertainties in comparison plots

<u>Description</u>	<u>Calculation</u>	<u>Experiment</u>	<u>Uncertainty *</u>	<u>Fig. No</u>
1. Pressure at ILHL	p 100-01	PE-PC-005	0.28 MPa	4, 11
2. Coolant temperature at ILHL	tempf-100-01	TE-PC-02B	3.0 K	5, 12
3. Reactor power	rktpow-0	RE-T-77-A	2.0 MW	6
4. Pressure at SG steam steam dome	p 530-02	PE-SGS-01	0.12 MPa	7, 13
5. Coolant temperature at SG secondary	tempg 515-06	TE-SGS-04	3.0 K	8, 14
6. Liquid level at SG secondary	cntrlvar-1	LT-P004-08B	0.08 m	9, 18
7. Mass flow rate downstream MSCV	mflowj-550	FT-P004-012	0.8 kg/s	10
8. Liquid level at pressurizer	cntrlvar-2	LE-PdEP139-6	0.06 m	15
9. Mass flow rate through PORV	mflowj-425	FR-PC-S231	0.2 kg/s	16
10. Fluid density at the intact loop hot leg	rho-100	DE-PC-02C	0.17 Mg/m ³	17

Note * : Measurement uncertainty referred to the reference [5]

Fig.1, Axonometric configuration of LOFT L9-1/L3-3 test

Fig. 2 RELAP5 Nodalization for LOFT Experiment L9-1/L3-3

Fig.3-a. Pressurizer spray valve control trip

Fig.3-b. Pressurizer PORV control trip

Fig.3-c. Makeup feed storage tank boundary condition trip

Fig.3-d MSCV byapass valve control trip

Fig.3-e MSCV open/close control trip

Fig.3-f Reactor scram trip

Fig.3-g Pressurizer heater control trip

Fig.4 Comparison of pressure at the intact loop hot leg (short term)

Fig.5 Comparison of coolant temperature at the intact loop hot leg (short term)

Fig.6 Comparison of reactor power

Fig.7 Comparison of pressure at SG steam dome (short term)

Fig.8 Comparison of coolant temperature at SG secondary side (short term)

Fig.9 Comparison of SG collapsed liquid level (short term)

Fig.10 Comparison of mass flow rate through MSCV (short term)

Fig.11 Comparison of pressure at the intact loop hot leg (long term)

Fig.12 Comparison of coolant temperature at the intact loop hot leg (long term)

Fig.13 Comparison of pressure at SG steam dome (long term)

Fig. 14 Comparison of coolant temperature at SG secondary side (long term)

Fig.15 Comparison of pressurizer collapsed liquid level (long term)

Fig.16 Comparison of mass flow rate through PORV (long term)

Fig.17 Comparison of fluid density at intact loop hot leg (long term)

Fig.18 Comparison of SG collapsed liquid level (long term)

Fig.19 The required CPU time versus the advanced time

Fig.20 Time step size of base case calculation

Appendix A Input Deck for Steady State Calculation

=loft 19-1 post test analysis deck

*-----]-----]-----]-----]-----]-----]-----]-----

* initial conditions

*

* core power = 50. mw

* pcs flow = 479.3 kg/s

* thot = 578. k

* tcold = 559.0 k

*

*-----]-----]-----]-----]-----]-----]-----]-----

0000100 new stdy-st

0000101 run

0000102 si

0000105 5. 10.

0000110 nitrogen

* time step control cards

* end time min dt max dt optn mnr mjr rst

*0000201 5400.0 1.e-6 0.5 2 4 200 200

*-----]-----]-----]-----]-----]-----]-----]-----

* modification for steady state run at 91/2/8

*-----]-----]-----]-----]-----]-----]-----]-----

0000201 1000.0 1.e-6 0.5 2 4 500 200

*

* minor edit variables

*

* pressure

0000301 p 345010000 * pe-bl-1

0000302 p 310010000 * pe-bl-2

0000303 p 315110000 * pe-bl-3

0000304 p 350010000 * pe-bl-4

0000305 p 315090000 * pe-bl-6

0000306 p 350020000 * pe-bl-8

0000307 p 185010000 * pe-pc-1

0000308 p 100010000 * pe-pc-2

0000309 p 420010000 * porv inlet

0000310 p 110010000 * pt-139-2,3,4

0000311 p 245010000 * pe-1up-1a,1b

0000312 p 215010000 * pe-1st-1a,b/pe-2st-1a,b

0000313 p 200010000 * pe-1st-3a,3b

0000314 p 530020000 * pt-p4-10a

0000315 p 535010000 * pt-p4-85

* temperatures

0000320 tempf 406010000 * spray tempf

0000321 tempf 310010000 * te-bl-2a,2b,2c

0000322 tempf 100010000 * te-pc-2a,2b,2c

0000323 tempf 185010000 * te-pc-1

0000324 tempf 115030000 * te-sg-1

0000325 tempf 115100000 * te-sg-2

0000326 tempf 515040000 * te-sg-3

0000328 tempf 415050000 * pzs volume 5

0000329 tempf 415040000 * te-139-19

0000330 tempf 415030000 * te-139-20

0000331 tempf 315120000 * te-p138-171

0000332 tempf 350020000 * te-p138-170

0000333 tempf 205010000 * te-1st-1/te-2st-1

0000334 tempf 210010000 * te-1st-2/te-2st-2

0000335 tempf 345010000 * te-bl-1

0000336 tempf 210030000 * te-1st-14/te-2st-14

0000337 tempf 210040000 * te-3up-2

0000338 tempf 245010000 * te-1up-6

0000339 tempf 246010000 * te-2up-4

0000340 tempf 250010000 * te-1up-3

* densities

0000341 rho 345010000 * de-bl-1

0000342 rho 310010000 * de-bl-2

0000343 rho 185010000 * de-pc-1

0000344 rho 100010000 * de-pc-2

0000345 rho 115120000 * de-pc-3

0000346 voidgj 400010000 * surge line density

0000347 rho 115040000 * s/g tubes

0000348 rho 115050000 * s/g tubes

0000349 rho 115060000 * s/g tubes

0000350 rho 115070000 * s/g tubes

* velocities

0000351 voidf 100010000 * ilhl nozzle

0000352 velf 100010000 * ilhl nozzle

0000353 velf 115030000 * s/g inlet

0000354 velf 400010000 * surge line

0000355 velfj 425000000 * porv liq vel

0000356 velg 100010000 * ilhl nozzle

0000357 velg 115030000 * s/g inlet

0000358 velg 400010000 * surge line

0000359 velgj 425000000 * porv vap vel

* mass flow rates

0000360 mflowj 100010000 * ilhl nozzle

0000361 mflowj 150010000 * pump outlet

0000362 mflowj 185020000 * dt-rake ilcl

0000363 mflowj 400010000 * pres. surge line flow

0000364 mflowj 407000000 * pzs spray flow

0000366 mflowj 425000000 * pres. relief valve flow

0000367 mflowj 550000000 * steam flow control valve

0000368 mflowj 548000000 * aux feed

0000369 mflowj 560000000 * main feed

0000370 cntrlvar 1 * s/g level

* cladding temperatures center module

0000371 htemp 230000110 * te-5h5-015

0000372 htemp 230000210 * te-5h5-034

0000373 htemp 230000310 * te-5h5-049

```

* peak centerline temperatures
*****
0000374 htemp 230000101 * core lower region
0000375 htemp 230000201 * core middle region
0000376 htemp 230000301 * core upper region
*****
* reactor kinetic parameters
*****
0000377 rktpow 0 * total reactor power
0000378 rkfpow 0 * fission decay power
0000379 rkgapow 0 * gamma decay power
0000380 rkcreac 0 * reactivity
0000381 pmphead 135 * pcpl head
0000382 pmphead 165 * pcpl head
0000384 cntrlvar 2 * pwr level
0000385 cntrlvar 3 * rx vessel level
0000386 mflowj 185010000
0000387 mflowj 185030000
0000388 mflowj 200020000
0000389 pmpvel 135
0000390 pmpvel 165
*****
*
* trips
*
*****
* variable trips
*****
0000501 p 100010000 le null 0 14.193103e6 l
* ecc check valve
0000502 p 600010000 ge p 185010000 20.e6 n
* accumulator check valve
0000503 p 615010000 ge p 185010000 20.e6 n
* isolation valve hot leg
0000504 time 0 lt null 0 0.0 l
* isolation valve cold leg
0000505 time 0 lt null 0 0.0 l
* qobv hot leg
0000506 time 0 lt null 0 0.0 l
* qobv cold leg
0000507 time 0 lt null 0 0.0 l
* check valve surge line pressurizer
0000508 time 0 ge null 0 0.0 l
* pressurizer relief valve
0000509 tempf 100010000 ge null 0 597.0 l
* steam control valve
0000510 time 0 lt null 0 0.0 l
* boundary system valve
0000511 time 0 lt null 0 0.0 l
* lpis trip
0000512 time 0 ge null 0 10000.0 l
* hpis trip
0000513 time 0 ge null 0 10000.0 l
*
0000520 p 530020000 gt null 0 7.103448e6 n
0000521 p 530020000 lt null 0 7.0344827e6 n

```

```

0000522 p 530020000 gt null 0 6.3448275e6 n
0000523 p 530020000 lt null 0 6.4137931e6 n
0000530 time 0 ge null 0 3600.0 n
0000531 p 530020000 gt p 547010000 0.0 n
0000536 time 0 ge null 0 10000.0 n
0000540 tempf 100010000 gt null 0 583.16 l
0000541 p 100010000 gt null 0 1.574553e7 l
0000550 time 0 ge null 0 10000.0 l
0000551 time 0 ge timeof 625 0.0 l
0000552 time 0 ge timeof 509 1580. l
0000560 p 100010000 le null 0 13.15862e6 n
0000561 time 0 ge timeof 552 265.0 l
0000562 time 0 gt null 0 5400.0 n
0000563 cntrlvar 1 lt null 0 2.1844 n
0000564 cntrlvar 1 gt null 0 2.9464 n
0000565 time 0 ge timeof 669 966. l
0000570 p 420010000 gt null 0 1.620058e7 n
0000571 p 420010000 lt null 0 1.606269e7 n
0000572 p 420010000 lt null 0 1.486300e7 n
0000573 p 420010000 gt null 0 1.506980e7 n
0000574 p 420010000 gt null 0 1.533874e7 n
0000575 p 420010000 lt null 0 1.505000e7 n
0000576 p 420010000 lt null 0 1.482853e7 n
0000577 p 420010000 gt null 0 1.495950e7 n
*****

```

* logical trips

```
*****
```

```

0000600 670
0000601 563 and 561 n
0000602 -563 and -564 n
0000603 655 and 602 n
0000604 609 or 609 l
0000605 572 and -509 n
0000606 -572 and -573 n
0000607 608 and 606 n
0000608 605 or 607 n
*0000609 540 or 541 l
*-----

```

* modification for steady state run at 91/2/8

```
*-----
```

```

0000609 504 or 504 l
0000610 612 or 520 n
0000611 -521 and -616 n
0000612 611 and 610 n
0000613 616 or 523 n
0000614 -522 and 613 n
0000615 -612 and 609 n
0000616 615 and 614 n
0000617 612 or 616 n
0000618 605 or 607 n
0000621 623 or 570 n
0000622 -571 and -571 n
0000623 621 and 622 n
0000624 509 and -552 n
0000625 623 or 624 n
0000626 576 and -509 n

```

```

0000627 -576 and -577 n
0000628 629 and 627 n
0000629 626 or 628 n
0000635 504 and 504 n
0000636 509 and -536 n
0000650 -652 and 550 n
0000651 650 or 652 n
0000652 -509 and 651 n
0000655 601 or 603 n
0000656 508 or 609 n
0000659 561 or 562 n
0000660 504 or 504 n
0000669 561 and 564 l
0000670 565 and -655 n
0000680 530 or 530 n
0000688 690 or 574 n
0000689 -575 and -551 n
0000690 688 and 689 n

```

```

*
* intact loop
*

```

reactor vessel nozzle - intact loop hot leg

```

1000000 rvnlhl branch
1000001 2 0
1000101 0.0634 1.5373 0.0 0.0 0.0 0.0
1000102 4.0e-5 0.0 00000
1000200 0 14901000. 1346300.0 2462060.0 0.0
1001101 250000000 100000000 0.0634 0.0 0.0 000100
1002101 100010000 105000000 0.0 0.05 0.05 000100
1001201 10.582000 11.005000 0.0
1002201 10.582000 10.625000 0.0

```

* pressurizer connection tee reactor vessel side

```

1050000 pztrvs branch
1050001 1 0
1050101 0.0634 1.634 0.0 0.0 0.0 0.0
1050102 4.0e-5 0.0 00000
1050200 0 1489610. 1346300. 2462190.0 0.0
1051101 105010000 110000000 0.0 0.05 0.05 000100
1051201 13.795000 13.974000 0.0

```

* steam generator inlet piping

```

1100000 sginlp branch
1100001 1 0
1100101 0.0 0.623 0.0303 0.0 0.0 0.0
1100102 4.0e-5 0.0 00000
1100200 0 14857200. 1346340. 24620400.0 0.000000
1101101 110010000 115000000 0.0 0.1 0.1 000100
1101201 13.801000 13.692000 0.0

```

* steam generator plus piping

```

1150000 sgppip pipe
1150001 13
1150101 0.0 3
1150102 0.151 9
1150103 0.0 12
1150104 0.0634 13
1150201 0.0 1
1150202 0.0512 2
1150203 0.0 9
1150204 0.0512 10
1150205 0.0 12
1150301 1.4385 1
1150302 0.708 2
1150303 0.63 3
1150304 1.067 5
1150305 0.45 7
1150306 1.067 9
1150307 0.63 10
1150308 0.547 11
1150309 0.689 12
1150310 0.559 13
1150401 0.09 1
1150402 0.057 2
1150403 0.335 3
1150404 0.0 9
1150405 0.335 10
1150406 0.0437 11
1150407 0.0462 12
1150408 0.0 13
1150501 0.0 13
1150601 0.0 1
1150602 90.0 6
1150603 -90.0 13
1150701 0.0 1
1150702 0.246 2
1150703 0.513 3
1150704 1.067 5
1150705 0.2865 6
1150706 -0.2865 7
1150707 -1.067 9
1150708 -0.513 10
1150709 -0.498 11
1150710 -0.689 12
1150711 -0.356 13
1150801 4.0e-5 0.0 2
1150802 4.0e-5 0.0102 3
1150803 1.0e-5 0.0103 9
1150804 4.0e-5 0.0102 10
1150805 4.0e-5 0.0 13
1150901 0.15 0.15 1
1150902 0.05 0.05 2
1150903 0.0 0.0 4
1150904 0.1 0.1 5
1150905 0.2 0.2 6
1150906 0.1 0.1 7

```

```

1150907 0.0 0.0 9
1150908 0.05 0.05 11
1150909 0.1 0.1 12
1151001 00000 13
1151101 000100 3
1151102 000000 8
1151103 000100 12
1151201 0 14871600. 1346350. 2462710.0 0.0 0.0 01
1151202 0 14877200. 1346350. 2462600.0 0.0 0.0 02
1151203 0 14793300. 1346370. 2464340.0 0.0 0.0 03
1151204 0 14770000. 1321980. 2464840.0 0.0 0.0 04
1151205 0 14746400. 1301720. 2465340.0 0.0 0.0 05
1151206 0 14729700. 1283950. 2465690.0 0.0 0.0 06
1151207 0 14721700. 1268380. 2465870.0 0.0 0.0 07
1151208 0 14715000. 1254890. 2466020.0 0.0 0.0 08
1151209 0 14707300. 1242570. 2466180.0 0.0 0.0 09
1151210 0 14707600. 1242600. 2466180.0 0.0 0.0 10
1151211 0 14631100. 1242600. 2467720.0 0.0 0.0 11
1151212 0 14621800. 1242600. 2467980.0 0.0 0.0 12
1151213 0 14616700. 1242600. 2468100.0 0.0 0.0 13
1151300 0
1151301 10.728000 10.670000 0.0 01
1151302 8.3370000 8.4284000 0.0 02
1151303 4.4456000 4.7693000 0.0 03
1151304 4.3865000 4.2164000 0.0 04
1151305 4.3407000 4.6700000 0.0 05
1151306 4.3009000 4.6296000 0.0 06
1151307 4.2676000 4.5954000 0.0 07
1151308 4.2398000 4.5671000 0.0 08
1151309 4.2249000 4.5338000 0.0 09
1151310 7.9665000 8.1922000 0.0 10
1151311 9.4925000 9.9460000 0.0 11
1151312 10.040000 10.505000 0.0 12
*****
*
* pump data
*
*****
* pump suction tee
*****
1200000 pmpsctt branch
1200001 3 0
1200101 0.0634 0.76 0.0 0.0 0.0 0.0
1200102 4.0e-5 0.0 00000
1200200 0 14613100. 1242600. 2458180.0 0.0
1201101 115010000 120000000 0.0 0.1 0.1 000000
1202101 120010000 125000000 0.0317 0.2 0.2 000100
1203101 120010000 155000000 0.0317 0.2 0.2 000100
1201201 10.040000 10.505000 0.0
1202201 5.2077000 5.2983000 0.0
1203201 5.2071000 5.2944000 0.0
*****
* pump1 suction tee outlet
*****
1250000 pmp1sctt branch
1250001 2 0
1250101 0.0 1.003 0.0613 0.0 90.0 0.521
1250102 4.0e-5 0.0 00000
1250200 0 14600300. 1242600. 2468180.0 0.0
1251101 125010000 130000000 0.0 0.1 0.1 000100
1252101 125000000 155000000 0.0 0.0 0.0 000100
1251201 7.8711000 8.2528000 0.0
1252201 -.11855000 -.13539000 0.0
*****
* pump 1 inlet
*****
1300000 pmp1inlet snglvol
1300101 0.0 0.457 0.0189 0.0 90.0 0.457
1300102 4.0e-5 0.0 00000
1300200 0 14578200. 1242600. 2468900.0 0.0
*****
* primary coolant pump 1
*****
1350000 pcump1 pump
1350101 0.0366 0.0 0.099 0.0 90.0 0.319
1350102 00000
1350108 130010000 0.0 0.0 0.0 000100
1350109 140000000 0.0 0.05 0.05 000100
1350200 0 14818100. 1242890. 2463900.0 0.0
1350201 0 8.8943000 9.2942000 0.0
1350202 0 8.8928000 8.1177000 0.0
*1350301 0 0 0 -1 0 509 0
*-----
* modification for steady state run at 91/2/8
*-----
1350301 0 0 0 -1 -1 504 0
1350302 369.00 .90178860 .31550 96.00 500.600 1.4310000
1350303 613.6 0.0 207.0000 0.00400 19.598000 0.0
1350310 0.0 0.0 0.0
*
*****
* single phase head curves
*****
* head curve no. 1
*-----[-----]-----[-----]-----[-----]-----
1351100 1 1
1351101 0.000000e+00 1.403600e+00
1351102 1.906100e-01 1.363600e+00
1351103 3.896300e-01 1.318600e+00
1351104 5.939600e-01 1.232800e+00
1351105 7.902000e-01 1.133600e+00
1351106 1.000000e+00 1.000000e+00
*-----[-----]-----[-----]-----[-----]-----
* head curve no. 2
*-----[-----]-----[-----]-----[-----]-----
1351200 1 2
1351201 0.000000e+00 -6.700000e-01
1351202 2.000000e-01 -5.000000e-01
1351203 4.000000e-01 -2.500000e-01
1351204 5.755400e-01 0.000000e+00
1351205 7.443200e-01 2.583000e-01
1351206 7.734800e-01 3.778000e-01

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1351207 8.631300e-01 6.326000e-01
1351208 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 3
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351300 1 3
1351301 -1.000000e+00 2.472200e+00
1351302 -8.057400e-01 2.047400e+00
1351303 -6.069000e-01 1.831000e+00
1351304 -4.068300e-01 1.624000e+00
1351305 -2.001710e-01 1.470500e+00
1351306 0.000000e+00 1.403600e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 4
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351400 1 4
1351401 -1.000000e+00 2.472200e+00
1351402 -8.229700e-01 1.996800e+00
1351403 -6.333200e-01 1.589700e+00
1351404 -4.553400e-01 1.327900e+00
1351405 -2.710900e-01 1.194900e+00
1351406 -1.771600e-01 1.060500e+00
1351407 -9.073000e-02 1.015600e+00
1351408 0.000000e+00 9.342790e-01
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 5
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351500 1 5
1351501 0.000000e+00 2.500000e-01
1351502 2.000000e-01 2.800000e-01
1351503 4.000000e-01 3.400000e-01
1351504 4.118000e-01 2.768000e-01
1351505 5.976300e-01 4.584000e-01
1351506 7.934670e-01 6.992000e-01
1351507 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 6
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351600 1 6
1351601 0.000000e+00 9.342790e-01
1351602 9.109900e-02 9.229000e-01
1351603 1.865090e-01 8.963000e-01
1351604 2.717620e-01 8.750000e-01
1351605 4.558720e-01 8.433000e-01
1351606 5.744060e-01 8.355000e-01
1351607 7.405760e-01 8.466000e-01
1351608 7.666190e-01 8.469000e-01
1351609 8.714710e-01 8.838000e-01
1351610 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 7
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351700 1 7
1351701 -1.000000e+00 -1.000000e+00
1351702 -8.000000e-01 -6.300000e-01
1351703 -6.000000e-01 -3.000000e-01

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1351704 -4.000000e-01 -5.000000e-02
1351705 -2.000000e-01 1.500000e-01
1351706 0.000000e+00 2.500000e-01
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* head curve no. 8
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351800 1 8
1351801 -1.000000e+00 -1.000000e+00
1351802 -8.000000e-01 -9.700000e-01
1351803 -6.000000e-01 -9.500000e-01
1351804 -4.000000e-01 -8.800000e-01
1351805 -2.000000e-01 -8.000000e-01
1351806 0.000000e+00 -6.700000e-01
*****
single phase torque data
*****
* torque curve no. 1
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1351900 2 1
1351901 0.000000e+00 6.032000e-01
1351902 1.930000e-01 6.325000e-01
1351903 3.930000e-01 7.369000e-01
1351904 5.955200e-01 8.331000e-01
1351905 7.978200e-01 9.229000e-01
1351906 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* torque curve no. 2
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1352000 2 2
1352001 0.000000e+00 -6.700000e-01
1352002 4.000000e-01 -2.500000e-01
1352003 5.000000e-01 1.500000e-01
1352004 7.372550e-01 5.265860e-01
1352005 7.680490e-01 6.065940e-01
1352006 8.672300e-01 7.436600e-01
1352007 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* torque curve no. 3
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1352100 2 3
1352101 -1.000000e+00 1.984300e+00
1352102 -8.009600e-01 1.394000e+00
1352103 -6.063800e-01 1.097500e+00
1352104 -4.068600e-01 8.220000e-01
1352105 -1.992800e-01 6.648000e-01
1352106 0.000000e+00 6.032000e-01
*-----1-----1-----1-----1-----1-----1-----1-----1-----
* torque curve no. 4
*-----1-----1-----1-----1-----1-----1-----1-----1-----
1352200 2 4
1352201 -1.000000e+00 1.984300e+00
1352202 -8.223400e-01 1.830800e+00
1352203 -6.337100e-01 1.682400e+00
1352204 -4.585300e-01 1.557000e+00
1352205 -2.670230e-01 1.436200e+00
1352206 -1.761070e-01 1.387900e+00

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1352207 -8.931000e-02 1.348100e+00
1352208 0.000000e+00 1.233610e+00
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 5
*-----1-----1-----1-----1-----1-----1-----
1352300 2 5
1352301 0.000000e+00 -4.500000e-01
1352302 4.000000e-01 -2.500000e-01
1352303 5.000000e-01 0.000000e+00
1352304 1.000000e+00 3.569000e-01
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 6
*-----1-----1-----1-----1-----1-----1-----
1352400 2 6
1352401 0.000000e+00 1.233610e+00
1352402 9.064300e-02 1.196500e+00
1352403 1.885690e-01 1.109600e+00
1352404 2.734700e-01 1.041600e+00
1352405 4.586690e-01 8.958000e-01
1352406 5.744800e-01 7.807000e-01
1352407 7.381600e-01 6.134000e-01
1352408 7.685200e-01 5.849000e-01
1352409 8.700570e-01 4.877000e-01
1352410 1.000000e+00 3.569000e-01
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 7
*-----1-----1-----1-----1-----1-----1-----
1352500 2 7
1352501 -1.000000e+00 -1.000000e+00
1352502 -3.000000e-01 -9.000000e-01
1352503 -1.000000e-01 -5.000000e-01
1352504 0.000000e+00 -4.500000e-01
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 8
*-----1-----1-----1-----1-----1-----1-----
1352600 2 8
1352601 -1.000000e+00 -1.000000e+00
1352602 -2.500000e-01 -9.000000e-01
1352603 -8.000000e-02 -8.000000e-01
1352604 0.000000e+00 -6.700000e-01
*****
two - phase multiplier data from 19-1 test data
*****
* head curve
*-----1-----1-----1-----1-----1-----1-----
1353000 0
1353001 0.000000e+00 0.000000e+00
1353002 2.000000e-02 2.000000e-02
1353003 6.000000e-02 5.000000e-02
1353004 1.000000e-01 1.000000e-01
1353005 2.000000e-01 4.600000e-01
1353006 2.400000e-01 8.000000e-01
1353007 3.000000e-01 9.600000e-01
1353008 4.000000e-01 9.800000e-01
1353009 6.000000e-01 9.700000e-01
1353010 8.000000e-01 9.000000e-01

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1353011 9.000000e-01 8.000000e-01
1353012 9.600000e-01 5.000000e-01
1353013 1.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* torque curve
*-----1-----1-----1-----1-----1-----1-----
1353100 0
1353101 0.000000e+00 0.000000e+00
1353102 1.250000e-01 7.000000e-02
1353103 1.650000e-01 1.250000e-01
1353104 2.400000e-01 5.600000e-01
1353105 8.000000e-01 5.600000e-01
1353106 9.600000e-01 4.500000e-01
1353107 1.000000e+00 0.000000e+00
*****
pump 2-phase difference data
*****
* head curve no. 1
*-----1-----1-----1-----1-----1-----1-----
1354100 1 1
1354101 0.000000e+00 0.000000e+00
1354102 1.000000e-01 8.300000e-01
1354103 2.000000e-01 1.090000e+00
1354104 5.000000e-01 1.020000e+00
1354105 7.000000e-01 1.010000e+00
1354106 9.000000e-01 9.400000e-01
1354107 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 2
*-----1-----1-----1-----1-----1-----1-----
1354200 1 2
1354201 0.000000e+00 0.000000e+00
1354202 1.000000e-01 -4.000000e-02
1354203 2.000000e-01 0.000000e+00
1354204 3.000000e-01 1.000000e-01
1354205 4.000000e-01 2.100000e-01
1354206 8.000000e-01 6.700000e-01
1354207 9.000000e-01 8.000000e-01
1354208 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 3
*-----1-----1-----1-----1-----1-----1-----
1354300 1 3
1354301 -1.000000e+00 -1.160000e+00
1354302 -9.000000e-01 -1.240000e+00
1354303 -8.000000e-01 -1.770000e+00
1354304 -7.000000e-01 -2.360000e+00
1354305 -6.000000e-01 -2.790000e+00
1354306 -5.000000e-01 -2.910000e+00
1354307 -4.000000e-01 -2.670000e+00
1354308 -2.500000e-01 -1.690000e+00
1354309 -1.000000e-01 -5.000000e-01
1354310 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 4
*-----1-----1-----1-----1-----1-----1-----

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```

1354400 1 4
1354401 -1.000000e+00 -1.160000e+00
1354402 -9.000000e-01 -7.800000e-01
1354403 -8.000000e-01 -5.000000e-01
1354404 -7.000000e-01 -3.100000e-01
1354405 -6.000000e-01 -1.700000e-01
1354406 -5.000000e-01 -8.000000e-02
1354407 -3.500000e-01 0.000000e+00
1354408 -2.000000e-01 5.000000e-02
1354409 -1.000000e-01 8.000000e-02
1354410 0.000000e+00 1.100000e-01
*-----1-----1-----1-----1-----1-----
* head curve no. 5
*-----1-----1-----1-----1-----1-----
1354500 1 5
1354501 0.000000e+00 0.000000e+00
1354502 2.000000e-01 -3.400000e-01
1354503 4.000000e-01 -6.500000e-01
1354504 6.000000e-01 -9.300000e-01
1354505 8.000000e-01 -1.190000e+00
1354506 1.000000e+00 -1.470000e+00
*-----1-----1-----1-----1-----1-----
* head curve no. 6
*-----1-----1-----1-----1-----1-----
1354600 1 6
1354601 0.000000e+00 1.100000e-01
1354602 1.000000e-01 1.300000e-01
1354603 2.500000e-01 1.500000e-01
1354604 4.000000e-01 1.300000e-01
1354605 5.000000e-01 7.000000e-02
1354606 6.000000e-01 -4.000000e-02
1354607 7.000000e-01 -2.300000e-01
1354608 8.000000e-01 -5.100000e-01
1354609 9.000000e-01 -9.100000e-01
1354610 1.000000e+00 -1.470000e+00
*-----1-----1-----1-----1-----1-----
* head curve no. 7
*-----1-----1-----1-----1-----1-----
1354700 1 7
1354701 -1.000000e+00 0.000000e+00
1354702 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----
* head curve no. 8
*-----1-----1-----1-----1-----1-----
1354800 1 8
1354801 -1.000000e+00 0.000000e+00
1354802 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----
* torque curve no. 1
*-----1-----1-----1-----1-----1-----
1354900 2 1
1354901 0.000000e+00 6.032000e-01
1354902 1.930000e-01 6.325000e-01
1354903 3.930000e-01 7.369000e-01
1354904 5.952000e-01 8.331000e-01
1354905 7.978200e-01 9.229000e-01

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1354906 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----
* torque curve no. 2
*-----1-----1-----1-----1-----1-----
1355000 2 2
1355001 0.000000e+00 -6.700000e-01
1355002 4.000000e-01 -2.500000e-01
1355003 5.000000e-01 1.500000e-01
1355004 7.372550e-01 5.265860e-01
1355005 7.680490e-01 6.065940e-01
1355006 8.672300e-01 7.436600e-01
1355007 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----
* torque curve no. 3
*-----1-----1-----1-----1-----1-----
1355100 2 3
1355101 -1.000000e+00 1.984300e+00
1355102 -8.009600e-01 1.394000e+00
1355103 -6.063800e-01 1.097500e+00
1355104 -4.068600e-01 8.220000e-01
1355105 -1.992800e-01 6.648000e-01
1355106 0.000000e+00 6.032000e-01
*-----1-----1-----1-----1-----1-----
* torque curve no. 4
*-----1-----1-----1-----1-----1-----
1355200 2 4
1355201 -1.000000e+00 1.984300e+00
1355202 -8.223400e-01 1.830800e+00
1355203 -6.337100e-01 1.682400e+00
1355204 -4.585300e-01 1.557000e+00
1355205 -2.670230e-01 1.436200e+00
1355206 -1.761070e-01 1.387900e+00
1355207 -8.931000e-02 1.348100e+00
1355208 0.000000e+00 1.233610e+00
*-----1-----1-----1-----1-----1-----
* torque curve no. 5
*-----1-----1-----1-----1-----1-----
1355300 2 5
1355301 0.000000e+00 -4.500000e-01
1355302 4.000000e-01 -2.500000e-01
1355303 5.000000e-01 0.000000e+00
1355304 1.000000e+00 3.569000e-01
*-----1-----1-----1-----1-----1-----
* torque curve no. 6
*-----1-----1-----1-----1-----1-----
1355400 2 6
1355401 0.000000e+00 1.233610e+00
1355402 9.064300e-02 1.196500e+00
1355403 1.885690e-01 1.109600e+00
1355404 2.734700e-01 1.041600e+00
1355405 4.586690e-01 8.958000e-01
1355406 5.744800e-01 7.807000e-01
1355407 7.381600e-01 6.134000e-01
1355408 7.685200e-01 5.849000e-01
1355409 8.700570e-01 4.877000e-01
1355410 1.000000e+00 3.569000e-01

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1750301 0.559 1
1750302 0.613 2
1750401 0.0 2
1750501 0.0 2
1750601 0.0 2
1750701 0.0 2
1750801 4.0e-5 0.0 2
1750901 0.15 0.15 1
1751001 00000 2
1751101 000100 1
1751201 0 15044100. 1242900. 2458830.0 0.0 0.0 01
1751202 0 15037400. 1242900. 2458990.0 0.0 0.0 02
1751300 0
1751301 10.035000 10.106000 0.0 01
*****
* ecc connection tee pump side
*****
1800000 ecct branch
1800001 1 0
1800101 0.0634 1.152 0.0 0.0 0.0 0.0
1800102 4.0e-5 0.0 00000
1800200 0 15034000. 1242910. 2259090.0 0.0
1801101 175010000 180000000 0.0 0.05 0.05 000100
1801201 10.035000 10.083000 0.0
*****
* cold leg pipe from ecc connection to reactor vessel
*****
1850000 rvnilel branch
1850001 3 0
1850101 0.0634 1.01 0.0 0.0 0.0 0.0
1850102 4.0e-5 0.0 00000
1850200 0 15032100. 1242910. 2459140.0 0.0
1851101 185010000 205000000 0.0634 1.0 1.0 000100
1852101 180010000 185000000 0.0 0.0 0.0 000100
1853101 185010000 223000000 0.0 45.0 45.0 000100
1851201 9.2743000 9.3795000 0.0
1852201 10.035000 10.064000 0.0
1853201 1.6570000 1.7271000 0.0
*****
*
* reactor vessel
*
*-----|-----|-----|-----|-----|-----|-----|
* inlet annulus top volume
*-----|-----|-----|-----|-----|-----|-----|
2000000 inantop branch
2000001 2 0
2000101 0.0 0.33 0.0855 0.0 90.0 0.33
2000102 4.0e-5 0.178 00000
2000200 0 15017400. 1243540. 2459500.0 0.0
2001101 200000000 205000000 0.0 0.0 0.0 000100
2002101 200000000 245010000 0.001 1800. 1800. 000100
2001201 -.0306700 -.03023076 .0
2002201 .06975000 .07019300 0.0
*-----|-----|-----|-----|-----|-----|-----|
* inlet annulus bottom volume

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*-----|-----|-----|-----|-----|-----|-----|
2050000 inanbot branch
2050001 1 0
2050101 0.0 0.424 0.11 0.0 -90.0 -0.424
2050102 4.0e-5 0.172 00000
2050200 0 15018400. 1242920. 2459460.0 0.0
2051101 205010000 210000000 0.0 0.0 0.0 000100
2051201 4.0266000 4.3312000 0.0
*-----|-----|-----|-----|-----|-----|-----|
* downcomer
*-----|-----|-----|-----|-----|-----|-----|
2100000 downcomr annulus
2100001 4
2100101 0.142 4
2100201 0.0 3
2100301 0.958 4
2100401 0.0 4
2100501 0.0 4
2100601 -90.0 4
2100801 4.0e-5 0.102 4
2100901 0.0 0.0 3
2101001 00000 4
2101101 000000 3
2101201 0 15017400. 1242940. 2459500.0 0.0 0.0 01
2101202 0 15023500. 1242960. 2459350.0 0.0 0.0 02
2101203 0 15029700. 1242980. 2459200.0 0.0 0.0 03
2101204 0 15035800. 1243000. 2459050.0 0.0 0.0 04
2101300 0
2101301 4.0266000 4.3398000 0.0 01
2101302 4.0266000 4.3397000 0.0 02
2101303 4.0266000 4.3396000 0.0 03
*-----|-----|-----|-----|-----|-----|-----|
* lower plenum top volume
*-----|-----|-----|-----|-----|-----|-----|
2150000 lwrplop branch
2150001 3 0
2150101 0.74 0.360 0.0 0.0 -90.0 -0.36
2150102 4.0e-5 0.0 00000
2150200 0 15044100. 1242880. 2458850.0 0.0
2151101 210010000 215000000 0.0 0.00 0.00 000100
2152101 215010000 220000000 0.0 0.00 0.00 000100
2153101 215000000 225000000 0.15 0.0 0.0 000100
2151201 4.0265000 4.3184000 0.0
2152201 -.0651070 -.0771765 0.0
2153201 2.4798000 2.5728000 0.0
*-----|-----|-----|-----|-----|-----|-----|
* lower plenum bottom volume
*-----|-----|-----|-----|-----|-----|-----|
2200000 lwrplot snglvol
2200101 0.79 0.37 0.0 0.0 -90.0 -0.37
2200102 4.0e-5 0.0 00000
2200200 0 15046800. 1241150. 2458780.0 0.0
*-----|-----|-----|-----|-----|-----|-----|
* core filler bypass
*-----|-----|-----|-----|-----|-----|-----|
2230000 fillegap annulus

```

```

2230001 7
2230101 2.9110-2 7
2230201 0.0 6
2230301 0.424 1
2230302 0.958 5
2230303 0.36 6
2230304 0.37 7
2230401 0.0 7
2230501 0.0 7
2230601 -90.0 7
2230801 4.0e-5 0.0 7
2230901 0.0 0.0 6
2231001 00000 7
2231101 000000 6
2231201 0 15023600. 1242730. 2459340.0 0.0 0.0 01
2231202 0 15028700. 1242320. 2459220.0 0.0 0.0 02
2231203 0 15035700. 1241930. 2459050.0 0.0 0.0 03
2231204 0 15042700. 1241540. 2458880.0 0.0 0.0 04
2231205 0 15049700. 1241160. 2458710.0 0.0 0.0 05
2231206 0 15054500. 1241010. 2458600.0 0.0 0.0 06
2231207 0 15057200. 1240860. 2458530.0 0.0 0.0 07
2231300 0
2231301 1.6569000 1.8115000 0.0 01
2231302 1.6565000 1.8111000 0.0 02
2231303 1.6561000 1.8107000 0.0 03
2231304 1.6558000 1.8103000 0.0 04
2231305 1.6554000 1.8099000 0.0 05
2231306 1.6553000 1.8097000 0.0 06
*-----1-----1-----1-----1-----1-----1-----
* junction from filler gap to lower plenum
*-----1-----1-----1-----1-----1-----1-----
2240000 flrgapp sngljun
2240101 223010000 220010000 0.0 10. 10. 000100
2240201 0 1.6552000 1.7051000 0.0
*-----1-----1-----1-----1-----1-----1-----
* lower core support structure
*-----1-----1-----1-----1-----1-----1-----
2250000 lcoreup branch
2250001 2 0
2250101 0.25 0.52 0.0 0.0 90.0 0.52
2250102 4.0e-5 0.095 00000
2250200 0 15032600. 1242900. 2459120.0 0
2251101 225010000 230000000 0.0975 0.3 0.3 000100
2252101 225010000 235000000 0.0 0.0 0.0 000100
2251201 3.3398000 3.6043000 0.0
2252201 2.2306000 2.3976000 0.0
*-----1-----1-----1-----1-----1-----1-----
* active core
*-----1-----1-----1-----1-----1-----1-----
2300000 core pipe
2300001 3
2300101 0.1705 3
2300201 0.1440 2
2300301 0.559 2
2300302 0.657 3
2300401 0.0 3

```

```

2300501 0.0 3
2300601 90.0 3
2300801 4.0e-5 0.012 3
2300901 0.5 0.5 2
2301001 00100 3
2301101 000100 2
2301201 0 15009300. 1289110. 2459680. 0.0 0.0 01
2301202 0 14996400. 1339030. 2459990. 0.0 0.0 02
2301203 0 14982500. 1354980. 2460310. 0.0 0.0 03
2301300 0
2301301 3.5187000 3.5227000 0.0 01
2301302 3.6127000 3.6166000 0.0 02
*-----1-----1-----1-----1-----1-----1-----
* core bypass volume
*-----1-----1-----1-----1-----1-----1-----
2350000 corebyps pipe
2350001 3
2350101 0.015 3
2350201 0.0 2
2350301 0.559 2
2350302 0.657 3
2350401 0.0 3
2350501 0.0 3
2350601 90.0 3
2350801 4.0e-5 0.003 3
2350901 0.0 0.0 2
2351001 00000 3
2351101 000000 2
2351201 0 15021500. 1242940. 2459390.0 0.0 0.0 01
2351202 0 15002400. 1242980. 2459850.0 0.0 0.0 02
2351203 0 14981700. 1243020. 2460330.0 0.0 0.0 03
2351300 0
2351301 2.2307000 2.3978000 0.0 01
2351302 2.2307000 2.3980000 0.0 02
*-----1-----1-----1-----1-----1-----1-----
* upper core support structure
*-----1-----1-----1-----1-----1-----1-----
2400000 ucosst branch
2400001 2 0
2400101 0.297 1.118 0.0 0.0 90.0 1.118
2400102 4.0e-5 0.145 00000
2400200 0 14966500. 1348980. 2460680.0 0.0
2401101 230010000 240000000 0.12 0.3 0.3 000100
2402101 235010000 240000000 0.0 0.0 0.0 000100
2401201 3.6456000 3.6509000 0.0
2402201 2.3080000 2.3981000 0.0
*-----1-----1-----1-----1-----1-----1-----
* upper flow skirt region
*-----1-----1-----1-----1-----1-----1-----
2450000 ufosre branch
2450001 1 0
2450101 0.114 0.843 0.0 0.0 90.0 0.843
2450102 4.0e-5 0.131 00000
2450200 0 14945200. 1347660. 2461140.0 0.0
2451101 240010000 245000000 0.0 0.0 0.0 000100
2451201 5.7436 6.0742 0.0

```

```

3101201 .21294000 .26136000 0.0
3102201 .00000000 .00320000 0.0
*-----1-----1-----1-----1-----1-----1-----1-----
* steam generator and pump simulation
*-----1-----1-----1-----1-----1-----1-----1-----
3150000      sgpsi      pipe
3150001      12
3150101 0.00836      2
3150102 0.108      8
3150103 0.0      10
3150104 0.00836      11
3150105 0.0525      12
3150201 0.0      2
3150202 0.0326      4
3150203 0.108      5
3150204 0.0326      7
3150205 0.0      8
3150206 0.0      9
3150207 0.0081      10
3150208 0.0      11
3150301 0.4054      1
3150302 0.5265      2
3150303 0.362      3
3150304 1.692      4
3150305 0.8495      6
3150306 1.692      7
3150307 0.362      8
3150308 1.346      9
3150309 1.325      10
3150310 1.842      11
3150311 0.667      12
3150401 0.0      8
3150402 0.0162      9
3150403 0.0648      10
3150404 0.0      12
3150601 90.0      5
3150602 -90.0      10
3150603 90.0      11
3150604 0.0      12
3150701 0.127      1
3150702 0.488      2
3150703 0.362      3
3150704 1.692      4
3150705 0.457      5
3150706 -0.457      6
3150707 -1.692      7
3150708 -0.362      8
3150709 -1.143      9
3150710 -0.686      10
3150711 1.214      11
3150712 0.0      12
3150801 4.0e-5      0.0      3
3150802 4.0e-5      0.124      4
3150803 4.0e-5      0.0      6
3150804 4.0e-5      0.124      7
3150805 4.0e-5      0.0      12

```

```

33000000 qobvhl valve
3300101 325010000 800000000 0.0466 0.0 0.0 000100
3300201 1 0.0 0.0 0.0
3300300 trpvlv
3300301 506
*-----1-----1-----1-----1-----1-----1-----
* reactor vessel nozzle - broken loop cold leg
*-----1-----1-----1-----1-----1-----1-----
33500000 rvabl branch
3350001 2 0
3350101 0.0634 0.7495 0.0 0.0 0.0 0.0
3350102 4.0e-5 0.0 00000
3350200 0 15018600. 1242920. 2459470.0 0.0
3351101 205000000 335000000 0.0634 1.0 1.0 000100
3352101 335010000 340000000 0.0 0.1 0.1 000000
3351201 .13054000 .15185000 0.0
3352201 .13051000 .13063000 0.0
*-----1-----1-----1-----1-----1-----1-----
* cold leg pipe to reflood assist bypass tee
*-----1-----1-----1-----1-----1-----1-----
34000000 ctbarv branch
3400001 1 0
3400101 0.0634 0.698 0.0 0.0 0.0 0.0
3400102 4.0e-5 0.0 00000
3400200 0 15018600. 1242870. 2459470.0 0.0
3401101 340010000 345000000 0.0 0.1 0.1 000000
3401201 .13049000 .13005000 0.0
*-----1-----1-----1-----1-----1-----1-----
* broken loop cold leg contraction to break plane
*-----1-----1-----1-----1-----1-----1-----
34500000 baocet branch
3450001 2 0
3450101 0.0634 0.974 0.0 0.0 0.0 0.0
3450102 4.0e-5 0.0 00000
3450200 0 15018600. 1242530. 2459470.0 0.0
3451101 345000000 385000000 0.0 0.0 0.0 000100
3452101 345010000 350000000 0.0 0.0 0.0 000100
3451201 .21311000 .19053000 0.0
3452201 .0 .0 0.0
*-----1-----1-----1-----1-----1-----1-----
* ecc tee isolation valve cold leg
*-----1-----1-----1-----1-----1-----1-----
35000000 etivcl pipe
3500001 2
3500101 0.0 2
3500201 0.0 1 * break plane
3500301 0.488 1
3500302 1.6085 2
3500401 0.00541 1
3500402 0.07770 2
3500601 0.0 2
3500801 4.0e-5 0.0 1
3500802 4.0e-5 0.0 2
3500901 0.0 0.0 1
3501001 00000 2
3501101 000100 1

```

```

3501201 0 15018600. 1067100. 2459470.0 0.0 0.0 01
3501202 0 15018600. 1173730. 2459470.0 0.0 0.0 02
3501300 0
3501301 .0 .0 0.0 01
*-----1-----1-----1-----1-----1-----
* isolation valve cold leg
*-----1-----1-----1-----1-----1-----
3550000 isvcl valve
3550101 350010000 360000000 0.0 0.0 0.0 000100
3550201 1 0.0 0.0 0.0
3550300 trpvlv
3550301 505
*-----1-----1-----1-----1-----1-----
* pipe section between isolation valve and qobv cold leg
*-----1-----1-----1-----1-----1-----
3600000 vvcl snglvcl
3600101 0.0525 0.813 0.0 0.0 0.0 0.0
3600102 4.0e-5 0.0 00000
3600200 3 14.74e6 558.
*-----1-----1-----1-----1-----1-----
* quick opening blowdown cold leg
*-----1-----1-----1-----1-----1-----
3650000 qobvcl valve
3650101 360010000 805000000 0.0466 0.0 0.0 000100
3650201 1 0.0 0.0 0.0
3650300 trpvlv
3650301 507
*-----1-----1-----1-----1-----1-----
* reflood assist bypass piping - cold leg side
*-----1-----1-----1-----1-----1-----
3700000 rabspcl branch
3700001 1 0
3700101 0.0388 2.203 0.0 0.0 90.0 0.653
3700102 4.0e-5 0.0 00000
3700200 0 14755500. 1239680.0 2460930.0 0.0
3701101 375010000 370000000 0.0 0.0 0.0 000100
3701201 .21294000 .24585000 0.0
*-----1-----1-----1-----1-----1-----
* reflood assist bypass parrel pipes hot leg side
*-----1-----1-----1-----1-----1-----
3750000 rabphl snglvcl
3750101 0.0776 0.0 0.0858 0.0 0.0 0.0
3750102 4.0e-5 0.0 00000
3750200 0 14957900. 1239760.0 2460880.0 0.0
*-----1-----1-----1-----1-----1-----
* reflood assist bypass valves
*-----1-----1-----1-----1-----1-----
3770000 rabsvlv sngljun
3770101 380010000 375000000 0.0 1.4e+4 1.4e+4 000000
3770201 0 .106460 .25646 0.0
*-----1-----1-----1-----1-----1-----
* reflood assist bypass parrel pipes cold leg side
*-----1-----1-----1-----1-----1-----
3800000 rabppcl snglvcl
3800101 0.0776 0.0 0.0855 0.0 0.0 0.0
3800102 4.0e-5 0.0 00000

```

```

3800200 0 15023400. 1240020.0 2459350.0 0.0
*-----1-----1-----1-----1-----1-----
* reflood assist bypass single pipe cold leg side
*-----1-----1-----1-----1-----1-----
3850000 rabspcl branch
3850001 1 0
3850101 0.0388 0.0 0.11802 0.0 -90.0 -0.653
3850102 4.0e-5 0.0 00000
3850200 0 15021000. 1240850.0 2459410.0 0.0
3851101 385010000 380000000 0.0 0.0 0.0 000100
3851201 .212920 .260740 0.0
*****
*
* pressurizer
*
*****
* surge line pcs side
*-----1-----1-----1-----1-----1-----
4000000 slpcs branch
4000001 2 0
4000101 0.00145 3.45 0.0 0.0 90.0 0.54
4000102 4.0e-5 0.0 00000
4000200 0 14923700. 1458370. 2461610.0 0.0
4001101 110000000 400000000 0.0 0.93 0.93 000100
4002101 400010000 405000000 0.0 0.93 0.93 000000
4001201 -.17675e-4 -.17772e-4 0.0
4002201 -.17696e-5 -.17696e-5 0.0
*-----1-----1-----1-----1-----1-----
* surge line pressurizer vessel
*-----1-----1-----1-----1-----1-----
4050000 slprv snglvcl
4050101 0.00145 3.45 0.0 0.0 90.0 0.60
4050102 4.0e-5 0.0 00000
4050200 0 14920000. 1494210.0 2461690.0 0.0
*-----1-----1-----1-----1-----1-----
* spray line
*-----1-----1-----1-----1-----1-----
4060000 spray branch
4060001 1 0
4060101 0.0003363 6.322 0.0 0.0 90.0
4060102 3.161 4.0e-5 0.0 00000
4060200 0 15075000. 1244040.0 2458090.0 0.0
4061101 406010000 420010000 2.4e-6 1.0392 1.0392 000100
4061201 .08890000 .08890000 0.0
*-----1-----1-----1-----1-----1-----
* spray valve
*-----1-----1-----1-----1-----1-----
4070000 sprvlv valve
4070101 406010000 420010000 3.34e-4 1.54e01 1.54e01
+ 000100
4070201 0 .000000 .000000 0.0
4070300 trpvlv
4070301 690
*-----1-----1-----1-----1-----1-----
* pressurizer surge line valve
*-----1-----1-----1-----1-----1-----

```



```

5251101 52510000 53000000 0.0 0.8 0.8 000100
5251201 .7175 .78659 0.0
*-----1-----1-----1-----1-----1-----1-----
* mist extractor and steam generator outlet pipe to scv
*-----1-----1-----1-----1-----1-----1-----
5300000 stmpipe pipe
5300001 2
5300101 1.2728 1
5300102 0.04635 2
5300201 0.01365 1
5300301 0.762 1
5300302 25.074 2
5300401 0.0 2
5300601 90.0 1
5300602 0.0 2
5300801 4.e-5 0.0 2
5300901 0.4 0.4 1
5301001 00000 2
5301101 000100 1
5301201 0 5670000.0 1148038.0 2591620. .9997400 0.0 01
5301202 0 5548250.0 1148038.0 2591620. .9989700 0.0 02
5301300 0
5301301 20.365 21.619 0.0 01
*-----1-----1-----1-----1-----1-----1-----
* pipe downstream of steam control valve
*-----1-----1-----1-----1-----1-----1-----
5350000 condint snglvol
5350101 0.06557 54.44 0.0 0.0 0.0 0.0
5350102 4.e-5 0.0 00000
5350200 0 2079110.0 914598.0 2598620.0 1.00000
*-----1-----1-----1-----1-----1-----1-----
* air cooled condenser
*-----1-----1-----1-----1-----1-----1-----
5400000 condnsr tmdpvovl
5400101 0.21677 17.67 0.0 0.0 0.0 0.0
5400102 4.e-5 0.02 00000
5400200 2
5400207 0.0 2.069e+6 1.0
*-----1-----1-----1-----1-----1-----1-----
* feed storage tank
*-----1-----1-----1-----1-----1-----1-----
5450000 feedtnk tmdpvovl
5450101 29.81 3.048 0.0 0.0 0.0 0.0
5450102 4.e-5 0.0 00000
5450200 1 656
5450201 -1.0 479.62 0.0
5450202 0.0 479.62 0.0
5450203 10.0 479.62 0.0
*-----1-----1-----1-----1-----1-----1-----
* steam control valve bypass
*-----1-----1-----1-----1-----1-----1-----
5460000 scvbyp valve
5460101 530010000 547000000 0.0 0.0 0.0 000000
5460201 0 .000000 .000000 0.0
5460300 trpvlv
5460301 670

```



```

8000101 0.0 1.0 0.1 0.0 0.0 0.0
8000102 0.0 0.0 00000
8000200 2
8000201 0.0 0.107e6 1.0
8000202 10000.0 0.107e6 1.0
*-----|-----|-----|-----|-----|-----|
* containment broken loop cold leg
*-----|-----|-----|-----|-----|-----|
8050000 c805 tmdpvov
8050101 0.0 1.0 0.1 0.0 0.0 0.0
8050102 0.0 0.0 00000
8050200 2
8050201 0.0 1.0e+5 1.0
8050202 10000.0 1.0e+5 1.0
*-----|-----|-----|-----|-----|-----|
* containment power operated relief valve
*-----|-----|-----|-----|-----|-----|
8100000 cporv tmdpvov
8100101 0.0 1.0 0.1 0.0 0.0 0.0
8100102 0.0 0.0 00000
8100200 2
8100201 0.0 0.107e+6 1.0
8100202 10000.0 0.107e+6 1.0
*-----|-----|-----|-----|-----|-----|
* boundary valve intact loop hot leg
*-----|-----|-----|-----|-----|-----|
9000000 bvalv valve
9000101 110010000 905000000 0.0 0.0 0.0 000100
9000201 0 0.0 0.0 0.0
9000300 trpviv
9000301 511
*-----|-----|-----|-----|-----|-----|
* boundary volume intact loop hot leg
*-----|-----|-----|-----|-----|-----|
9050000 bvolum tmdpvov
9050101 0.0 1.0 0.1 0.0 0.0 0.0
9050102 0.0 0.0 00000
9050200 3
9050201 0.0 14.9664e6 577.86
9050202 10000.0 14.9664e6 577.86
*-----|-----|-----|-----|-----|-----|
*
* heat structure input data
*
*****
* steam generator heat structures
*
*****
* steam generator tubing
*****
10060000 6 8 2 1 0.0051054
10060100 0 1
10060101 7 0.006348984
10060201 6 7
10060301 0.0 7

```

```

10060401 540.0 8
10060501 115040000 10000 1 1 1687.481 6
10060601 515040000 10000 1 1 1687.481 3
10060602 515060000 -10000 1 1 1687.481 6
10060701 0 0 0 0 0 6
10060801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
10060901 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
*****
* tubesheet central section
*****
11151000 2 4 2 1 5.1054e-3
11151100 0 1
11151101 1 6.35e-3
11151102 2 7.072376e-3
11151201 6 1
11151202 5 3
11151301 0.0 3
11151401 577.0 4
11151501 115030000 70000 1 1 0.25 2
11151601 -939 0 3949 1 0.25 2
11151701 0 0.0 0.0 0.0 2
11151801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
*****
* tube sheet periphery
*****
11152000 2 20 1 1 0.0
11152100 0 1
11152101 19 0.623795
11152201 5 19
11152301 0.0 19
11152401 577.0 20
11152501 115030000 0 1 1 0.1579621 1
11152502 115100000 0 1 1 0.1579621 2
11152601 515030000 0 1 1 0.1579621 2
11152701 0 0.0 0.0 0.0 2
11152801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
11152901 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
*****
* intact loop piping
*****
11001000 12 11 2 1 0.142
11001100 0 1
11001101 10 0.1780
11001201 4 10
11001301 0.0 10
11001401 540.0 11
11001501 100010000 0 1 1 1.5373 1
11001502 105010000 0 1 1 1.634 2
11001503 110010000 0 1 1 0.623 3
11001504 115010000 0 1 1 1.4385 4
11001505 115120000 0 1 1 0.689 5
11001506 115130000 0 1 1 0.559 6
11001507 120010000 0 1 1 0.76 7
11001508 150010000 0 1 1 0.4966 8
11001509 175010000 0 1 1 0.559 9
11001510 175020000 0 1 1 0.613 10

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11001511 180010000 0 1 1 0.701 11
11001512 185010000 0 1 1 1.461 12
11001601 -939 0 3949 1 1.5373 1
11001602 -939 0 3949 1 1.634 2
11001603 -939 0 3949 1 0.623 3
11001604 -939 0 3949 1 1.4385 4
11001605 -939 0 3949 1 0.689 5
11001606 -939 0 3949 1 0.559 6
11001607 -939 0 3949 1 0.76 7
11001608 -939 0 3949 1 0.4966 8
11001609 -939 0 3949 1 0.559 9
11001610 -939 0 3949 1 0.613 10
11001611 -939 0 3949 1 0.701 11
11001612 -939 0 3949 1 1.461 12
11001701 0 0 0 0 12
11001801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
11001802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
11001803 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 3 * mod 3
11001804 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 4 * mod 3
11001805 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 5 * mod 3
11001806 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
11001807 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 7 * mod 3
11001808 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 8 * mod 3
11001809 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 9 * mod 3
11001810 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 10 * mod 3
11001811 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 11 * mod 3
11001812 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 12 * mod 3
*-----|-----|-----|-----|-----|-----|-----|-----|
* steam generator connections
*-----|-----|-----|-----|-----|-----|-----|-----|
11002000 2 11 2 1 0.1625
11002100 0 1
11002101 10 0.203
11002201 4 10
11002301 0.0 10
11002401 540.0 11
11002501 115020000 0 1 1 0.708 1
11002502 115110000 0 1 1 0.547 2
11002601 -939 0 3949 1 0.708 1
11002602 -939 0 3949 1 0.547 2
11002701 0 0 0 0 2
11002801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
11002802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
*-----|-----|-----|-----|-----|-----|-----|-----|
* .216 meter diameter piping
*-----|-----|-----|-----|-----|-----|-----|-----|
11003000 7 11 2 1 0.108
11003100 0 1
11003101 10 0.1365
11003201 4 10
11003301 0.0 10
11003401 540.0 11
11003501 125010000 0 1 1 1.00 1
11003502 130010000 0 1 1 0.457 2
11003503 140010000 0 1 1 0.502 3
11003504 145010000 0 1 1 1.4084 4

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```

11003505 155010000 0      1      1      1.003  5
11003506 160010000 0      1      1      0.457  6
11003507 170010000 0      1      1      0.514  7
11003601 -939  0      3949  1      1.00  1
11003602 -939  0      3949  1      0.457  2
11003603 -939  0      3949  1      0.502  3
11003604 -939  0      3949  1      1.4084  4
11003605 -939  0      3949  1      1.003  5
11003606 -939  0      3949  1      0.457  6
11003607 -939  0      3949  1      0.514  7
11003701 0      0      0      0      7
11003801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
11003802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
11003803 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 3 * mod 3
11003804 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 4 * mod 3
11003805 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 5 * mod 3
11003806 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
11003807 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 7 * mod 3
*-----1-----1-----1-----1-----1-----1-----
* steam generator plena
*-----1-----1-----1-----1-----1-----1-----
11004000 2      11      3      1      0.6858
11004100 0      1
11004101 10     0.7747
11004201 5      10
11004301 0.0    10
11004401 540.0  11
11004501 115030000 0      1      1      0.25  1
11004502 115100000 0      1      1      0.25  2
11004601 -939  0      3949  1      0.25  1
11004602 -939  0      3949  1      0.25  2
11004701 0      0      0      0      2
11004801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
11004802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
11004901 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
*****
* reactor vessel heat structures
*****
* the reactor vessel wall is not modelled above the nozzles.
* the vessel to filler gap is assumed to insulate the vessel
* from the fillers. the vessel to filler gap is not modelled
* at this elevation.
* filler blocks inlet annulus top volume
* station 264 to 277
*****
12000000 1      21      2      1      0.508
12000100 0      1
12000101 20     0.7264
12000201 4      20
12000301 0.0    20
12000401 558.0  21
12000501 200010000 0      1      1      0.33  1
12000601 0      0      0      1      0.33  1
12000701 0      0.0    0.0    0.0    1
12000801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****

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```

* core support barrel
* station 96.44 to 277
*****
12001000 6      11      2      1      0.381
12001100 0      1
12001101 10     0.419
12001201 4      10
12001301 0.0    10
12001401 558.0  11
12001501 0      0      0      1      0.33  1
12001502 0      0      0      1      0.424  2
12001503 0      0      0      1      0.958  3
12001504 0      0      0      1      0.958  4
12001505 0      0      0      1      0.958  5
12001506 0      0      0      1      0.958  6
12001601 200010000 0      1      1      0.33  1
12001602 205010000 0      1      1      0.424  2
12001603 210010000 0      1      1      0.958  3
12001604 210020000 0      1      1      0.958  4
12001605 210030000 0      1      1      0.958  5
12001606 210040000 0      1      1      0.958  6
12001701 0      0.0    0.0    0.0    0.0    6
12001901 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
12001902 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
12001903 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
*****
* filler blocks inlet annulus lower volume
* station 247.3 to 264.0
*****
12050000 1      21      2      1      0.501
12050100 0      1
12050101 20     0.7264
12050102 4      20
12050103 0.0    20
12050401 558.0  21
12050501 205010000 0      1      1      0.424  1
12050601 223010000 0      1      1      0.424  1
12050701 0      0.0    0.0    0.0    1
12050801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
12050901 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
* downcomer and lower plenum
* station 67.7 to 247.3
*****
12100000 6      21      2      1      0.47
12100100 0      1
12100101 20     0.7264
12100201 4      20
12100301 0.0    20
12100401 558.0  21
12100501 210010000 10000 1      1      0.958  4
12100505 215010000 0      1      1      0.36  5
12100506 220010000 0      1      1      0.37  6
12100601 223020000 0      1      1      0.958  1
12100602 223030000 0      1      1      0.958  2
12100603 223040000 0      1      1      0.958  3

```

12100604	223050000	0	1	1	0.958	4
12100605	223060000	0	1	1	0.36	5
12100606	223070000	0	1	1	0.37	6
12100701	0	0.0	0.0	0.0	0.0	6
12100801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 4 * mod 3
12100802	0.0	11.0	11.0	0.0	0.0	0.0 0.0 1.0 5 * mod 3
12100803	0.0	11.0	11.0	0.0	0.0	0.0 0.0 1.0 6 * mod 3
12100901	0.0	11.0	11.0	0.0	0.0	0.0 0.0 1.0 4 * mod 3
12100902	0.0	11.0	11.0	0.0	0.0	0.0 0.0 1.0 5 * mod 3
12100903	0.0	11.0	11.0	0.0	0.0	0.0 0.0 1.0 6 * mod 3

 * reactor vessel wall above station 178 - 5.50 inches thick
 * station 178 to 258 rv not modelled above bottom of nozzles

12110000	3	11	2	1	0.7328	
12110100	0	1				
12110101	10	0.8725				
12110201	5	10				
12110301	0.0	10				
12110401	558.0	11				
12110501	223010000	0	1	1	0.424	1
12110502	223020000	0	1	1	0.958	2
12110503	223030000	0	1	1	0.6500	3
12110601	-939	0	3949	1	0.424	1
12110602	-939	0	3949	1	0.958	2
12110603	-939	0	3949	1	0.6500	3
12110701	0	0.0	0.0	0.0	0.0	3
12110801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3
12110802	0.0	11.0	11.0	0.0	0.0	0.0 1.0 2 * mod 3
12110803	0.0	11.0	11.0	0.0	0.0	0.0 1.0 3 * mod 3

 * reactor vessel wall bellow station 178 - 3.62 inches thick
 * station 67.7 to 178

12120000	5	7	2	1	0.7328	
12120100	0	1				
12120101	6	0.8247				
12120201	5	6				
12120301	0.0	6				
12120401	558.0	7				
12120501	223030000	0	1	1	0.308	1
12120502	223040000	10000	1	1	0.958	3
12120503	223060000	0	1	1	0.3603	4
12120504	223070000	0	1	1	0.37	5
12120601	-939	0	3949	1	0.308	1
12120602	-939	0	3949	1	0.958	3
12120603	-939	0	3949	1	0.36	4
12120604	-939	0	3949	1	0.37	5
12120701	0	0.0	0.0	0.0	0.0	5
12120801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3
12120802	0.0	11.0	11.0	0.0	0.0	0.0 1.0 3 * mod 3
12120803	0.0	11.0	11.0	0.0	0.0	0.0 1.0 4 * mod 3
12120804	0.0	11.0	11.0	0.0	0.0	0.0 1.0 5 * mod 3

 * reactor vessel bottom station 67.7

12200000	1	11	1	1	0.0	
12200100	0	1				
12200101	10	0.092				
12200201	5	10				
12200301	0.0	10				
12200401	558.0	11				
12200501	220010000	0	1	0	1.68	1
12200601	-939	0	3949	0	1.68	1
12200701	0	0.0	0.0	0.0	0.0	1
12200801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3
12200901	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3

 * flow skirt - core filler assembly station 96.44 to 261.13

12250000	7	11	2	1	0.3	
12250100	0	1				
12250101	10	0.38				
12250201	4	10				
12250301	0.0	10				
12250401	558.0	11				
12250501	225010000	0	1	1	0.52	1
12250502	230010000	0	1	1	0.559	2
12250503	230020000	0	1	1	0.559	3
12250504	230030000	0	1	1	0.657	4
12250505	240010000	0	1	1	1.118	5
12250506	245010000	0	1	1	0.42	6
12250507	246010000	0	1	1	0.35	7
12250601	0	0	0	1	0.52	1
12250602	0	0	0	1	0.559	2
12250603	0	0	0	1	0.559	3
12250604	0	0	0	1	0.657	4
12250605	0	0	0	1	1.118	5
12250606	0	0	0	1	0.42	6
12250607	0	0	0	1	0.35	7
12250701	0	0.0	0.0	0.0	0.0	7
12250801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3
12250802	0.0	11.0	11.0	0.0	0.0	0.0 1.0 3 * mod 3
12250803	0.0	11.0	11.0	0.0	0.0	0.0 1.0 4 * mod 3
12250804	0.0	11.0	11.0	0.0	0.0	0.0 1.0 5 * mod 3
12250805	0.0	11.0	11.0	0.0	0.0	0.0 1.0 6 * mod 3
12250806	0.0	11.0	11.0	0.0	0.0	0.0 1.0 7 * mod 3

 * lower core support structure station 96.44 to 116.91
 * includes core support barrel lip , lower core support
 * structure , and fuel module lower end boxes

12260000	1	7	2	1	0.282	
12260100	0	1				
12260101	6	0.3				
12260201	4	6				
12260301	0.0	6				
12260401	558.0	7				
12260501	225010000	0	1	1	0.52	1
12260601	0	0	0	1	0.52	1
12260701	0	0.0	0.0	0.0	0.0	1
12260801	0.0	11.0	11.0	0.0	0.0	0.0 1.0 1 * mod 3

```

*****
* active core station 116.91 to 182.94
*****
12300000 3      10      2      1      0.0
12300100 0      1
12300101 5      4.647e-3
12300102 1      4.742e-3
12300103 3      5.359e-3
12300201 1      5
12300202 2      6
12300203 3      9
12300301 1.0    5
12300302 0.0    9
12300401 558.0  10
12300501 0      0      0      1      725.1  3
12300601 230010000 0      1      1      725.1  1
12300602 230020000 0      1      1      725.1  2
12300603 230030000 0      1      1      725.1  3
12300701 1000    0.41209 0.0    0.0    1
12300702 1000    0.44565 0.0    0.0    2
12300703 1000    0.14226 0.0    0.0    3
12300901 0.0124 11.0  11.0  0.0  0.0  0.0  0.0  1.0 3 *mod 3
*****
* upper core support structure station 190.5 to 234.5
*****
12400000 1      7      2      1      0.282
12400100 0      1
12400101 6      0.31
12400201 4      6
12400301 0.0    6
12400401 558.0  7
12400501 240010000 0      1      1      1.118  1
12400601 0      0      0      1      1.118  1
12400701 0      0.0    0.0    0.0    1
12400801 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 1 *mod 3
*****
* fuel modules station 187.6 to 258.4
*****
12460000 1      5      1      1      0.0
12460100 0      1
12460101 4      0.01
12460201 4      4
12460301 0.0    4
12460401 558.0  5
12460501 245010000 0      1      1      1.8    1
12460601 246010000 0      1      1      1.8    1
12460701 0      0.0    0.0    1.8    1
12460801 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 1 *mod 3
12460901 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 1 *mod 3
*****
* core support barrel - upper plenum lower volume
* station 264 to 297.6
* reactor vessel not modelled above bottom of nozzles
* the vessel to filler gap is assumed to insulate the vessel
* from the fillers. the vessel to filler gap is not modelled
* at this elevation.

```

```

*****
12500000 1      11      2      1      0.381
12500100 0      1
12500101 10     0.419
12500201 5      10
12500301 0.0    10
12500401 558.0  11
12500501 250010000 0      1      1      0.854  1
12500601 0      0      0      1      0.854  1
12500701 0      0.0    0.0    0.0    1
12500801 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 1 *mod 3
*****
* internals upper plenum
*****
12510000 2      5      1      1      0.0
12510100 0      1
12510101 4      0.005
12510201 4      4
12510301 0.0    4
12510401 558.0  5
12510501 250010000 0      1      1      1.0    1
12510502 250010000 0      1      1      1.0    2
12510601 0      0      0      1      1.0    2
12510701 0      0.0    0.0    0.0    2
12510801 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 2 *mod 3
*****
* core support barrel - upper plenum top volume
* station 297.6 to 325
* reactor vessel not modelled above bottom of nozzles
* the vessel to filler gap is assumed to insulate the vessel
* from the fillers. the vessel to filler gap is not modelled
* at this elevation.
*****
12501000 1      21      2      1      0.381
12501100 0      1
12501101 20     0.728
12501201 5      20
12501301 0.0    20
12501401 558.0  21
12501501 250010000 0      1      1      0.712  1
12501601 0      0      0      1      0.712  1
12501701 0      0.0    0.0    0.0    1
12501801 0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0 1 *mod 3
*****
* upper head top plate station 325
*****
12550000 1      21      1      1      0.0
12550100 0      1
12550101 20     0.474
12550201 5      20
12550301 0.0    20
12550401 558.0  21
12550501 250010000 0      1      1      0.712  1
12550601 -939    0      3949  1      0.712  1
12550701 0      0.0    0.0    0.0    1

```

```

12550801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
* broken loop hot leg piping heat structures
*****
13150000 2 11 2 1 0.0515
13150100 0 1
13150101 10 0.0705
13150201 4 10
13150301 0.0 10
13150401 540.0 11
13150501 315010000 0 1 1 0.4054 1
13150502 315020000 0 1 1 0.5265 2
13150601 -939 0 3979 1 0.4054 1
13150602 -939 0 3979 1 0.5265 2
13150701 0 0 0 0 0 2
13150801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
13150802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
*****13151000 1 11 2 1
0.0550
13151100 0 1
13151101 10 0.0705
13151201 4 10
13151301 0.0 10
13151401 540.0 11
13151501 315090000 0 1 1 0.0120357 1
13151601 -939 0 3979 1 0.0120357 1
13151701 0 0 0 0 0 1
13151801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
13152000 1 11 2 1 0.0660
13152100 0 1
13152101 10 0.0840
13152201 4 10
13152301 0.0 10
13152401 540.0 11
13152501 315110000 0 1 1 0.00836 1
13152601 -939 0 3979 1 0.00836 1
13152701 0 0 0 0 0 1
13152801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
13153000 6 11 2 1 0.1835
13153100 0 1
13153101 10 0.2285
13153201 4 10
13153301 0.0 10
13153401 540.0 11
13153501 315030000 10000 1 1 0.108 6
13153601 -939 0 3979 1 0.108 6
13153701 0 0 0 0 0 6
13153801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 6 * mod 3
*****
13154000 1 11 2 1 0.1285
13154100 0 1
13154101 10 0 1620
13154201 4 10
13154301 0.0 10

```

```

13154401 540.0 11
13154501 315120000 0 1 1 0.0525 1
13154601 -939 0 3979 1 0.0525 1
13154701 0 0 0 0 0 1
13154801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
13155000 1 11 2 1 0.1420
13155100 0 1
13155101 10 0.1780
13155201 4 10
13155301 0.0 10
13155401 540.0 11
13155501 315100000 0 1 1 0.0489057 1
13155601 -939 0 3979 1 0.0489057 1
13155701 0 0 0 0 0 1
13155801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
* nozzle piping
*****
13000000 3 11 2 1 0.1420
13000100 0 1
13000101 10 0.1780
13000201 4 10
13000301 0.0 10
13000401 540.0 11
13000501 300010000 0 1 1 0.876 1
13000502 305010000 0 1 1 0.698 2
13000503 310010000 0 1 1 1.424 3
13000601 -939 0 3979 1 0.876 1
13000602 -939 0 3979 1 0.698 2
13000603 -939 0 3979 1 1.424 3
13000701 0 0 0 0 0 3
13000801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
13000802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
13000803 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 3 * mod 3
*****
* broken loop cold leg
*****
* nozzle piping
*****
13350000 3 11 2 1 0.1420
13350100 0 1
13350101 10 0.1780
13350201 4 10
13350301 0.0 10
13350401 540.0 11
13350501 335010000 0 1 1 0.7495 1
13350502 340010000 0 1 1 0.698 2
13350503 345010000 0 1 1 0.974 3
13350601 -939 0 3949 1 0.7495 1
13350602 -939 0 3949 1 0.698 2
13350603 -939 0 3949 1 0.974 3
13350701 0 0 0 0 0 3
13350801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
13350802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
13350803 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 3 * mod 3

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*****
13501000 1 11 2 1 0.0550
13501100 0 1
13501101 10 0.1780
13501201 4 10
13501301 0.0 10
13501401 540.0 11
13501501 350010000 0 1 1 0.488 1
13501601 -939 0 3949 1 0.488 1
13501701 0 0 0 0 1
13501801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
13502000 1 11 2 1 0.0865
13502100 0 1
13502101 10 0.1095
13502201 4 10
13502301 0.0 10
13502401 540.0 11
13502501 350020000 0 1 1 1.6085 1
13502601 -939 0 3949 1 1.6085 1
13502701 0 0 0 0 1
13502801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
* reflow assist piping and valves [rabvs]
*****
13700000 4 11 2 1 0.111
13700100 0 1
13700101 10 0.1365
13700201 4 10
13700301 0.0 10
13700401 540.0 11
13700501 370010000 0 1 1 2.00 1
13700502 375010000 0 1 1 1.10567 2
13700503 380010000 0 1 1 1.101804 3
13700504 385010000 0 1 1 3.04201 4
13700601 -939 0 3979 1 2.00 1
13700602 -939 0 3979 1 1.10567 2
13700603 -939 0 3949 1 1.101804 3
13700604 -939 0 3949 1 3.04201 4
13700701 0 0 0 0 4
13700801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
13700802 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 2 * mod 3
13700803 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 3 * mod 3
13700804 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 4 * mod 3
*****
* pressurizer heat structures
*****
* vessel bottom
*-----1-----1-----1-----1-----1-----1-----
14151000 1 11 1 1 0.0
14151100 0 1
14151101 10 0.0762
14151201 5 10
14151301 0.0 10
14151401 617.0 11
14151501 415010000 0 1 1 0.362 1

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14151601 -939 0 3969 1 0.362 1
14151701 0 0 0 0 1
14151801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*-----1-----1-----1-----1-----1-----1-----
* vessel sides - large diameter section
*-----1-----1-----1-----1-----1-----1-----
14152000 7 11 2 1 0.42291
14152100 0 1
14152101 10 0.49911
14152201 5 10
14152301 0.0 10
14152401 617.0 11
14152501 415010000 0 1 1 0.224 1
14152502 415020000 10000 1 1 0.403 3
14152503 415040000 10000 1 1 0.207 5
14152504 415060000 10000 1 1 0.1705 7
14152601 -939 0 3969 1 0.224 1
14152602 -939 0 3969 1 0.403 3
14152603 -939 0 3969 1 0.207 5
14152604 -939 0 3969 1 0.1705 7
14152701 0 0 0 0 7
14152801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 7 * mod 3
*-----1-----1-----1-----1-----1-----1-----
* vessel sides - small diameter section
*-----1-----1-----1-----1-----1-----1-----
14162000 1 11 2 1 0.2032
14162100 0 1
14162101 10 0.3683
14162201 5 10
14162301 0.0 10
14162401 617.0 11
14162501 415080000 0 1 1 0.118 1
14162601 -939 0 3969 1 0.118 1
14162701 0 0 0 0 1
14162801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3
*****
* pressurizer heaters
*****
14172000 12 9 2 1 0.0
14172100 0 1
14172101 3 4.0132e-3
14172102 2 4.3942e-3
14172103 1 5.6642e-3
14172104 2 8.3820e-3
14172201 7 3
14172202 8 5
14172203 7 6
14172204 4 8
14172301 0.0 3
14172302 1.0 5
14172303 0.0 8
14172401 617.6 9
14172501 0 0 0 1 0.6096 12
14172601 415020000 0 1 1 0.6096 12
14172701 417 1.0 0.0 0.0 9 *cycli
14172702 418 1.0 0.0 0.0 12 *backu

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20100113 1.69982e3 2.391875
20100114 1.97759e3 2.289762
20100115 2.25537e3 2.307069
20100116 2.53315e3 2.433413
20100117 2.81093e3 2.661870
20100118 3.08871e3 2.994171
*-----1-----1-----1-----1-----1-----1-----
* gap - thermal conductivity
*-----1-----1-----1-----1-----1-----1-----
20100201 273.15 0.14
20100202 590.0 0.24
20100203 810.0 0.29
20100204 1090.0 0.36
20100205 1370.0 0.42
20100206 3260.0 0.75
*-----1-----1-----1-----1-----1-----1-----
* zircaloy-4 - thermal conductivity from matpro
*-----1-----1-----1-----1-----1-----1-----
20100301 380.4 13.6
20100302 469.3 14.6
20100303 577.6 15.8
20100304 685.9 17.3
20100305 774.8 18.4
20100306 872.0 19.8
20100307 973.2 21.8
20100308 1073.2 23.2
20100309 1123.2 25.4
20100310 1152.3 24.2
20100311 1232.2 25.5
20100312 1331.2 26.6
20100313 1404.2 28.2
20100314 1576.2 33.0
20100315 1625.2 36.7
20100316 1755.2 41.2
20100317 2273.2 55.0
*-----1-----1-----1-----1-----1-----1-----
* s-steel - thermal conductivity
*-----1-----1-----1-----1-----1-----1-----
20100401 273.15 12.98
20100402 1199.82 25.1
*-----1-----1-----1-----1-----1-----1-----
* inconel-600 - thermal conductivity
*-----1-----1-----1-----1-----1-----1-----
20100601 366.5 13.85
20100602 477.6 15.92
20100603 588.7 18.17
20100604 700.0 20.42
20100605 810.9 22.50
20100606 922.0 24.92
20100607 1033.2 26.83
20100608 1144.3 29.42
20100609 1477.6 36.06
*-----1-----1-----1-----1-----1-----1-----
* uo2 - volumetric heat capacity
*-----1-----1-----1-----1-----1-----1-----
20100151 2.73150e2 2.310427e6

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20100152 3.23150e2 2.571985e6
20100153 3.73150e2 2.746357e6
20100154 6.7315e2 3.138694e6
20100155 1.37315e3 3.443844e6
20100156 1.77315e3 3.531030e6
20100157 1.97315e3 3.792588e6
20100158 2.17315e3 4.228518e6
20100159 2.37315e3 4.882412e6
20100160 2.67315e3 6.015829e6
20100161 2.77315e3 6.320980e6
20100162 2.87315e3 6.582538e6
20100163 2.97315e3 6.713317e6
20100164 3.11315e3 6.800503e6
20100165 4.69982e3 6.800503e6
*-----1-----1-----1-----1-----1-----1-----
* gap - volumetric heat capacity
*-----1-----1-----1-----1-----1-----1-----
20100251 273.15 5.4
20100252 3260.0 5.4
*-----1-----1-----1-----1-----1-----1-----
* zircaloy-4 - volumetric heat capacity from matpro
*-----1-----1-----1-----1-----1-----1-----
20100351 255.4 1.904e6
20100352 1077.6 2.312e6
20100353 1185.9 5.712e6
20100354 1248.4 2.311e6
20100355 2199.8 2.312e6
*-----1-----1-----1-----1-----1-----1-----
* s-steel - volumetric heat capacity
*-----1-----1-----1-----1-----1-----1-----
20100451 273.15 3.83e6
20100452 366.5 3.83e6
20100453 1366.5 5.376e6
*-----1-----1-----1-----1-----1-----1-----
* inconel-600 - volumetric heat capacity
*-----1-----1-----1-----1-----1-----1-----
20100651 366.5 3.908+6
20100652 477.6 4.084+6
20100653 588.7 4.260+6
20100654 700.0 4.436+6
20100656 810.9 4.665+6
20100657 922.0 4.929+6
20100658 1033.2 5.105+6
20100659 1477.6 5.727+6
*-----1-----1-----1-----1-----1-----1-----
* magnesium oxide - thermal conductivity
*-----1-----1-----1-----1-----1-----1-----
20100701 373.15 0.2451
20100702 422.04 0.2405
20100703 477.59 0.2352
20100704 533.15 0.2300
20100705 588.71 0.2249
20100706 644.26 0.2196
20100707 699.82 0.2143
20100708 755.37 0.2091
20100709 810.93 0.2039

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20500401 0.0 9.90000-2 rho 135010000
20500402 1.83732-2 rho 140010000
20500403 6.33000-2 rho 145010000
20500404 3.14844-2 rho 150010000
20500405 9.90000-2 rho 165010000
20500406 1.88124-2 rho 170010000
20500407 3.54406-2 rho 175010000
20500408 3.88642-2 rho 175020000
20500409 4.44434-2 rho 180010000
20500410 9.26274-2 rho 185010000
*-----1-----1-----1-----1-----1-----
* reactor
*-----1-----1-----1-----1-----1-----
20500500 pcsvol5 sum 1.0 0.0 1
20500501 0.0 2.66400-1 rho 215010000
20500502 2.92300-1 rho 220010000
20500503 1.30000-1 rho 225010000
20500504 9.53095-2 rho 230010000
20500505 9.53095-2 rho 230020000
20500506 0.1120185 rho 230030000
20500507 8.38500-3 rho 235010000
20500508 8.38500-3 rho 235020000
20500509 9.35500-3 rho 235030000
20500510 3.32046-1 rho 240010000
20500511 9.61020-2 rho 245010000
20500512 1.28100-1 rho 246010000
20500513 2.45952-1 rho 250010000
20500514 1.73728-1 rho 250010000
*-----1-----1-----1-----1-----1-----
* hot leg broken loop
*-----1-----1-----1-----1-----1-----
20500600 pcsvol6 sum 1.0 0.0 1
20500601 0.0 5.55384-2 rho 300010000
20500602 4.42532-2 rho 305010000
20500603 6.68000-2 rho 310010000
20500604 3.38914-3 rho 315010000
20500605 4.40154-3 rho 315020000
20500606 3.90960-2 rho 315030000
20500607 1.82736-1 rho 315040000
20500608 9.17460-2 rho 315050000
20500609 9.17460-2 rho 315060000
20500610 1.82736-1 rho 315070000
20500611 3.90960-2 rho 315080000
20500612 1.62000-2 rho 315090000
20500613 6.48000-2 rho 315100000
20500614 .01539912 rho 315110000
20500615 3.50175-2 rho 315120000
20500616 8.54764-2 rho 370010000
20500617 8.58000-2 rho 375010000
*-----1-----1-----1-----1-----1-----
* cold leg broken loop
*-----1-----1-----1-----1-----1-----
20500700 pcsvol7 sum 1.0 0.0 1
20500701 0.0 4.75183-2 rho 335010000
20500702 4.42532-2 rho 340010000
20500703 6.17516-2 rho 345010000

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20500704 5.41000-3 rho 350010000
20500705 8.55000-2 rho 380010000
20500706 1.18030-1 rho 385010000
*-----1-----1-----1-----1-----1-----
* pressurizer
*-----1-----1-----1-----1-----1-----
20500800 pcsvol8 sum 1.0 0.0 1
20500801 0.0 5.00250-3 rho 400010000
20500802 5.00250-3 rho 405010000
20500803 8.10880-2 rho 415010000
20500804 2.27695-1 rho 415020000
20500805 2.27695-1 rho 415030000
20500806 1.16955-1 rho 415040000
20500807 1.16955-1 rho 415050000
20500808 7.94530-2 rho 415060000
20500809 7.94530-2 rho 415070000
20500810 1.53400-2 rho 415080000
*-----1-----1-----1-----1-----1-----
* reactor vessel downcomer mass
*-----1-----1-----1-----1-----1-----
20500900 dwnrmss sum 1.0 0.0 1
20500901 0.0 8.55000-2 rho 200010000
20500902 1.10000-1 rho 205010000
20500903 1.36036-1 rho 210010000
20500904 1.36036-1 rho 210020000
20500905 1.36036-1 rho 210030000
20500906 1.36036-1 rho 210040000
20500907 1.23426-2 rho 223010000
20500908 2.78874-2 rho 223020000
20500909 2.78874-2 rho 223030000
20500910 2.78874-2 rho 223040000
20500911 2.78874-2 rho 223050000
20500912 1.04796-2 rho 223060000
20500913 1.04796-2 rho 223070000
*-----1-----1-----1-----1-----1-----
* pcs mass
*-----1-----1-----1-----1-----1-----
20501000 pcsmass sum 1.0 0.0 1
20501001 0.0 1.0 cntrlvar 41
20501002 1.0 cntrlvar 42
20501003 1.0 cntrlvar 43
20501004 1.0 cntrlvar 4
20501005 1.0 cntrlvar 5
20501006 1.0 cntrlvar 6
20501007 1.0 cntrlvar 7
20501008 1.0 cntrlvar 8
20501009 1.0 cntrlvar 9
*-----1-----1-----1-----1-----1-----
* break energy computer
*-----1-----1-----1-----1-----1-----
20542500 pvfstm div 1.0 0.0 1
20542501 rhof 420010000 p 420010000
*
20542600 hfstm sum 1.0 0.0 1
20542601 0.0 1.0 uf 420010000
20542602 1.0 cntrlvar 425

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20511307      1.86543      htrnr      212000401
20511308      1.91724      htrnr      212000501
20511309      1.68000      htrnr      220000101
20511310      0.71200      htrnr      255000101
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   heat loss from pzs
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511400 pzrheat  sum      1.0      0.0      1
20511401 0.0      0.362      htrnr      415100101
20511402      0.702464      htrnr      415200101
20511403      1.26381      htrnr      415200201
20511404      1.26381      htrnr      415200301
20511405      0.649152      htrnr      415200401
20511406      0.649152      htrnr      415200501
20511407      0.534688      htrnr      415200601
20511408      0.534688      htrnr      415200701
20511409      0.273063      htrnr      416200101
20511410      0.130000      htrnr      420100101
20511411      0.273063      htrnr      420200101
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   heat loss from s/g
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511500 sgheat  sum      1.0      0.0      1
20511501 0.0      3.5343      htrnr      530000101
20511502      3.5343      htrnr      530000201
20511503      3.33022      htrnr      530000301
20511504      3.33022      htrnr      530000401
20511505      2.40258      htrnr      530000501
20511506      3.29404      htrnr      530000601
20511507      3.29404      htrnr      530000701
20511508      3.29404      htrnr      530000801
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   total heat loss from major components
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511600 tothead  sum      1.0      0.0      1
20511601 0.0      1.0      cntrlvar  113
20511602      1.0      cntrlvar  114
20511603      1.0      cntrlvar  115
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   heat loss from broken loop hot leg
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511700 blhlheat sum      1.0      0.0      1
20511701 0.0      0.97972      htrnr      300000101
20511702      0.78065      htrnr      300000201
20511703      1.59260      htrnr      300000301
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   heat loss from broken loop cold leg
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511800 blclheat sum      1.0      0.0      1
20511801 0.0      0.83825      htrnr      335000101
20511802      0.78065      htrnr      335000201
20511803      1.0893      htrnr      335000301
*-----1-----1-----1-----1-----1-----1-----1-----1-----
*   heat loss from rabs piping
*-----1-----1-----1-----1-----1-----1-----1-----1-----
20511900 rabheat  sum      1.0      0.0      1

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20511901	0.0	1.7153	htrnr	370000101
20511902		0.94828	htrnr	370000201
20511903		0.94497	htrnr	370000301
20511904		2.6090	htrnr	370000401
*-----1-----1-----1-----1-----1-----				
* heat loss from intact loop hot leg				
*-----1-----1-----1-----1-----1-----				
20512000	ilclheat	sum	1.0	0.0 1
20512001	0.0	1.7193	htrnr	100100101
20512002		1.8275	htrnr	100100201
20512003		0.69677	htrnr	100100301
20512004		1.6088	htrnr	100100401
20512005		0.90304	htrnr	100200101
20512006		1.8855	htrnr	100400101
*-----1-----1-----1-----1-----1-----				
* heat loss from intact loop cold leg				
*-----1-----1-----1-----1-----1-----				
20512100	ilclheat	sum	1.0	0.0 1
20512101	0.0	0.77058	htrnr	100100501
20512102		0.62519	htrnr	100100601
20512103		0.84999	htrnr	100100701
20512104		0.55540	htrnr	100100801
20512105		0.62519	htrnr	100100901
20512106		0.68558	htrnr	100101001
20512107		0.78400	htrnr	100101101
20512108		1.6340	htrnr	100101201
20512109		0.69769	htrnr	100200201
20512110		0.85765	htrnr	100300101
20512111		0.39195	htrnr	100300201
20512112		0.43054	htrnr	100300301
20512113		1.2079	htrnr	100300401
20512114		0.86023	htrnr	100300501
20512115		0.39195	htrnr	100300601
20512116		0.44083	htrnr	100300701
20512117		1.8855	htrnr	100400201
*-----1-----1-----1-----1-----1-----				
* total heat loss to environment				
*-----1-----1-----1-----1-----1-----				
20512200	sumhtls	sum	1.0	0.0 1
20512201	0.0	1.0	cntrlvar	116
20512202		1.0	cntrlvar	117
20512203		1.0	cntrlvar	118
20512204		1.0	cntrlvar	119
20512205		1.0	cntrlvar	120
20512206		1.0	cntrlvar	121
*-----1-----1-----1-----1-----1-----				
* metal heating in p2r				
*-----1-----1-----1-----1-----1-----				
20512300	p2rmtht	sum	1.0	0.0 1
20512301	0.0	0.3620	htrnr	415100100
20512302		0.59522	htrnr	415200100
20512303		1.07086	htrnr	415200200
20512304		1.07086	htrnr	415200300
20512305		0.550045	htrnr	415200400
20512306		0.550045	htrnr	415200500
20512307		0.453056	htrnr	415200600

20512308		0.453056	htrnr	415200700
20512309		0.150656	htrnr	416200100
20512310		0.13000	htrnr	420100100
20512311		0.150656	htrnr	420200100
*-----1-----1-----1-----1-----1-----				
* metal heating in reactor vessel (1st part)				
*-----1-----1-----1-----1-----1-----				
20525100	rv1	sum	1.0	0.0 1
20525101	0.0	1.05331	htrnr	200000100
20525102		0.79000	htrnr	200100101
20525103		1.01501	htrnr	200100201
20525104		2.29335	htrnr	200100301
20525105		2.29335	htrnr	200100401
20525106		2.29335	htrnr	200100501
20525107		2.29335	htrnr	200100601
20525108		1.33475	htrnr	205000100
20525109		1.93518	htrnr	205000101
20525110		2.82907	htrnr	210000100
20525111		2.82907	htrnr	210000200
20525112		2.82907	htrnr	210000300
20525113		2.82907	htrnr	210000400
20525114		1.06311	htrnr	210000500
20525115		1.09265	htrnr	210000600
20525116		4.37241	htrnr	210000101
20525117		4.37241	htrnr	210000201
20525118		4.37241	htrnr	210000301
20525119		4.37241	htrnr	210000401
20525120		1.64308	htrnr	210000501
*-----1-----1-----1-----1-----1-----				
20525200	rv2	sum	1.0	0.0 1
20525201	0.0	1.68872	htrnr	210000601
20525202		1.95223	htrnr	211000100
20525203		4.41094	htrnr	211000200
20525204		2.99281	htrnr	211000300
20525205		1.41813	htrnr	212000100
20525206		4.41094	htrnr	212000200
20525207		4.41094	htrnr	212000300
20525208		1.65755	htrnr	212000400
20525209		1.70360	htrnr	212000500
20525210		1.6800	htrnr	220000100
*-----1-----1-----1-----1-----1-----				
20525300	rv3	sum	1.0	0.0 1
20525301	0.0	0.695734	htrnr	225000700
20525302		0.921366	htrnr	226000100
20525303		1.98094	htrnr	240000100
20525304		1.80000	htrnr	246000100
20525305		1.80000	htrnr	246000101
20525306		2.04439	htrnr	250000100
20525307		1.00000	htrnr	251000100
20525308		1.00000	htrnr	251000200
20525309		1.70445	htrnr	250100100
20525310		0.71200	htrnr	255000100
20525311		1.68000	htrnr	220000101
20525312		0.980177	htrnr	225000100
20525313		1.05369	htrnr	225000200
20525314		1.05369	htrnr	225000300


```

20525315      1.23842 htrnr  225000400
20525316      2.10738 htrnr  225000500
20525317      0.791681 htrnr  225000600
20525318      1.0      cntrlvar 251
20525319      1.0      cntrlvar 252
*-----1-----1-----1-----1-----1-----1-----
* metal heating in broken loop (1st part)
*-----1-----1-----1-----1-----1-----1-----
20512600 bklpmht sum      1.0      0.0      1
20512601 0.0      0.157878 htrnr  300000100
20512602      0.622764 htrnr  300000200
20512603      1.27051 htrnr  300000300
20512616      0.668713 htrnr  335000100
20512617      0.622764 htrnr  335000200
20512618      0.869015 htrnr  335000300
*-----1-----1-----1-----1-----1-----1-----
* metal heating in broken loop
*-----1-----1-----1-----1-----1-----1-----
20512700 bklpmt sum      1.0      0.0      1
20512701 0.0      1.39487 htrnr  370000100
20512702      0.771131 htrnr  370000200
20512703      0.768435 htrnr  370000300
20512704      2.12160 htrnr  370000400
20512705      1.0      cntrlvar 126
*-----1-----1-----1-----1-----1-----1-----
* metal heating in intact loop hot leg
*-----1-----1-----1-----1-----1-----1-----
20512800 ilhlpmht sum      1.0      0.0      1
20512801 0.0      1.3716 htrnr  100100100
20512802      1.45787 htrnr  100100200
20512803      0.55548 htrnr  100100300
20512804      1.28345 htrnr  100100400
20512805      0.72288 htrnr  100200100
20512806      1.4772 htrnr  100400100
*-----1-----1-----1-----1-----1-----1-----
* metal heating in intact loop cold leg
*-----1-----1-----1-----1-----1-----1-----
20512900 ilclmht sum      1.0      0.0      1
20512901 0.0      0.614734 htrnr  100100500
20512902      0.498747 htrnr  100100600
20512903      0.678081 htrnr  100100700
20512904      0.443073 htrnr  100100800
20512905      0.498747 htrnr  100100900
20512906      0.546926 htrnr  100101000
20512907      0.625441 htrnr  100101100
20512908      1.30352 htrnr  100101200
20512909      0.558497 htrnr  100200200
20512910      0.678584 htrnr  100300100
20512911      0.310113 htrnr  100300200
20512912      0.34069 htrnr  100300300
20512913      0.955718 htrnr  100300400
20512914      0.680620 htrnr  100300500
20512915      0.310113 htrnr  100300600
20512916      0.348792 htrnr  100300700
20512917      1.4772 htrnr  100400200
*-----1-----1-----1-----1-----1-----1-----

```

```

* metal heating in broken loop simulators
*-----1-----1-----1-----1-----1-----1-----
20513000 blhlsim sum      1.0      0.0      1
20513001 0.0      0.1312 htrnr  315000100
20513002      0.1703 htrnr  315000200
20513003      0.0042 htrnr  315100100
20513004      0.00347 htrnr  315200100
20513005      0.12452 htrnr  315300100
20513006      0.12452 htrnr  315300200
20513007      0.12452 htrnr  315300300
20513008      0.12452 htrnr  315300400
20513009      0.12452 htrnr  315300500
20513010      0.12452 htrnr  315300600
20513011      0.04239 htrnr  315400100
20513012      0.04363 htrnr  315500100
*-----1-----1-----1-----1-----1-----1-----
* metal heating in steam generator
*-----1-----1-----1-----1-----1-----1-----
20555100 sgmth1 sum      1.0      0.0      1
20555101 0.0      1.47943 htrnr  500000100
20555102      1.47943 htrnr  500000200
20555103      0.291097 htrnr  500000300
20555104      1.52566 htrnr  500000101
20555105      1.52566 htrnr  500000201
20555106      0.300194 htrnr  500000301
20555107      0.615526 htrnr  515000100
20555108      2.88042 htrnr  515000200
20555109      2.88042 htrnr  515000300
20555110      2.88042 htrnr  515000400
20555111      0.627655 htrnr  515000101
20555112      2.93718 htrnr  515000201
20555113      2.93718 htrnr  515000301
20555114      2.93718 htrnr  515000401
*
20555200 sgmth2 sum      1.0      0.0      1
20555201 0.0      3.40507 htrnr  530000100
20555202      3.40507 htrnr  530000200
20555203      3.20846 htrnr  530000300
20555204      3.30846 htrnr  530000400
20555205      2.31474 htrnr  530000500
20555206      3.17360 htrnr  530000600
20555207      3.17360 htrnr  530000700
20555208      3.17360 htrnr  530000800
*-----1-----1-----1-----1-----1-----1-----
* pcs-tubesheet heat transfer
*-----1-----1-----1-----1-----1-----1-----
20513200 pcstub sum      1.0      0.0      1
20513201 0.0      56.4226 htrnr  115100100
20513202      56.4226 htrnr  115100200
20513203      0.157962 htrnr  115200100
20513204      0.157962 htrnr  115200200
*-----1-----1-----1-----1-----1-----1-----
* tubesheet-scs heat transfer
*-----1-----1-----1-----1-----1-----1-----
20513300 tushscs sum      1.0      0.0      1
20513301 0.0      0.157962 htrnr  115200101

```

2 of 2


```

*-----|-----|-----|-----|-----|-----|-----|
20562100 rvhx/v mult 1.0 0.0 1
20562101 cntrlvar 620
*****
* total massless energy flows from pcs excluding qcore and qsg
*****
20562200 qstruc sum 1.0 0.0 1
20562201 0.0 1.0 cntrlvar 123 * przr
20562202 1.0 cntrlvar 620 * rv
20562203 1.0 cntrlvar 171 * bl
20562204 1.0 cntrlvar 128 * ilhl
20562205 1.0 cntrlvar 129 * ilcl
20562300 qstruc/v mult 0.126646 0.0 1
20562301 cntrlvar 622
*****
* sum of all massless energy flows from pcs
*****
20562400 de/dt sum 1.0 0.0 1
20562401 0.0 1.0 cntrlvar 111 * core
20562402 1.0 cntrlvar 112 * sg
20562403 1.0 cntrlvar 622 * structure
20562404 1.0 cntrlvar 166 * pumps
20562500 de/dt/vv mult 0.126646 0.0 1
20562501 cntrlvar 624
*****
* sum of mass flow energy flows and massless energy flows
*****
20562600 dtqflo sum 1.0 0.0 1
20562601 0.0 1.0 cntrlvar 624 * de/dt
20562602 -1.0 cntrlvar 433 * porv
20562700 dtqf/v mult 0.126646 0.0 1
20562701 cntrlvar 626
*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*$$$*
*
*-----|-----|-----|-----|-----|-----|-----|
* primary coolant pump speed controllers
*-----|-----|-----|-----|-----|-----|-----|
* calculate mass flow error
*-----|-----|-----|-----|-----|-----|-----|
20590100 msserr sum 1.0 0.0 1
20590101 479.30 -1.0 mflowj 100010000
*-----|-----|-----|-----|-----|-----|-----|
* pump 1 speed
*-----|-----|-----|-----|-----|-----|-----|
20590200 pcp1spd integral 0.34482 333.7236 1
20590201 cntrlvar 901
*-----|-----|-----|-----|-----|-----|-----|
* pcp1 pump velocity table
*-----|-----|-----|-----|-----|-----|-----|
1356100 508 cntrlvar 902
1356101 0.0 0.0
1356102 369.0 369.0
*-----|-----|-----|-----|-----|-----|-----|
* modify pcp1 pump data
*-----|-----|-----|-----|-----|-----|-----|
1350301 0 0 0 -1 0 504 0

```

```

*-----|-----|-----|-----|-----|-----|-----|
* pump 2 speed
*-----|-----|-----|-----|-----|-----|-----|
20590300 pcp2spd integral 0.34482 331.9524 1
20590301 cntrlvar 901
*-----|-----|-----|-----|-----|-----|-----|
* pcp2 pump velocity table
*-----|-----|-----|-----|-----|-----|-----|
1656100 508 cntrlvar 903
1656101 0.0 0.0
1656102 369.0 369.0
*-----|-----|-----|-----|-----|-----|-----|
* modify pcp2 pump data
*-----|-----|-----|-----|-----|-----|-----|
1650301 135 135 135 -1 0 504 0
*-----|-----|-----|-----|-----|-----|-----|
* pressurizer spray valve controller
*-----|-----|-----|-----|-----|-----|-----|
* spray valve
*-----|-----|-----|-----|-----|-----|-----|
4070000 sprlv valve
4070101 406010000 420010000 3.3451e-4 1.5432e01
1.5432e01 000100
4070201 0 .00000000 .00000000 0.0
4070300 srvvlv
4070301 904 999
*-----|-----|-----|-----|-----|-----|-----|
* spray valve position calculator
*-----|-----|-----|-----|-----|-----|-----|
20590400 spray sum -1.0 0.0 1 * contin
+ 3 0.0 1.0
20590401 14.93+6 -1.0 p 420010000
*-----|-----|-----|-----|-----|-----|-----|
* position vs area table
*-----|-----|-----|-----|-----|-----|-----|
20299900 normarea
20299901 0.0 0.0
20299902 0.0001 0.0
20299903 1.0 1.0
*-----|-----|-----|-----|-----|-----|-----|
* pressurizer level control using charging and letdown
components
*-----|-----|-----|-----|-----|-----|-----|
* charging reservoir
*-----|-----|-----|-----|-----|-----|-----|
*9800000 chrg tmdpvol
*9800101 1.0 1.0 0.0 0.0 0.0 0.0
*9800102 4.0-5 0.0 00000
*9800200 3
*9800201 0.0 2.07+07 558.9
*-----|-----|-----|-----|-----|-----|-----|
* charging valve
*-----|-----|-----|-----|-----|-----|-----|
*9850000 chrg valve
*9850101 980000000 185000000 3.8e-05 0.0 0.0
000100

```

```

*9850201 0 .00000000 .00000000 0.0
*9850300 srvvlv
*9850301 905 999
*-----1-----1-----1-----
* charging valve position calculator
*-----1-----1-----1-----
*20590500 charge sum 7.7 0.0 1 *contin
*+ 3 0.0 1.0
*20590501 0.92 -1.0 cntrlvar 2
*-----1-----1-----1-----
* letdown sink
*-----1-----1-----1-----
*9900000 ltdwn tmdpvol
*9900101 1.0 1.0 0.0 0.0 0.0 0.0
*9900102 4.0-5 0.0 00000
*9900200 3
*9900201 0.0 1.4+7 558.9
*-----1-----1-----1-----
* letdown valve
*-----1-----1-----1-----
*9950000 ltdwn valve
*9950101 185000000 990000000 2.5-5 0.0 0.0
000100
*9950201 0 .00000000 .00000000 0.0
*9950300 srvvlv
*9950301 906 999
*-----1-----1-----1-----
* letdown valve position calculator
*-----1-----1-----1-----
*20590600 letdown sum -7.7 0.0 1 *contin
*+ 3 0.0 1.0
*20590601 1.10 -1.0 cntrlvar 2
*-----1-----1-----1-----1-----1-----1-----
* steam valve controller
*-----1-----1-----1-----1-----1-----1-----
* changes to steam valve
*-----1-----1-----1-----
*5500201 0 19.758 22.082 0.0
*5500300 srvvlv
*5500301 910 540
*20254000 normarea
*20254001 0.0 0.0
*20254002 0.0001 0.0
*20254003 1.0 1.0
*-----1-----1-----1-----
* compute delta t error
*-----1-----1-----1-----
*20590700 delta sum 1.0 0.0 1
*20590701 559.0 -1. tempf 185010000
*-----1-----1-----1-----
* filter delta t thru deadband
*-----1-----1-----1-----
*20590800 deadband function 1.0 0.0 1
*20590801 cntrlvar 907 908
*20290800 reac-t
*20290801 -100. -100.

```

```

*20290802 -0.25 -0.25
*20290803 -0.25 0.0
*20290804 0.25 0.0
*20290805 0.25 0.25
*20290806 100. 100.
*-----1-----1-----1-----
* integrate delta t error
*-----1-----1-----1-----
*20590900 int integral 1.0 0.0 1
*20590901 cntrlvar 908
*-----1-----1-----1-----
* steam valve position calculator
*-----1-----1-----1-----
*20591000 tcontrol sum 1.0 0.645229 0 *conti
*+ 3 0.6 0.90
*20591001 0.645229 -0.07126 cntrlvar 908
*20591002 -0.01492 cntrlvar 909
*-----1-----1-----1-----1-----1-----1-----
* simplified feed system controller
*-----1-----1-----1-----1-----1-----1-----
20591100 sglvlerr sum 1.0 0.0 1
20591101 3.09 -1.0 cntrlvar 001
20591200 feedflow sum 1.0 0.0 1
20591201 0.0 1.0 mflowj 550000000
20591202 48.4 cntrlvar 911
*-----1-----1-----1-----
* replace feed junction table
*-----1-----1-----1-----
5600200 1 0 cntrlvar 912
5600201 -100.0 25.553 0.0 0.0
5600202 -1.0 0.0 0.0 0.0
5600203 0.0 0.0 0.0 0.0
5600204 50.0 50.0 0.0 0.0

```

Appendix B Input Deck for Transient Calculation

=loft 19-1 post test analysis deck

*-----[-----]-----[-----]-----[-----]-----[-----]-----

* initial conditions
 * pcp pressure = 14.901 mpa
 * core power = 50. mw
 * pcs flow = 479.3 kg/s
 * thot = 578. k
 * tcold = 559.0 k
 *

*-----[-----]-----[-----]-----[-----]-----[-----]-----

0000100 restart transnt

0000101 run

0000102 si

*0000103 16006

0000103 6934

0000105 5. 10.

* time step control cards

*	end time	min dt	max dt	optn	mnr	mjr	rst
0000201	200.00	1.e-6	1.0	2	1	30	100
0000202	1000.0	1.e-6	1.0	2	5	300	500
0000203	2000.0	1.e-6	0.1	2	50	3000	5000
0000204	4000.0	1.e-6	0.5	2	10	1000	2000
0000205	8000.0	1.e-6	0.1	2	50	4000	5000
0000206	10000.	1.e-6	0.5	2	10	2000	2000

*

* minor edit variables

*

* pressure

*0000301	p	345010000	* pe-bl-1
0000301	p	310010000	* pe-bl-2
*0000303	p	315110000	* pe-bl-3
*0000304	p	350010000	* pe-bl-4
*0000305	p	315090000	* pe-bl-6
*0000306	p	350020000	* pe-bl-8
0000302	p	185010000	* pe-pc-1
0000303	p	100010000	* pe-pc-2
0000304	p	420010000	* porv inlet
*0000310	p	110010000	* pt-139-2,3,4
0000305	p	245010000	* pe-1up-1a,1b
0000306	p	215010000	* pe-1st-1a,b/pe-2st-1a,b
*0000313	p	200010000	* pe-1st-3a,3b
0000307	p	530010000	* pe-sgs-01
0000308	p	535010000	* pt-p4-85

* temperatures

0000309	tempf	406010000	* spray tempf
0000310	tempf	310010000	* te-bl-2a,2b,2c
0000311	tempf	100010000	* te-pc-2a,2b,2c
0000312	tempf	185010000	* te-pc-1
0000313	tempf	115030000	* te-sg-1
0000314	tempf	115100000	* te-sg-2
0000315	tempf	515070000	* te-sg-4

*0000328	tempf	415050000	* pzt volume 5
0000316	tempf	415040000	* te-139-19
*0000330	tempf	415030000	* te-139-20
*0000331	tempf	315120000	* te-p138-171
*0000332	tempf	350020000	* te-p138-170
*0000333	tempf	205010000	* te-1st-1/te-2st-1
0000317	tempf	210010000	* te-1st-2/te-2st-2
*0000335	tempf	345010000	* te-bl-1
*0000336	tempf	210030000	* te-1st-14/te-2st-14
*0000337	tempf	210040000	* te-3up-2
*0000338	tempf	245010000	* te-1up-6
*0000339	tempf	246010000	* te-2up-4
*0000340	tempf	250010000	* te-1up-3

* densities

*0000341	rho	345010000	* de-bl-1
0000318	rho	310010000	* de-bl-2
0000319	rho	185010000	* de-pc-1
0000320	rho	100010000	* de-pc-2
*0000345	rho	115120000	* de-pc-3
0000321	voidgj	400010000	* surge line density
*0000347	rho	115040000	* s/g tubes
*0000348	rho	115050000	* s/g tubes
*0000349	rho	115060000	* s/g tubes
*0000350	rho	115070000	* s/g tubes

* velocities

*0000351	voidf	100010000	* ilhl nozzle
*0000352	velf	100010000	* ilhl nozzle
*0000353	velf	115030000	* s/g inlet
*0000354	velf	400010000	* surge line
*0000355	velfj	425000000	* porv liq vel
*0000356	velg	100010000	* ilhl nozzle
*0000357	velg	115030000	* s/g inlet
*0000358	velg	400010000	* surge line
*0000359	velgj	425000000	* porv vap vel

* mass flow rates

0000322	mflowj	100010000	* ilhl nozzle
*0000361	mflowj	150010000	* pump outlet
*0000362	mflowj	185020000	* dt-rake ilcl
0000323	mflowj	400010000	* pres. surge line flow
0000324	mflowj	407000000	* pzt spray flow
0000325	mflowj	425000000	* pres. relief valve flow
0000326	mflowj	550000000	* steam flow control valve
0000327	mflowj	548000000	* aux feed
*0000369	mflowj	560000000	* main feed

* cladding temperatures center module

*0000371	httemp	230000110	* te-5h5-015
*0000372	httemp	230000210	* te-5h5-034


```

*0000373 htemp 230000310 * te-5h5-049
*****
* peak centerline temperatures
*****
*0000374 htemp 230000101 * core lower region
*0000375 htemp 230000201 * core middle region
*0000376 htemp 230000301 * core upper region
*****
* reactor kinetic parameters
*****
0000328 rktpow 0 * total reactor power
*0000378 rkfpow 0 * fission decay power
*0000379 rkgapow 0 * gamma decay power
*0000380 rkreact 0 * reactivity
*0000381 pmphead 135 * pcpl head
*0000382 pmphead 165 * pcpl2 head
0000329 mflowj 185010000
0000330 mflowj 185030000
*0000388 mflowj 200020000
0000331 pmpvel 135
*****
* control variable requests
*****
0000332 cntrlvar 001
0000333 cntrlvar 002
0000334 cntrlvar 003
0000335 cntrlvar 041
0000336 cntrlvar 042
0000337 cntrlvar 043
0000338 cntrlvar 004
0000339 cntrlvar 005
0000340 cntrlvar 006
0000341 cntrlvar 007
0000342 cntrlvar 008
0000343 cntrlvar 009
0000344 cntrlvar 010
0000345 cntrlvar 433
0000346 cntrlvar 434
0000347 cntrlvar 111
0000348 cntrlvar 112
0000349 cntrlvar 113
0000350 cntrlvar 114
0000351 cntrlvar 115
0000352 cntrlvar 116
0000353 cntrlvar 117
0000354 cntrlvar 118
0000355 cntrlvar 119
0000356 cntrlvar 120
0000357 cntrlvar 121
0000358 cntrlvar 122
0000359 cntrlvar 123
0000360 cntrlvar 251
0000361 cntrlvar 252
0000362 cntrlvar 253
0000363 cntrlvar 126
0000364 cntrlvar 127

0000365 cntrlvar 128
0000366 cntrlvar 129
0000367 cntrlvar 130
0000368 cntrlvar 551
0000369 cntrlvar 552
0000370 cntrlvar 132
0000371 cntrlvar 133
0000372 cntrlvar 170
0000373 cntrlvar 171
0000374 cntrlvar 570
0000375 cntrlvar 573
0000376 cntrlvar 153
0000377 cntrlvar 154
0000378 cntrlvar 155
0000379 cntrlvar 156
0000380 cntrlvar 157
0000381 cntrlvar 160
0000382 cntrlvar 161
0000383 cntrlvar 166
0000384 cntrlvar 167
0000385 cntrlvar 620
0000386 cntrlvar 621
0000387 cntrlvar 622
0000388 cntrlvar 623
0000389 cntrlvar 624
0000390 cntrlvar 625
0000391 cntrlvar 626
0000392 cntrlvar 627
0000393 tempg 515070000
0000394 rho 420010000
0000395 cputime 0
20800095 dt 0
20800096 dtcrnt 0
*****
*
*
* trips
*
*****
* variable trips
*****
0000501 p 100010000 le null 0 14.193103e6 l
* ecc check valve
0000502 p 600010000 ge p 185010000 20.e6 n
* accumulator check valve
0000503 p 615010000 ge p 185010000 20.e6 n
* isolation valve hot leg
0000504 time 0 lt null 0 0.0 l
* isolation valve cold leg
0000505 time 0 lt null 0 0.0 l
* qobv hot leg
0000506 time 0 lt null 0 0.0 l
* qobv cold leg
0000507 time 0 lt null 0 0.0 l
* check valve surge line pressurizer
0000508 time 0 ge null 0 0.0 l

```

```

*      pressurizer relief valve
0000509 tempf 100010000 ge null 0      597.0      1
*      steam control valve
0000510 time 0      lt null 0      0.0      1
*      boundary system valve
0000511 time 0      lt null 0      0.0      1
*      lps trip
0000512 time 0      ge null 0      10000.0      1
*      hpis trip
0000513 time 0      ge null 0      10000.0      1
*
0000520 p 530020000 gt null 0      7.103448e6 n
0000521 p 530020000 lt null 0      7.0344827e6 n
0000522 p 530020000 gt null 0      6.3448275e6 n
0000523 p 530020000 lt null 0      6.4137931e6 n
0000530 time 0      ge null 0      3600.0      n
0000531 p 530020000 gt p 547010000 0.0      n
0000536 time 0      ge null 0      10000.0      n
0000540 tempf 100010000 gt null 0      583.16      1
0000541 p 100010000 gt null 0      1.574553e7 1
0000550 time 0      ge null 0      10000.0      1
0000551 time 0      ge timeof 625      0.0      1
0000552 time 0      ge timeof 509      1580.      1
0000560 p 100010000 le null 0      13.15862e6 n
0000561 time 0      ge timeof 552      265.0      1
0000562 time 0      gt null 0      5400.0      n
0000563 cntrlvar 1      lt null 0      2.1844      n
0000564 cntrlvar 1      gt null 0      2.9464      n
0000565 time 0      ge timeof 669      966.      1
0000570 p 420010000 gt null 0      1.620058e7 n
0000571 p 420010000 lt null 0      1.606269e7 n
0000572 p 420010000 lt null 0      1.486300e7 n
0000573 p 420010000 gt null 0      1.506980e7 n
0000574 p 420010000 gt null 0      1.533874e7 n
0000575 p 420010000 lt null 0      1.505000e7 n
0000576 p 420010000 lt null 0      1.482853e7 n
0000577 p 420010000 gt null 0      1.495950e7 n
*****
* logical trips
*****
0000600 536
*      modify from 670 in original input
0000601 563      and      561      n
0000602 -563      and      -564      n
0000603 655      and      602      n
0000604 609      or      609      1
0000605 572      and      -509      n
0000606 -572      and      -573      n
0000607 608      and      606      n
0000608 605      or      607      n
0000609 540      or      541      1
0000610 612      or      520      n
0000611 -521      and      -616      n
0000612 611      and      610      n
0000613 616      or      523      n
0000614 -522      and      613      n

0000615 -612      and      609      n
0000616 615      and      614      n
0000617 612      or      616      n
0000618 605      or      607      n
0000621 623      or      570      n
0000622 -571      and      -571      n
0000623 621      and      622      n
0000624 509      and      -552      n
0000625 623      or      624      n
0000626 576      and      -509      n
0000627 -576      and      -577      n
0000628 629      and      627      n
0000629 626      or      628      n
0000635 504      and      504      n
0000636 509      and      -536      n
0000650 -652      and      550      n
0000651 650      or      652      n
0000652 -509      and      651      n
0000655 601      or      603      n
0000656 508      or      609      n
0000659 561      or      562      n
0000660 504      or      504      n
0000669 561      and      564      1
0000670 565      and      -655      n
0000680 530      or      530      n
0000688 690      or      574      n
0000689 -575      and      -551      n
0000690 688      and      689      n
**** pzz heater delete
14201000 delete
14202000 delete
*----1----1----1
* control variable 114 re-define
*----1----1----1
20511400 pzzheat sum 1.0 0.0 1
20511401 0.0 0.362 htrnr 415100101
20511402 0.702464 htrnr 415200101
20511403 1.26381 htrnr 415200201
20511404 1.26381 htrnr 415200301
20511405 0.649152 htrnr 415200401
20511406 0.649152 htrnr 415200501
20511407 0.534688 htrnr 415200601
20511408 0.534688 htrnr 415200701
20511409 0.273063 htrnr 416200101
*----1----1----1
* control variable 123 redefine
*----1----1----1
20512300 pzz sum 1.0 0. 1
20512301 0.0 0.362 htrnr 415100100
20512302 0.59522 htrnr 415200100
20512303 1.07086 htrnr 415200200
20512304 1.07086 htrnr 415200300
20512305 0.550045 htrnr 415200400
20512306 0.550045 htrnr 415200500
20512307 0.453056 htrnr 415200600
20512308 0.453056 htrnr 415200700

```

```

20512309      0.150656 htrnr  416200100
*****
* primary coolant pump 1
*****
1350000      pcump1      pump
1350101      0.0366      0.0      0.099      0.0      90.0      0.319
1350102      00000
1350108      130010000 0.0      0.0      0.0      000100
1350109      140000000 0.0      0.05      0.05      000100
1350200      0      14818100. 1242890. 2463900.0 0.0
1350201      0      8.8943000 9.2942000 0.0
1350202      0      8.8928000 8.1177000 0.0
1350301      0 0 0      -1      0      509      0
1350302      369.00 90178860 .31550 96.00 500.60 1.4310
1350303      613.6      0.0      207.0000 0.0040000 19.598000 0.0
1350310      0.0      0.0      0.0
*
*****
* single phase head curves
*****
* head curve no. 1
*-----|-----|-----|-----|-----|-----|-----|
1351100      1      1
1351101      0.000000e+00      1.403600e+00
1351102      1.906100e-01      1.363600e+00
1351103      3.896300e-01      1.318600e+00
1351104      5.939600e-01      1.232800e+00
1351105      7.902000e-01      1.133600e+00
1351106      1.000000e+00      1.000000e+00
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 2
*-----|-----|-----|-----|-----|-----|-----|
1351200      1      2
1351201      0.000000e+00      -6.700000e-01
1351202      2.000000e-01      -5.000000e-01
1351203      4.000000e-01      -2.500000e-01
1351204      5.755400e-01      0.000000e+00
1351205      7.443200e-01      2.583000e-01
1351206      7.734800e-01      3.778000e-01
1351207      8.631300e-01      6.326000e-01
1351208      1.000000e+00      1.000000e+00
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 3
*-----|-----|-----|-----|-----|-----|-----|
1351300      1      3
1351301      -1.000000e+00      2.472200e+00
1351302      -8.057400e-01      2.047400e+00
1351303      -6.069000e-01      1.831000e+00
1351304      -4.068300e-01      1.624000e+00
1351305      -2.001710e-01      1.470500e+00
1351306      0.000000e+00      1.403600e+00
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 4
*-----|-----|-----|-----|-----|-----|-----|
1351400      1      4
1351401      -1.000000e+00      2.472200e+00

```

```

1351402      -8.229700e-01      1.996800e+00
1351403      -6.333200e-01      1.589700e+00
1351404      -4.553400e-01      1.327900e+00
1351405      -2.710900e-01      1.194900e+00
1351406      -1.771600e-01      1.060500e+00
1351407      -9.073000e-02      1.015600e+00
1351408      0.000000e+00      9.342790e-01
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 5
*-----|-----|-----|-----|-----|-----|-----|
1351500      1      5
1351501      0.000000e+00      2.500000e-01
1351502      2.000000e-01      2.800000e-01
1351503      4.000000e-01      3.400000e-01
1351504      4.118000e-01      2.768000e-01
1351505      5.976300e-01      4.584000e-01
1351506      7.934670e-01      6.992000e-01
1351507      1.000000e+00      1.000000e+00
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 6
*-----|-----|-----|-----|-----|-----|-----|
1351600      1      6
1351601      0.000000e+00      9.342790e-01
1351602      9.109900e-02      9.229000e-01
1351603      1.865090e-01      8.963000e-01
1351604      2.717620e-01      8.750000e-01
1351605      4.558720e-01      8.433000e-01
1351606      5.744060e-01      8.355000e-01
1351607      7.405760e-01      8.466000e-01
1351608      7.666190e-01      8.469000e-01
1351609      8.714710e-01      8.838000e-01
1351610      1.000000e+00      1.000000e+00
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 7
*-----|-----|-----|-----|-----|-----|-----|
1351700      1      7
1351701      -1.000000e+00      -1.000000e+00
1351702      -8.000000e-01      -6.300000e-01
1351703      -6.000000e-01      -3.000000e-01
1351704      -4.000000e-01      -5.000000e-02
1351705      -2.000000e-01      1.500000e-01
1351706      0.000000e+00      2.500000e-01
*-----|-----|-----|-----|-----|-----|-----|
* head curve no. 8
*-----|-----|-----|-----|-----|-----|-----|
1351800      1      8
1351801      -1.000000e+00      -1.000000e+00
1351802      -8.000000e-01      -9.700000e-01
1351803      -6.000000e-01      -9.500000e-01
1351804      -4.000000e-01      -8.800000e-01
1351805      -2.000000e-01      -8.000000e-01
1351806      0.000000e+00      -6.700000e-01
*****
* single phase torque data
*****
* torque curve no. 1

```



```

* head curve no. 1
*-----1-----1-----1-----1-----1-----1-----
1354100 1 1
1354101 0.000000e+00 0.000000e+00
1354102 1.000000e-01 8.300000e-01
1354103 2.000000e-01 1.090000e+00
1354104 5.000000e-01 1.020000e+00
1354105 7.000000e-01 1.010000e+00
1354106 9.000000e-01 9.400000e-01
1354107 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 2
*-----1-----1-----1-----1-----1-----1-----
1354200 1 2
1354201 0.000000e+00 0.000000e+00
1354202 1.000000e-01 -4.000000e-02
1354203 2.000000e-01 0.000000e+00
1354204 3.000000e-01 1.000000e-01
1354205 4.000000e-01 2.100000e-01
1354206 8.000000e-01 6.700000e-01
1354207 9.000000e-01 8.000000e-01
1354208 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 3
*-----1-----1-----1-----1-----1-----1-----
1354300 1 3
1354301 -1.000000e+00 -1.160000e+00
1354302 -9.000000e-01 -1.240000e+00
1354303 -8.000000e-01 -1.770000e+00
1354304 -7.000000e-01 -2.360000e+00
1354305 -6.000000e-01 -2.790000e+00
1354306 -5.000000e-01 -2.910000e+00
1354307 -4.000000e-01 -2.670000e+00
1354308 -2.500000e-01 -1.690000e+00
1354309 -1.000000e-01 -5.000000e-01
1354310 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 4
*-----1-----1-----1-----1-----1-----1-----
1354400 1 4
1354401 -1.000000e+00 -1.160000e+00
1354402 -9.000000e-01 -7.800000e-01
1354403 -8.000000e-01 -5.000000e-01
1354404 -7.000000e-01 -3.100000e-01
1354405 -6.000000e-01 -1.700000e-01
1354406 -5.000000e-01 -8.000000e-02
1354407 -3.500000e-01 0.000000e+00
1354408 -2.000000e-01 5.000000e-02
1354409 -1.000000e-01 8.000000e-02
1354410 0.000000e+00 1.100000e-01
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 5
*-----1-----1-----1-----1-----1-----1-----
1354500 1 5
1354501 0.000000e+00 0.000000e+00
1354502 2.000000e-01 -3.400000e-01

```

```

1354503 4.000000e-01 -6.500000e-01
1354504 6.000000e-01 -9.300000e-01
1354505 8.000000e-01 -1.190000e+00
1354506 1.000000e+00 -1.470000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 6
*-----1-----1-----1-----1-----1-----1-----
1354600 1 6
1354601 0.000000e+00 1.100000e-01
1354602 1.000000e-01 1.300000e-01
1354603 2.500000e-01 1.500000e-01
1354604 4.000000e-01 1.300000e-01
1354605 5.000000e-01 7.000000e-02
1354606 6.000000e-01 -4.000000e-02
1354607 7.000000e-01 -2.300000e-01
1354608 8.000000e-01 -5.100000e-01
1354609 9.000000e-01 -9.100000e-01
1354610 1.000000e+00 -1.470000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 7
*-----1-----1-----1-----1-----1-----1-----
1354700 1 7
1354701 -1.000000e+00 0.000000e+00
1354702 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* head curve no. 8
*-----1-----1-----1-----1-----1-----1-----
1354800 1 8
1354801 -1.000000e+00 0.000000e+00
1354802 0.000000e+00 0.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 1
*-----1-----1-----1-----1-----1-----1-----
1354900 2 1
1354901 0.000000e+00 6.032000e-01
1354902 1.930000e-01 6.325000e-01
1354903 3.930000e-01 7.369000e-01
1354904 5.955200e-01 8.331000e-01
1354905 7.978200e-01 9.229000e-01
1354906 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 2
*-----1-----1-----1-----1-----1-----1-----
1355000 2 2
1355001 0.000000e+00 -6.700000e-01
1355002 4.000000e-01 -2.500000e-01
1355003 5.000000e-01 1.500000e-01
1355004 7.372550e-01 5.265860e-01
1355005 7.680490e-01 6.065940e-01
1355006 8.672300e-01 7.436600e-01
1355007 1.000000e+00 1.000000e+00
*-----1-----1-----1-----1-----1-----1-----
* torque curve no. 3
*-----1-----1-----1-----1-----1-----1-----
1355100 2 3
1355101 -1.000000e+00 1.984300e+00

```

```

1355102 -8.009600e-01 1.394000e+00
1355103 -6.063800e-01 1.097500e+00
1355104 -4.068600e-01 8.220000e-01
1355105 -1.992800e-01 6.648000e-01
1355106 0.000000e+00 6.032000e-01

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* torque curve no. 4

```

*-----1-----1-----1-----1-----1-----1-----

```

```

1355200 2 4
1355201 -1.000000e+00 1.984300e+00
1355202 -8.223400e-01 1.830800e+00
1355203 -6.337100e-01 1.682400e+00
1355204 -4.585300e-01 1.557000e+00
1355205 -2.670230e-01 1.436200e+00
1355206 -1.761070e-01 1.387900e+00
1355207 -8.931000e-02 1.348100e+00
1355208 0.000000e+00 1.233610e+00

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* torque curve no. 5

```

*-----1-----1-----1-----1-----1-----1-----

```

```

1355300 2 5
1355301 0.000000e+00 -4.500000e-01
1355302 4.000000e-01 -2.500000e-01
1355303 5.000000e-01 0.000000e+00
1355304 1.000000e+00 3.569000e-01

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* torque curve no. 6

```

*-----1-----1-----1-----1-----1-----1-----

```

```

1355400 2 6
1355401 0.000000e+00 1.233610e+00
1355402 9.064300e-02 1.196500e+00
1355403 1.885690e-01 1.109600e+00
1355404 2.734700e-01 1.041600e+00
1355405 4.586690e-01 8.958000e-01
1355406 5.744800e-01 7.807000e-01
1355407 7.381600e-01 6.134000e-01
1355408 7.685200e-01 5.849000e-01
1355409 8.700570e-01 4.877000e-01
1355410 1.000000e+00 3.569000e-01

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* torque curve no. 7

```

*-----1-----1-----1-----1-----1-----1-----

```

```

1355500 2 7
1355501 -1.000000e+00 -1.000000e+00
1355502 -3.000000e-01 -9.000000e-01
1355503 -1.000000e-01 -5.000000e-01
1355504 0.000000e+00 -4.500000e-01

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* torque curve no. 8

```

*-----1-----1-----1-----1-----1-----1-----

```

```

1355600 2 8
1355601 -1.000000e+00 -1.000000e+00
1355602 -2.500000e-01 -9.000000e-01
1355603 -8.000000e-02 -8.000000e-01
1355604 0.000000e+00 -6.700000e-01

```

```

*****

```

* pcpl pump velocity table

```

*****

```

```

1356100 536
1356101 0.0 0.0
1356102 1.0 220.

```

```

*****

```

* primary coolant pump 2

```

*****

```

```

1650000 pcplump2 pump
1650101 0.0366 0.0 0.099 0.0 90.0 0.319
1650102 00000
1650108 160010000 0.0 0.0 0.0 000100
1650109 170000000 0.0 0.1 0.1 000100
1650200 0 14832700. 1242890. 2463590.0 0.0
1650201 0 8.4974000 8.8872000 0.0
1650202 0 8.4959000 6.6507000 0.0
1650301 135 135 135 -1 135 509 0
1650302 369.0 89699187 31550 96.000 500.60000 1.431
1650303 613.6 0.0 207.433 0.004 19.5980 0.0
1650310 0.0 0.0 0.0

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* spray valve

```

*-----1-----1-----1-----1-----1-----1-----

```

```

4070000 sprlv valve
4070101 406010000 420010000 3.3451e-4 15.432 15.432
000100

```

```

4070201 0 .000000 .000000 0.0

```

```

4070300 trplv

```

```

4070301 690

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* air cooled condenser

```

*-----1-----1-----1-----1-----1-----1-----

```

```

5470000 condens tmdpvpl
5470101 0.21677 17.67 0.0 0.0 0.0 0.0
5470102 4.e-5 0.0 00000
5470200 1 680
5470201 0.0 559.15 0.999
5470202 18000. 334.15 0.999

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* aux feed water

```

*-----1-----1-----1-----1-----1-----1-----

```

```

5480000 auxfeed tmdpjun
5480101 553000000 510000000 0.10
5480200 1 655
5480201 -1.0 0.0 0.0 0.0
5480202 0.0 0.0 0.0 0.0
5480203 0.0 2.5207 0.0 0.0

```

```

*-----1-----1-----1-----1-----1-----1-----

```

* steam flow control valve

```

*-----1-----1-----1-----1-----1-----1-----

```

```

*5500000 cv-p4-1 valve
*5500101 530010000 535000000 0.0043266 0.0 0.0 000100
*5500201 0 18.276 20.246 0.0

```

* initial velocity modified from 21.268, 21.599 in original one

```

*5500300 mtrvlv

```


DATE

FILMED

4 / 13 / 94

END

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