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Assessment of RELAP5/MOD3.2.2 Gamma With the LOFT L9–3 Experiment Simulating an Anticipated Transient Without Scram

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Abstract

The present work is to assess the capability of RELAP5/MOD3.2.2gamma to predict the system response following an Anticipated Transient Without Scram (ATWS) event. The experiment L9-3 which is a unique nuclear experiment simulating an ATWS event induced by loss of feedwater accident in Loss-of-Fluid-Test (LOFT) is calculated. The experimental condition and sequence are reviewed and a calculation modeling is developed with the important test specific features. The result of RELAP5 calculation is compared with the experimental data, and the predictability of the system response of the primary coolant system (PCS), the reactor power, and the steam generator (SG) secondary system is discussed. The base case showed a good agreement for the RCS pressure, temperature and reactor power with the experimental data. Therefore, it is shown that the RCS thermal-hydraulic response, the reactor power response, and the secondary system response following the LOFT L9-3 experiment can be reasonably predicted by the RELAP5 code under the current modeling scheme, and thus, that the code can be reasonably applied to the analysis of the system thermal-hydraulic response during the ATWS event in real plant. In addition, four parameters such as subcooled discharge coefficient of PORV, loss coefficient of spray valve, steam generator nodalization and moderator density coefficient (MDC) were selected and the effect of those parameters on the total discharged energy through the pressurizer safety relief valves is evaluated.

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Executive Summary

Anticipated operating transients during which the reactor does not scram as designed, i.e., ATWS (Anticipated Transient Without Scram), can be occurred by multiple failures. The rapid excursion of the RCS pressure and temperature by loss of feedwater and no scram could result in damaging of the reactor core. To resolve this concern, the system thermal-hydraulic behavior following an ATWS event should be understood, and the capability of the plant safety features to mitigate the event should be assured. For this aspect, a thermal-hydraulic analysis code to be applied to the system response following an ATWS event should be verified for relevant experiment simulating the ATWS event.

The Experiment L9-3 conducted in the Loss-of-Fluid-Test (LOFT) facility was a unique one simulating an ATWS event in pressurized water reactor (PWR).

The present study aims to evaluate the capability of RELAP5/MOD3.2.2gamma code to predict the system response using the L9-3 experiment data. Also, this study is purposed to suggest major modeling scheme for future application to PWR plant analysis, as well as to understand the parametric effect on the thermal-hydraulic response following the ATWS. For those purposes, an effort to improve the predicted system response during the experiment was attempted starting from the previous result as a base line.

The standard RELAP5/MOD3.2.2gama code was used in the present calculation. The LOFT system was modeled by 134 hydrodynamic volumes, 143 junctions, and 148 heat structures, in which the reactor vessel, the primary coolant system (PCS), the steam generator (SG), the SG secondary system, and the pressurizer were included.

The base case calculation was performed and its result was compared with the corresponded experimental data. The code predictability was discussed on the important parameters including the PCS pressure, the coolant temperatures at hot/cold legs, the discharged mass flow rate through safety relief valve, the reactor power, the water level and pressure of the SG secondary side. The calculation result showed a good agreement with the experimental data although a little difference in the heat transfer to the SG secondary side.

Sensitivity calculations were performed varying several parameters such as subcooled discharge coefficient of the pilot operated relief valve (PORV), loss coefficient of spray valve, steam generator nodalization and moderator density coefficient (MDC), which were selected from the input model improvement to seek a better agreement with the experimental data. And the effect of those parameters on the system response was evaluated in terms of the total discharged energy through relief valves, which was believed to provide the insight on the effect in real plant ATWS mitigation. As a result, it was found that the subcooled discharge coefficient of PORV and the loss coefficient of spray valve had a significant effect on the behavior of the RCS pressure, and that the fine nodalization of SG U-tubes increased the primary to secondary heat transfer rate. And, the account of the additional negative reactivity inserted into the core as a result of pre-experiment power gave a good agreement for the coolant temperature between the experiment and the calculation. And the calculated total discharged energy through the relief valves larger than that of the experiment in the range of 25.7 ~ 72.8 %. Based on the parametric study, it is important to use an accurate MDC data in the analysis of an ATWS in the real plant, and the loss coefficient of spray valve should be carefully determined.

1. Introduction

Anticipated Transients Without Scram (ATWS) is defined as any of anticipated operating transients during which the reactor does not scram as designed [1]. The significance of ATWS for reactor safety is that some ATWS events could result in damaging of the reactor core and releasing of a large amount of radioactive fission products. The alternative system initiating auxiliary feedwater and turbine trip, diverse from the existing system was required by the current ATWS rule [1].

The existing nuclear power plants constructed before YGN Units 3&4 in Korea were not known to have such an ATWS mitigating features, although there have been some attempts to study the ATWS mitigating features preliminarily. Based on the fact that the core damage frequency (CDF) from the ATWS events was 3.8×10^{-7}/RY for the YGN Units 3&4 [2] and a higher CDF can be expected for the plants older than the YGN Units 3&4 due to the aging effects, the ATWS can be a significant safety concern for the existing plants.

In designing the ATWS mitigating features and evaluating the plant-specific ATWS coping capability, it is required to determine the thermal-hydraulic response of both primary and secondary systems following the ATWS event. The role of ATWS analysis is to confirm the ATWS system response is within the maximum pressure of the reactor coolant system (RCS) less than the ASME Service Class C (3200 psia), which has been considered as a bound during the deliberation leading to the final ATWS rule [3]. Also the reasonability of the success criterion such as the favorable moderator temperature coefficient (MTC) in the probabilistic safety assessment should be evaluated through the plant specific thermal-hydraulic analysis.

Thermal-hydraulic response during the ATWS event was generally known to be related to the dryout phenomena in steam generator (SG) secondary side, the single- and two-phase coolant discharge phenomena through the relief valves on the pressurizer in RCS, and the reactivity feedback process to power through the MTC [4]. Therefore, thermal-hydraulic analysis computer code should have a capability to predict those phenomena and should be verified by the applicable experimental data simulating those phenomena. The experiment L9-3 [5] which was a unique nuclear experiment simulating an ATWS event induced by loss of feedwater accident, conducted at the Loss-of-Fluid-Test (LOFT) facility has been a appropriate one to benchmark computer codes. The analysis of the LOFT L9-3 experiment was conducted by several researchers using the RELAP5 code [5]. It was reported that the code could reasonably predict the RCS thermal-hydraulic response, the reactor power response and the secondary system response following the experiment. In those analyses, the safety relief valve (SRV) opened more than two times by the over-prediction of the RCS pressure whereas it opened only one time in the experiment. And, the further sensitivity studies were needed on the effect of steam generator modeling, the SRV discharge modeling, and the MDC feedback on the system response.

The present work evaluates the capability of the RELAP5/MOD3.2.2gamma code [6] to predict the system response following the ATWS event. For this purpose, the experiment L9-3 was assessed. The experimental condition and sequence were reviewed and a calculation modeling was developed with the important test-specific features. The RELAP5 calculation result was compared with the experimental data and the predictability of the system response of the RCS, the reactor power, and the SG secondary system was analyzed.

Also, this study aims to suggest major modeling scheme for future application to PWR plant analysis, as well as to understand the parametric effect on the thermal-hydraulic response following the ATWS. For those purposes, an effort to improve the predicted system response during the experiment was attempted. And, sensitivity calculations were performed varying several parameters such as subcooled discharge coefficient of PORV, loss coefficient of spray valve, steam generator nodalization and MDC, which were selected from the input model improvement to seek a better agreement with experimental data. The effect of those parameters on the system response was evaluated in terms of the total discharged energy through relief valves, which was believed to provide the insight into the analysis on real plant ATWS mitigation.

2. Facility and Test Description

2.1 Facility Description

The LOFT facility is a 50 MWt pressurized water reactor (PWR) with 1/60 power-to-volume scale with the Westinghouse four loop PWR. It has various instrumentation to measure and to provide data on the thermal-hydraulic and nuclear condition throughout the system. The LOFT facility consists of five major system : reactor system, primary coolant system, blowdown suppression system, emergency core cooling system and secondary coolant system. The length of the core and the reactor vessel is 1.68 and 7 m, respectively. The overall configuration is shown in Fig. 1.

2.2 Test Description

Experiment L9-3 is one of the anticipated transient with multiple failures test performed at the Loss-of-Fluid-Test (LOFT) facility and simulated a loss-of-feedwater anticipated transient without scram (ATWS). The objectives of Experiment L9-3 were to provide experimental data for benchmarking vendors' ATWS computer codes as required by the USNRC proposed ATWS rule (SECY-80-409) [7], to evaluate alternative methods of achieving long-term shutdown (without the insertion of control rods) following an ATWS event to address concerns defined in the proposed rule, and to determine the transient reactor power by using available neutron flux instrumentation and measured core thermal-hydraulic parameters to address the applicability of the point kinetics model used in predicting transient reactor power. The experimental data was also used to determine the steam generator secondary dryout behavior and its effect on the primary system response characteristics and to determine the two-phase and subcooled flow characteristics of pressurizer pilot operated relief valve (PORV) and safety relief valve (SRV) at high pressure (≥ 17 MPa).

For those purposes, a two-position actuator relief valve was installed on the pressurizer to simulate a scaled PORV and a scaled SRV in addition to the plant

PORV and SRV. The relief capacity of valve scaled to the minimum PORV capacity of a generic Westinghouse PWR. [8]

Prior to the experiment, the primary system pressure was 14.98 ± 0.06 MPa, the mass flow rate over the loop was 467.6 ± 2.7 kg/s, and the reactor power was 48.7 ± 1.2 MWt. Table 1 summarizes an initial condition on the experiment. Measurement uncertainties of the important parameters were also presented in the table.

The experiment was initiated by turning off the main feedwater pump. The steam generator steam control valve was closed manually at 67.3 s. The experimental PORV opened at 67.3 ± 0.2 s, and the experimental SRV opened at 96.8 ± 0.2 s at their set-point pressures. The maximum pressure occurred at 17.4 MPa, and the SRV could prevent the further pressure increase as designed. The plant recovery was initiated at about 600 s by starting one high pressure injection system (HPSI), starting the secondary coolant system auxiliary feedwater, and opening the PORV. The control rods remained withdrawn. Major sequence of events for experiment L9-3 are summarized in Table 2.

3. Code and Modeling

3.1 Code Description

The standard RELAP5/MOD3.2.2gamma code, was used without any modification in the present analysis. The code has some improved capabilities when compared to the previous versions including computational time step control, flow anormalies, mass error reduction, etc. The detailed description of the improvements can be found in the reference [6].

3.2 Input Modeling

The LOFT facility was modeled by 134 hydrodynamic volumes, 143 junctions, and 148 heat structures. Figure 2 shows a RELAP5 nodalization diagram for the calculation of test L9-3. The RELAP5 nodalization was based on the previous study on the assessment for the LOFT L9-1 experiment [9]. Changes from the previous one are the SG U-tube model with 12 volumes and the SG separator flow paths. The used models and options were based on the user guideline of the code [6]. A steady state input deck and a transient input deck are presented in Appendix A and B.

The primary coolant system (PCS) composed of an intact loop and a broken loop, the former included a hot leg, a pump suction tee, two primary coolant punps (PCP) and a cold leg. The intact loop was modeled by 25 hydrodynamic volumes. All piping metal structures exposed to environmental atmosphere were simulated by the heat structure to consider the heat loss.

The reactor vessel was modeled 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, 6, 7 volumes stacked vertically, respectively. Totally 26 volumes and 50 heat structures were used. The rod bundle interface 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 reactor kinetics model was used for simulating the moderator density and doppler temperature feedback and a scram curve was provided. The ANS-79 model was used for a decay heat simulation.

The pressurizer system was modeled by a surge line, 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. To consider the environmental heat loss from the pressurizer vessel wall, the vessel wall was modeled by nine heat structures.

The steam generator consisted of a SG inlet plenum, U-tubes, a outlet plenum, a feedwater inlet annulus, a SG secondary side downcomer, a boiler section, a separator inlet annulus, a separator, a main steam control valve (MSCV) and a MSCV downstream piping. All of the SG metal wall and U-tubes were described by the proper heat structures. The rod bundle interfacial friction option was used for the volumes contacted with the U-tubes heat structures. The separator section in SG was modeled by a branch component and a separator component. The separator inlet junction is connected to the bottom of the volume 520, as shown in Fig. 2.

The initial condition for the transient calculation was obtained by RELAP5 steady state run. The calculated parameter was compared with the experimental data in Table 1. As shown in the table, all the important parameters were well-agreed to those of the test within a range of measurement uncertainty. For the transient calculation, all the major sequence were modeled including the SG feedwater pump trip, the pressurizer spray actuation, the pressurizer PORV open/close, the SRV open/close, the SG main steam control valve (MSCV) manual-closure, and the MSCV bypass valve open/close. The primary coolant pumps were modeled to run continuously throughout the transient.

4. Review of Sensitivity Parameters

As mentioned above, the previous calculation showed a reasonable prediction on L9-3 transient progression. However, an over-prediction of the system pressure and temperature was identified as a weakness in the RELAP5 assessment. The weakness dues mainly to the input model simulating the test not to the thermal-hydraulic models in the code. By this reason, an attempt to improve the input model was performed through the extensive sensitivity study on the several parameters. As a result, a base case was selected which gave a good agreement for the RCS pressure, temperature and reactor power with the experimental data within a range of measurement uncertainty.

In the base case calculation, the contribution of Xenon buildup to core reactivity was considered. The amount of negative reactivity inserted into the core as a result of pre-experiment power operations was calculated as 22% of the total (Xenon plus moderator) negative reactivity. This is the maximum Xenon-reduced reactivity which was reported in reference [11]. Figure 3 shows the moderator density coefficient of base case and the case with no additional source of negative reactivity (Case D). In the base case, the subcooled discharge coefficient of PORV was set to 1.0, the loss coefficient of spray valve was set to 0.0, and the steam generator tubes were divided into 12 volumes.

In sensitivity calculations, four cases were performed varying the parameters such that the subcooled discharge coefficient of PORV was set to 1.1 in Case A, the loss coefficient of spray valve was set to 15.432 in Case B, the steam generator tubes were divided into 34 instead of 12 in Case C, and the previous MDC curve in Fig. 3 used in Case D.

To assess the comparative effect of those parameters, the total discharged energy through relief valves was calculated. It is the important factor in mitigating the RCS pressure and was calculated by integrating the instantaneous energy flow curve presented in Fig. 4 with time as the Equation (1). It was calculated from the time of the PORV open to 200 seconds. Because the most important thermal-hydraulic phenomenon, i.e., SG secondary side dryout, single- and two-phase coolant discharge and moderator temperature feedback to reactor power were observed before 200 seconds. The differences between calculation and experiment determined by the Equation (2) in each case were compared to identify the most dominant parameter to concern in the analysis of the ATWS at real plant.

$$E_{tot} = \int_{PORV\ OPEN}^{200} \dot{m} h dt \tag{1}$$

$$\delta E = E_{Cal} - E_{Exp} \tag{2}$$

Figure 4 shows the energy flows through the PORV and SRV in cases of experiment and base calculation. The total discharged energy of other four cases are calculated as the same method.

5. Result and Discussions

With the initial and boundary conditions described in the Chapter 3, a transient RELAP5 run was executed up to 600 seconds. Because the most important thermal-hydraulic phenomena were observed before 200 seconds, the calculation result is discussed in short-term response (up to 200 seconds). During 200 to 600 seconds, the system was observed to stabilized after coolant discharge.

5.1 Base Case

RCS Response

Figure 5 shows a comparison of RCS pressurizer pressure between the experiment and the RELAP5 calculation. At the beginning of the transient initiation, the main feedwater was lost and the auxiliary feedwater was unavailable throughout transient, which led to the RCS pressure increase up to the pressurizer spray setpoint at 30 seconds and 55 seconds in the experiment. After that, the RCS pressure continued to increase due to the depletion of heat removal capability of SG secondary side. In the experiment, the pressurizer PORV was opened at 74 seconds and the SRV at 96.8 seconds. The maximum RCS pressure was observed as the same as the SRV opening setpoint pressure, i.e., 17.24 MPa. After discharging the RCS coolant, the RCS was in the saturated condition at high temperature, which lowered the reactor power through the MTC feedback. The RCS pressure could be maintained within the range of the pressurizer PORV open/close setpoint (16~16.2 MPa) under this condition.

The result of RELAP5 calculation shows a good agreement with the experimental data until the PORV open. Each actuation of the pressurizer spray valve and the PORV was well predicted even with the deviation in timing of the SRV open, and the maximum RCS pressure was reasonably calculated. However, after the PORV open, the calculation showed an over-prediction of the pressure. Also, the PORV open/close cycling response was delayed. The reason for such a SRV response is the excessive coolant expansion due to the coolant temperature over-prediction.

Figure 6 shows a comparison of coolant temperatures at hot and cold legs between the calculation and the experiment. The coolant temperature increased slowly, and then rapidly due to the complete loss of the SG secondary side heat removal capability. Both the temperatures moved eventually to the same level as the reactor power decreased to zero. The calculated temperatures are well agreed with the experimental data up to 100 seconds and then a little over-predicted. However, the difference between the calculation and the experiment is within the measurement uncertainty (±4.3K). It is indicated that the negative feedback effect of the MDC with respect to the coolant temperature was appropriately modeled.

Figure 7 shows a comparison of the discharged coolant mass flow rate through the PORV and SRV between the calculation and the experiment. In the experiment, the discharged flow rate was 1 kg/sec for the PORV and 4.6 kg/sec for the combined SRV. During the PORV cycling mode, 2.6 kg/sec of coolant was discharged per cycle. The calculation showed a large mass discharge (4.9 kg/sec) for the combined SRV and a small discharge (1.9 kg/sec) for the PORV cycling. The total discharged energy through the relief valves was 312.73 MJ and this is larger by 25.7 % than that of the experiment.

Reactor Power Response

Figure 8 shows a comparison of the reactor power between the experiment and the RELAP5 calculation. In the experiment, the reactor power was slowly decreased due to the moderator density feedback caused by the coolant temperature increase. After 50 seconds, the reactor power was significantly decreased to 2 MW level by the coolant temperature increase by 40 K. The power calculated by the RELAP5 was generally agreed with the experimental data. It is obvious that the MDC data used for the point kinetics model in the present RELAP5 calculation was appropriate one.

Secondary System Response

Figure 9 shows a comparison of SG secondary side pressure between the experiment and the RELAP5 calculation. The SG pressure increased due to the continuous heat transfer from the RCS, as the main feedwater was lost in the test. The increasing rate of SG pressure was gradually reduced and eventually reversed as the reactor power decreased. The MSCV was closed at 67 seconds which led SG pressure to re-increase. After that, the SG pressure was maintained at about 6.4 MPa, by the steam bypass valve open/close. The calculated SG pressure was generally close to the experimental data although it was a little over-predicted. The reason for the over-prediction is believed to the high steaming rate in the SG which caused by the present SG modeling scheme e.g., the recirculation ratio.

Figure 10 shows a comparison of the SG secondary side liquid level between the experiment and the RELAP5 calculation. It is shown that the RELAP5 calculation was well agreed with the experimental behavior. The complete dryout of the SG was shown at 100 seconds in calculation, while the complete dryout was not found in the experiment. This deviation may due to the SG modeling scheme and/or RELAP5 code model.

5.2 Parametric Study

The parametric study and the discharged energy through relief valves are summarized in Table 3. The effects of each parameter on the thermal-hydraulic response in ATWS event are followings.

Subcooled Discharge Coefficient of PORV (Case A)

In Case A, the subcooled discharge coefficient of PORV was set to 1.1. There were no outstanding effects in the RCS temperatures and the reactor power compared with the base case. However, the behavior of the RCS pressure is significantly influenced by the subcooled discharge coefficient. As the coefficient increased, the discharged flow also increased, which resulted in the mitigation of the RCS pressure increasing. Figure 11 shows that the PORV opened three times before opening the SRV in the calculation whereas it opened only one time in the experiment. And, it can be identified that the PORV open/close frequency decreased because the pressure drops sharply after the PORV open and reaches the closing set point fast. The total discharged energy through the relief valves was 318.14 MJ which is larger by 27.9 % than that of the experiment.

Loss Coefficient of Spray Valve (Case B)

Sensitivity calculation for the loss coefficient of spray valve was conducted by setting it to 15.432, which was used in the previous calculation [12]. The coefficient has a remarkable effect on the RCS pressure as shown in Fig. 11. The pressure increased more rapidly and reached the setpoint of PORV open earlier than the experiment. This is because the RCS pressure was not appropriately controlled by the small amount of spray limited by the junction loss coefficient. Also, the pressure shows a large increment after the PORV open, which resulted in the increase of the energy discharge through the PORV. The total discharged energy through the relief valves was 318.39 MJ and this is larger by 28.0 % than that of the experiment. And, the increase of the loss coefficient has negligible effects on the RCS temperatures and the reactor power compared with the base case.

Steam Generator Node Number (Case C)

Using the modeling scheme that the steam generator tubes were divided into 34 volumes, the coolant temperature increased slowly at the nearest to the experimental curve as shown in Fig. 12. This means that the heat transfer rate increased from the primary to the secondary. By this reason, the time delay of the second spray open was happened as the pressure did not increase to the setpoint of the spray open. The pressure decreased sharply after the PORV open and the time of the SRV open was delayed by 17 seconds as shown in Fig. 11. The reactor power showed abrupt drop at 60 seconds when the coolant temperature rise rapidly. The total discharged energy through the relief valves was 316.12 MJ and this is larger by 27.1 % than that of the experiment.

Moderator Density Coefficient (Case D)

Figure 11 shows that the pressure increased unreasonably when the MDC curve was chosen as Case D in Fig. 3. This is because the negative feedback effect of the MDC with respect to the coolant temperature was not appropriately modeled. In Fig. 13, the reactor power was over-predicted though the coolant temperature was higher than the experimental data as shown in Fig. 12. The total discharged energy through the relief valves was 429.98 MJ and this is larger by 72.8 % than that of the experiment. Therefore, the most care should be taken in choosing the accurate input MDC data in the analysis of the ATWS.

5.3 Run Statistics

The main frame computer used in the present calculation was a IBM Personal Computer (Pentium II 500 MHz) with DOS operating system. In the base case calculation, the grind time is can be calculated as follows.

Computer time, CPU = 157.08 – 1.31 = 155.77 (sec)
Number of time step, DT = 4421
Number of volume, C = 128
Grind time = CPU×1000/(C×DT) = 0.27527 CPU m sec/vol/step

Figure 14 shows the required CPU time with respect to the transient time for the base case run. And the time step size is also plotted in Fig. 15. The maximum time step was set to 0.05 second up to 200 seconds. Using the RELAP5/MOD3.2.2gamma time code, the step size was always same to the Courant time limit. In the Fig. 16, the mass error of the base case calculation is represented. The maximum mass error was less than 1.0 kg, while the total system mass was 5079 kg until 200 seconds.

6. Summary and Conclusions

The present study aims to evaluate the capability of the RELAP5/MOD3 code to predict the thermal-hydraulic system response following the ATWS events. The experiment L9-3 which was a unique nuclear experiment simulating an ATWS event induced by loss of feedwater accident in the LOFT facility was calculated. In addition, a sensitivity calculation was performed on such parameters as the subcooled discharge coefficient of PORV, the loss coefficient of spray valve, the steam generator nodalization and the MDC. Main observations and conclusions are as follows:

1) The RELAP5 code reasonably predicted the RCS thermal-hydraulic response, the reactor power response, and the secondary system response following the LOFT L9-3 experiment under the current modeling scheme. Therefore, the code can be reasonably applied to the analysis of thermal-hydraulic response following the ATWS in real plant.
2) The subcooled discharge coefficient of PORV and the loss coefficient of spray valve had a significant effect on the behavior of the RCS pressure, and the fine nodalization f the SG U-tubes increased the primary to secondary heat transfer rate. And, the account of the additional negative reactivity inserted into the core as a result of pre-experiment power gave a good agreement for the coolant temperature between the experiment and the calculation.
3) The total discharged energy through the relief valves was calculated, and the value was larger than that of the experiment in the range of 25.7 ~ 72.8 %.
4) It is important to use an accurate MDC data in the analysis of an ATWS in the real plant, and the loss coefficient of spray valve should be carefully determined. This sensitivity study will provide useful information for the analysis of an ATWS in the real plant.

References

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[7] USNRC, *Proposed Rulemaking to Amend 10 CFR 50 Concerning Anticipated Transient Without Scram (ATWS) Event*, SECY-80-409, Sept. 1980

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[11] J. P. Adams, *Experiment Analysis and Summary Report for LOFT ATWS Experiment L9-3 and L9-4*, NUREG/CR-3417 September 1983

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Table 1 Initial Condition for Experiment L9-3

Parameter	Measured	Calculated	
		Base Case	Case C
Primary Coolant System			
Mass flow rate(kg/s)	467.6±2.7	467.6	467.6
Hot leg pressure(MPa)	14.98±0.06	14.97	14.96
Core ΔT(K)	19.4±2.2	19.35	19.36
Intact loop average temperature (K)	566.7±1.5	567.4	567.0
Cold leg temperature (K)	557.0±1.5	557.70	557.33
Hot leg temperature (K)	576.4±1.6	577.05	576.69
Reactor Vessel			
Power level (MWt)	48.7±1.2	48.7	48.7
Maximum linear heat generation rate (kW/m)	51.6±3.9	51.6	51.6
Pressurizer			
Liquid temperature(K)	615.2±0.3	611.24	611.0
Pressure (MPa)	14.98±0.06	14.98	14.98
Liquid level (m)	1.00±0.03	0.9820	0.9865
Steam Generator Secondary Side			
Liquid level (m)	3.15±0.09	3.148	3.155
Liquid temperature(K)	544.4±0.7	544.0	544.08
Pressure (MPa)	5.61±0.06	5.583	5.584
Mass flow rate(kg/s)	25.7±1.1	25.85	25.85

Table 2 Sequence of Events for Experiment L9-3

Event	Time (second)	
	Experiment	Calculated (Base Case)
Main feedwater pump tripped off	0.0	0.0
Pressurizer spray valve cycling initiated	29.5 ± 2.0	30.01
Steam generator MSCV closed	67.3 ± 1.0	67.3
Experiment PORV opened	73.8 ± 0.2	74.52
Steam generator liquid level reached bottom of indicating range (0.25 m above bottom)	94.5 ± 4.0	77.01
Experiment SRV opened	96.8 ± 0.2	105.02
Experiment SRV closed	107 ± 1	119.0
Experiment PORV closed	123 ± 1	149.5
Experiment PORV cycling initiated	125.4 ± 0.2	153.03
Experiment PORV cycling terminated	208	218.04
End of ATWS phase / start of recovery	601.1 ± 0.2	---
End of calculation	---	600.0

Table 3 Summary of Parametric Study and Discharged Energy

	PORV Discharge Coef.	Spray Loss Coef.	S/G Node #	MDC Curve	E_{Cal} (MJ)	δE (MJ)
Base Case	1.0	0.0	12	Base Case	312.73	63.97
Case A	1.1	0.0	12	Base Case	318.14	69.38
Case B	1.0	15.432	12	Base Case	318.39	69.63
Case C	1.0	0.0	34	Base Case	316.12	67.36
Case D	1.0	0.0	12	Case D	429.98	181.22

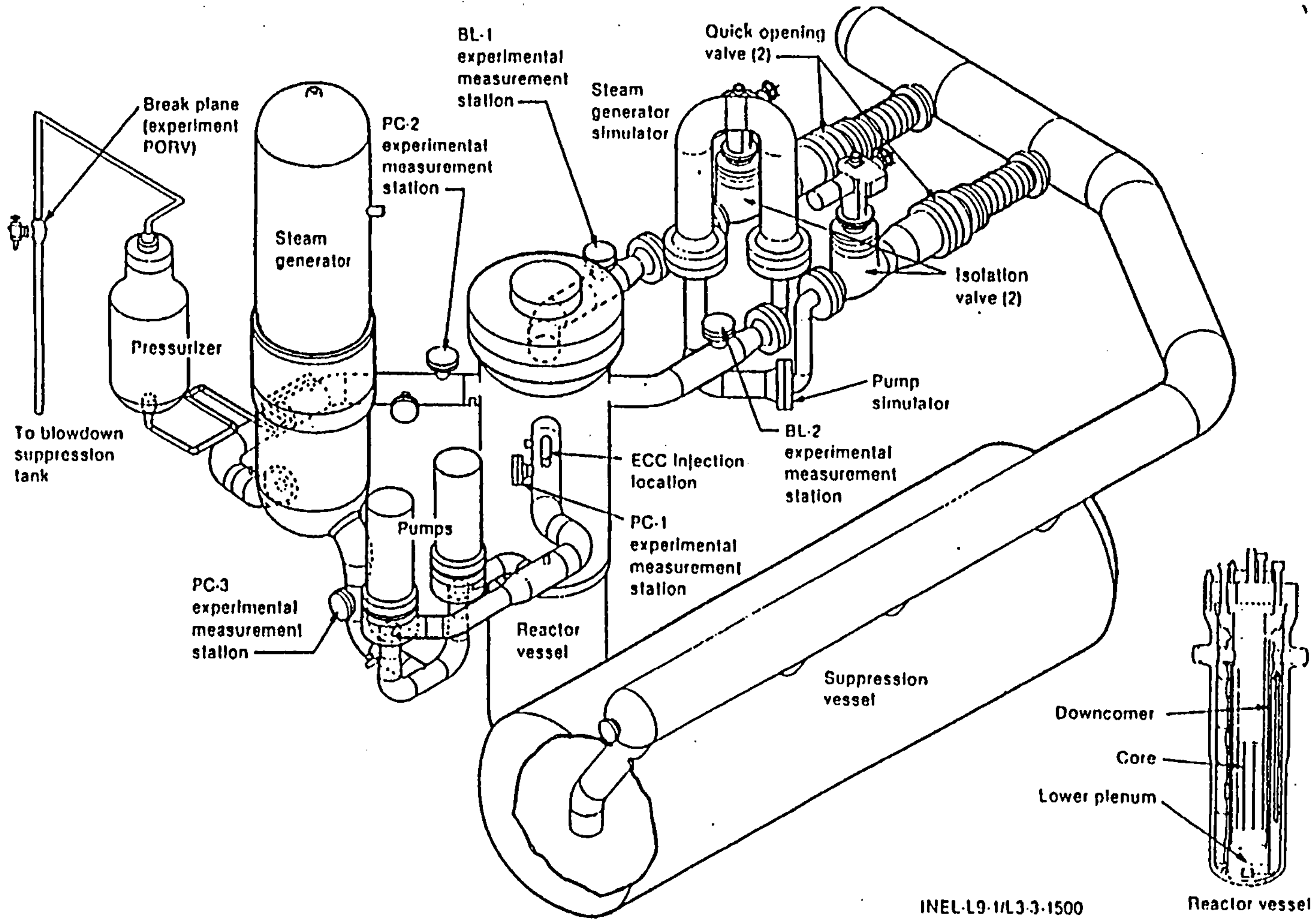

Fig. 1 LOFT System Configuration

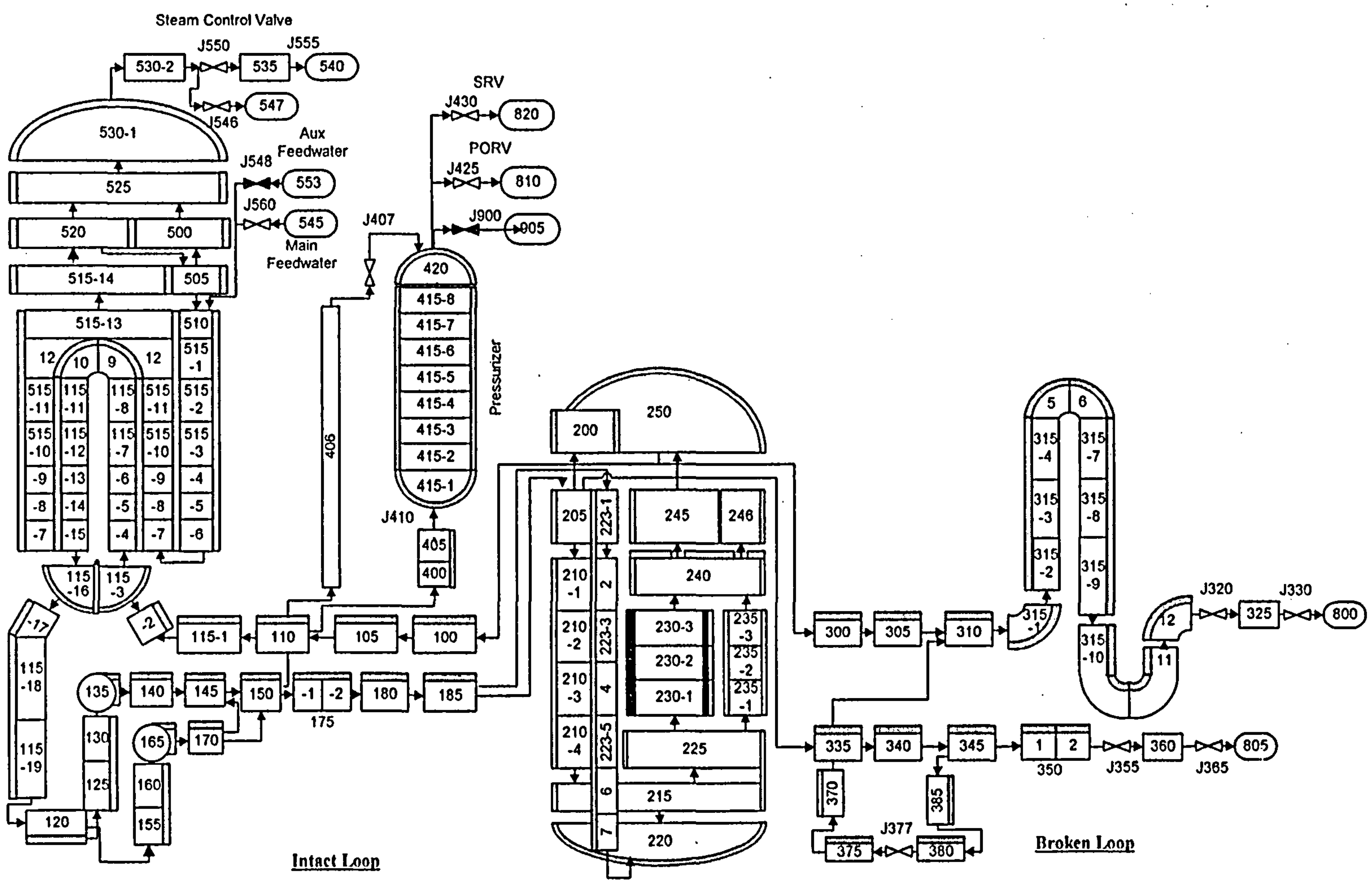

Fig. 2 RELAP5 Nodalization Diagram for Calculation of LOFT L9-3 Test

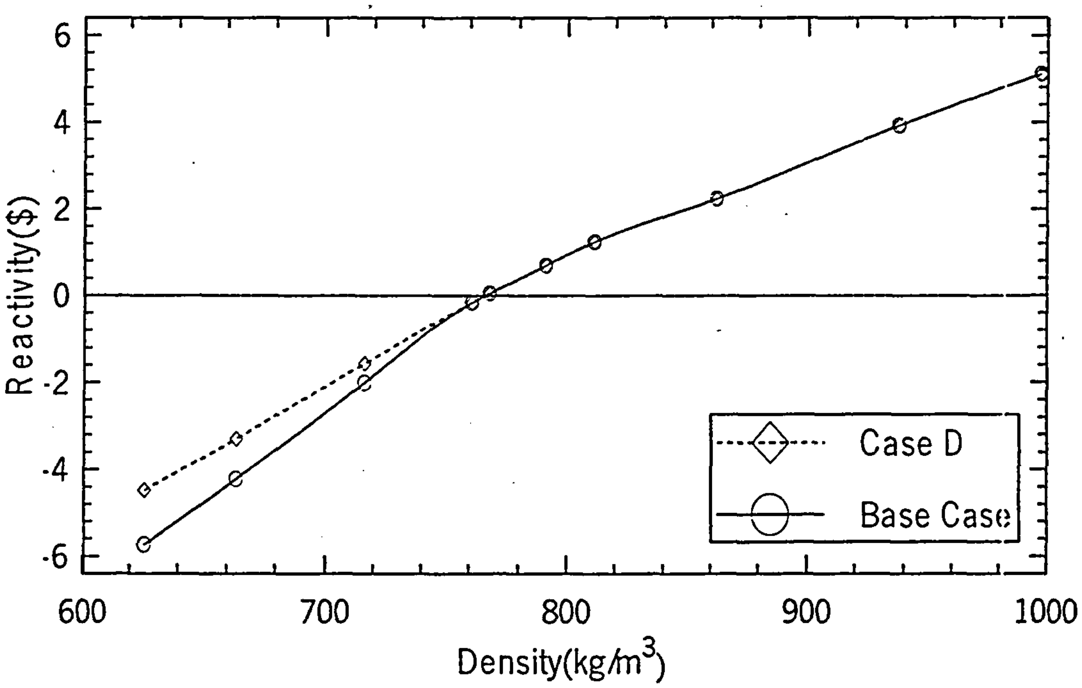

Fig. 3 Moderator Density Coefficient

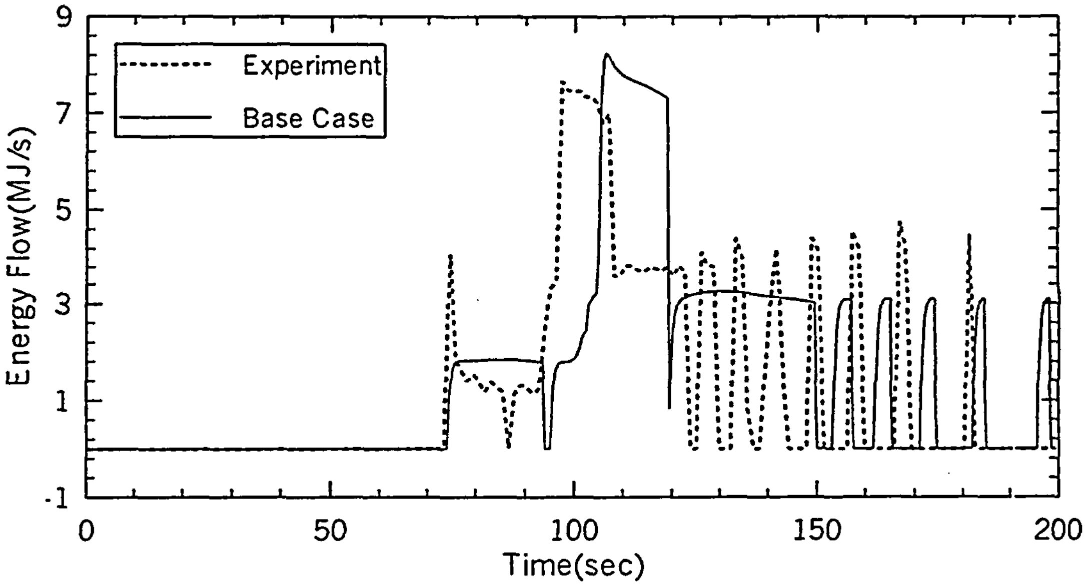

Fig. 4 Energy Flows through Relief Valves

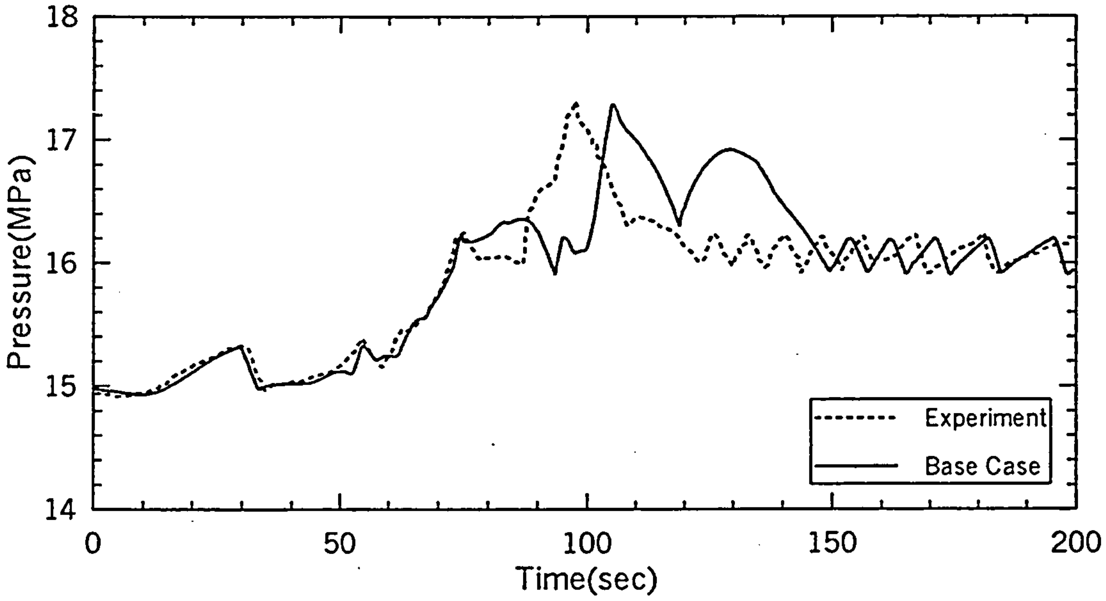

Fig. 5 Comparison of RCS Pressure

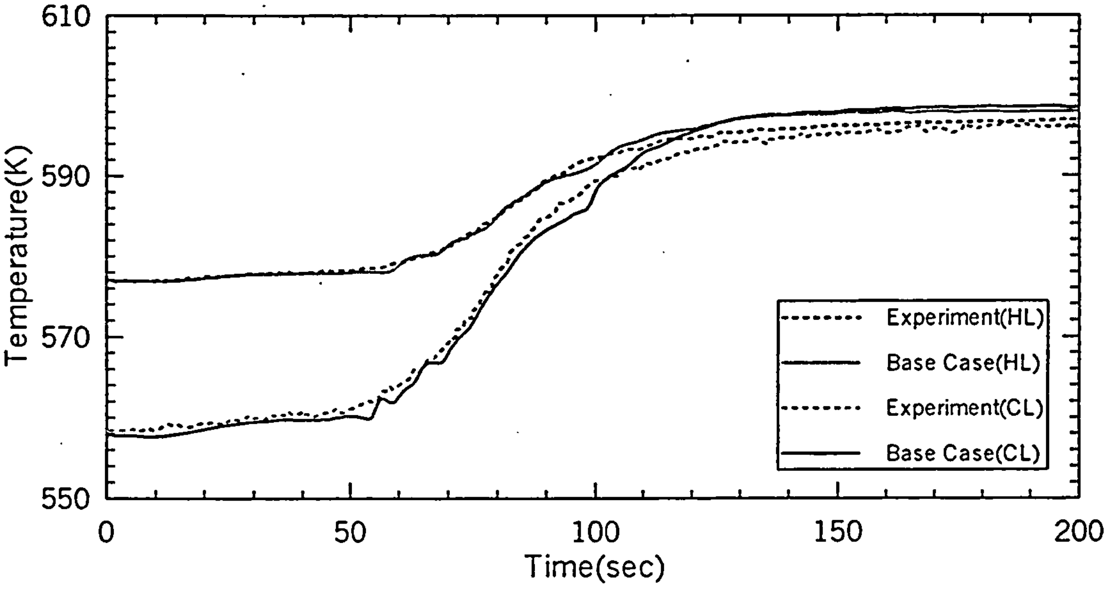

Fig. 6 Comparison of Coolant Temperatures at Hot and Cold Legs

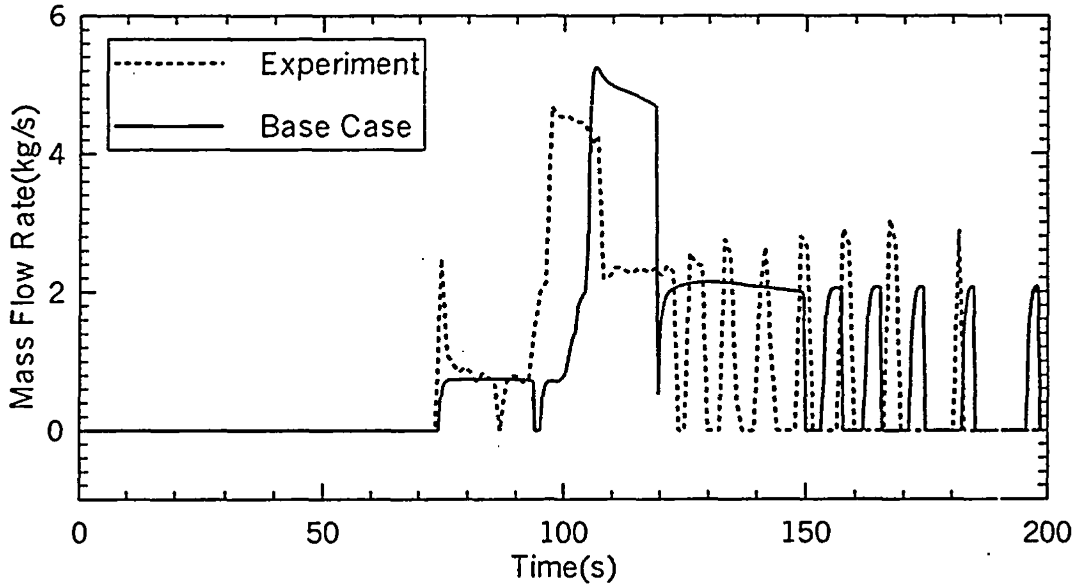

Fig. 7 Comparison of Discharged Flow through PORV and SRV

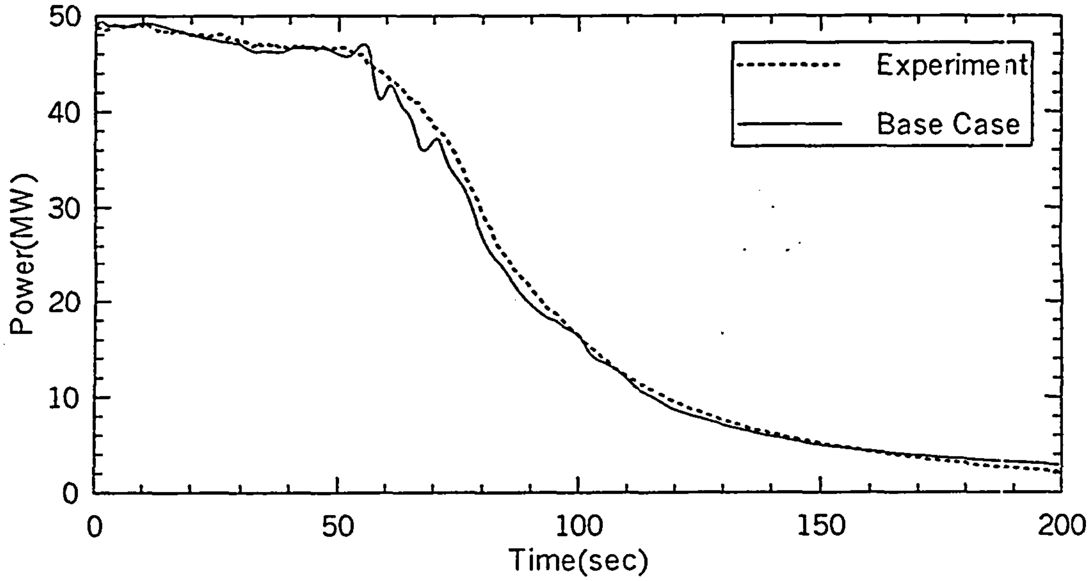

Fig. 8 Comparison of Reactor Power

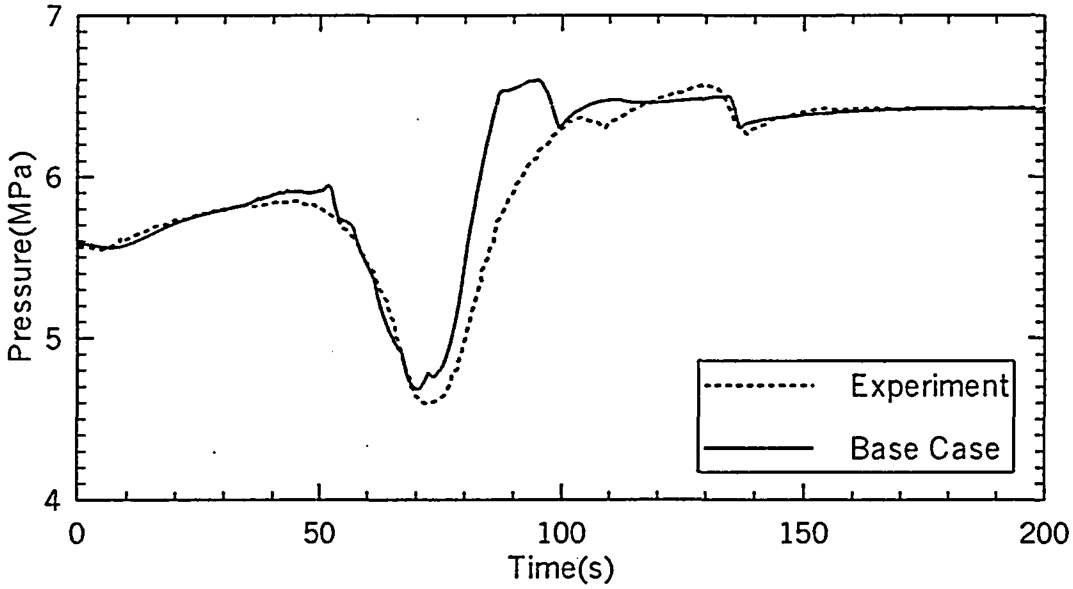

Fig. 9 Comparison of SG Secondary Side Pressure

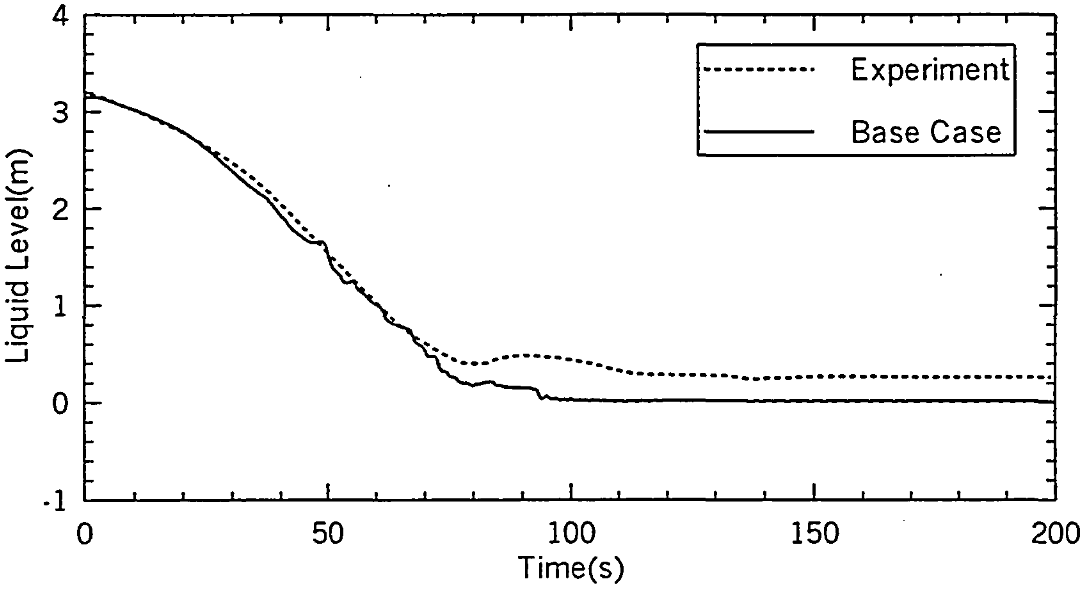

Fig. 10 Comparison of SG Liquid Level

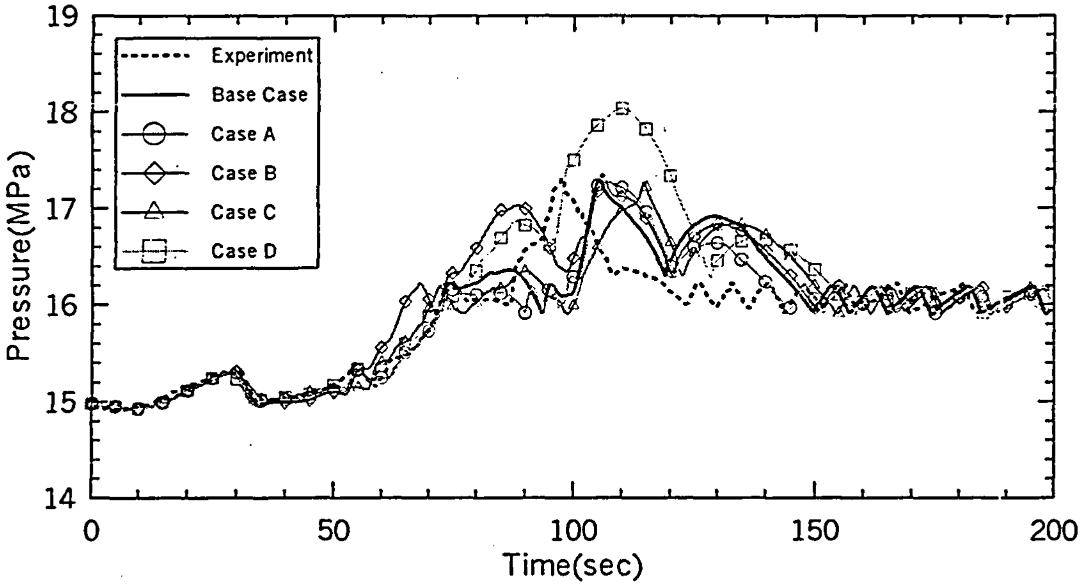

Fig. 11 Parametric Effect on RCS Pressure

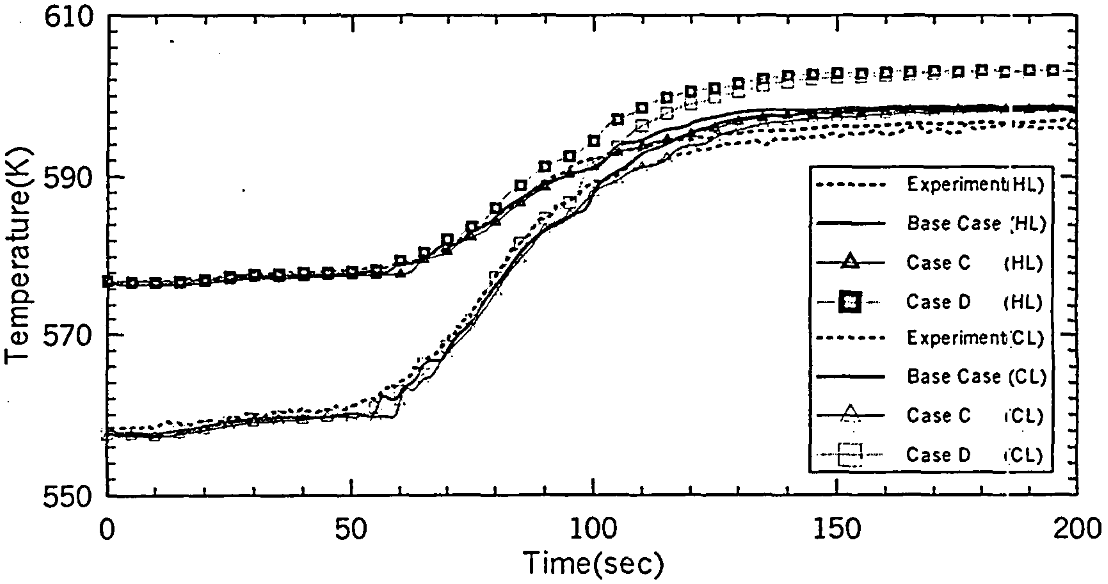

Fig. 12 Parametric Effect on Coolant Temperatures at Hot and Cold Legs

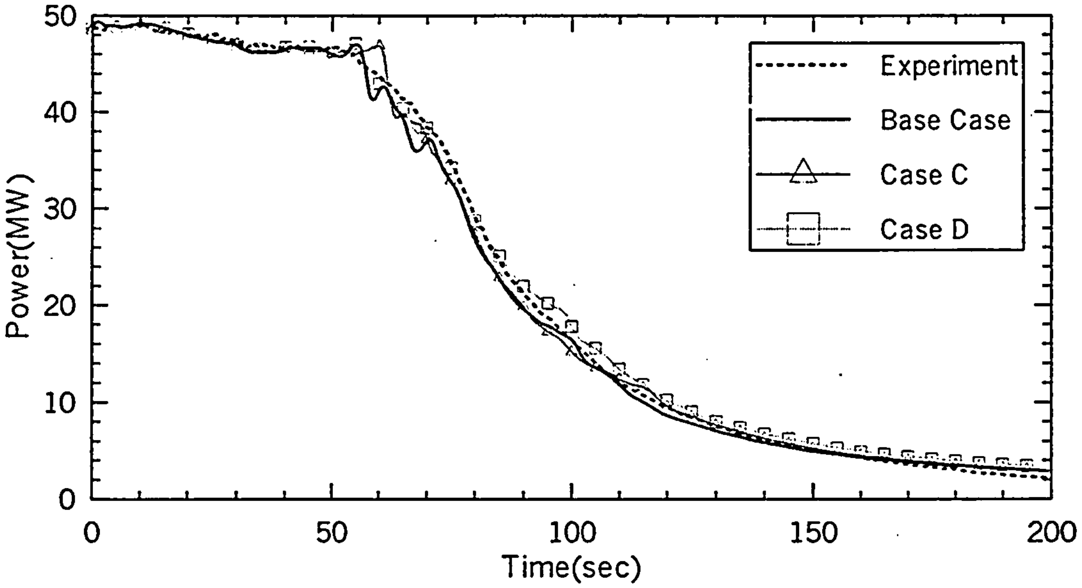

Fig. 13 Parametric Effect on Reactor Power

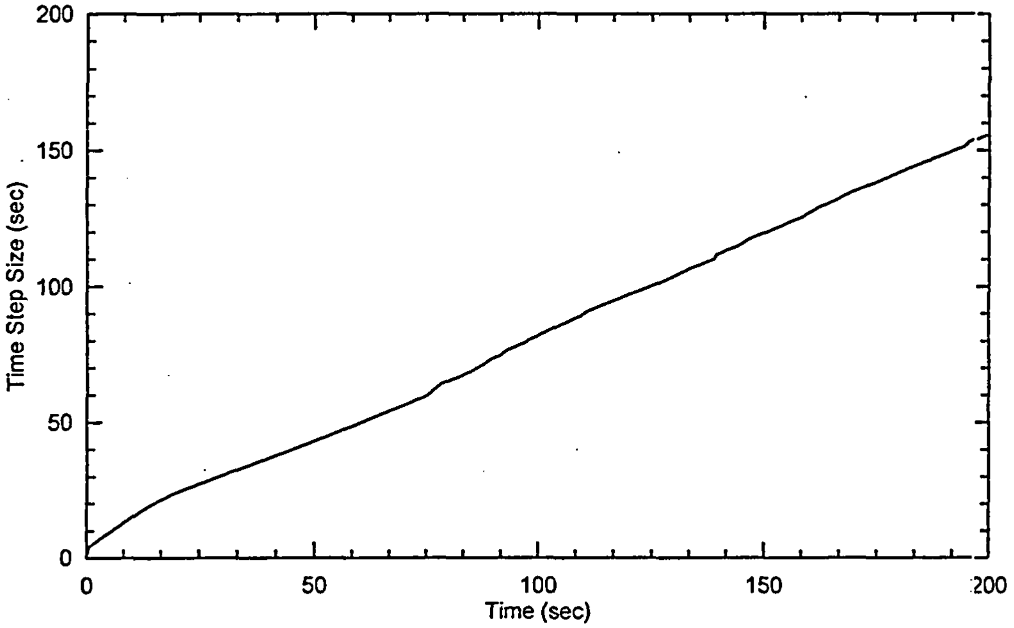

Fig. 14 The Required CPU Time in the Base Case Calculation

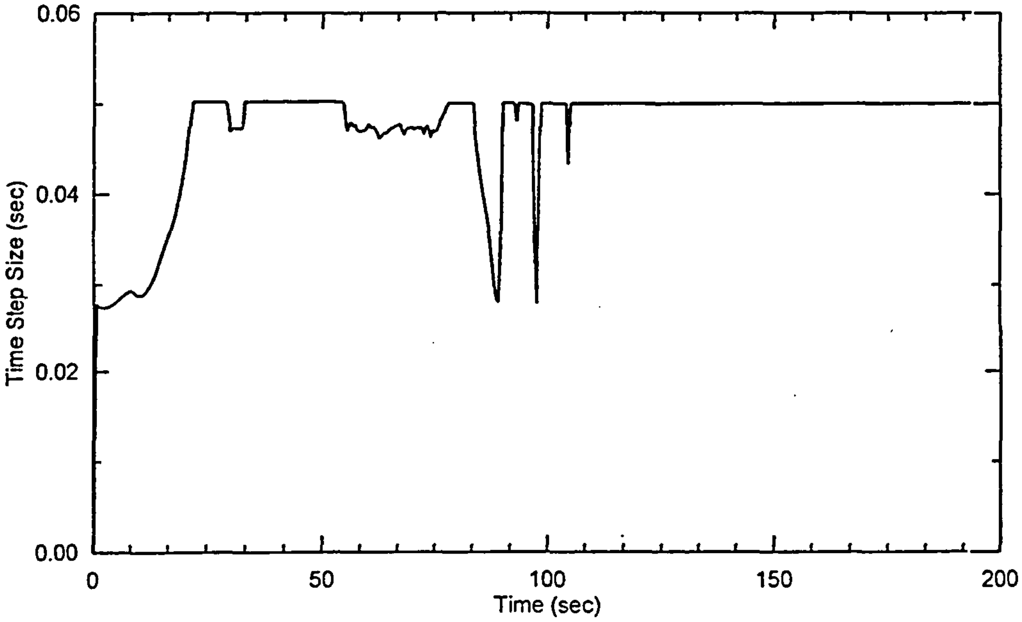

Fig. 15 The Time Step Size of Base Case Calculation

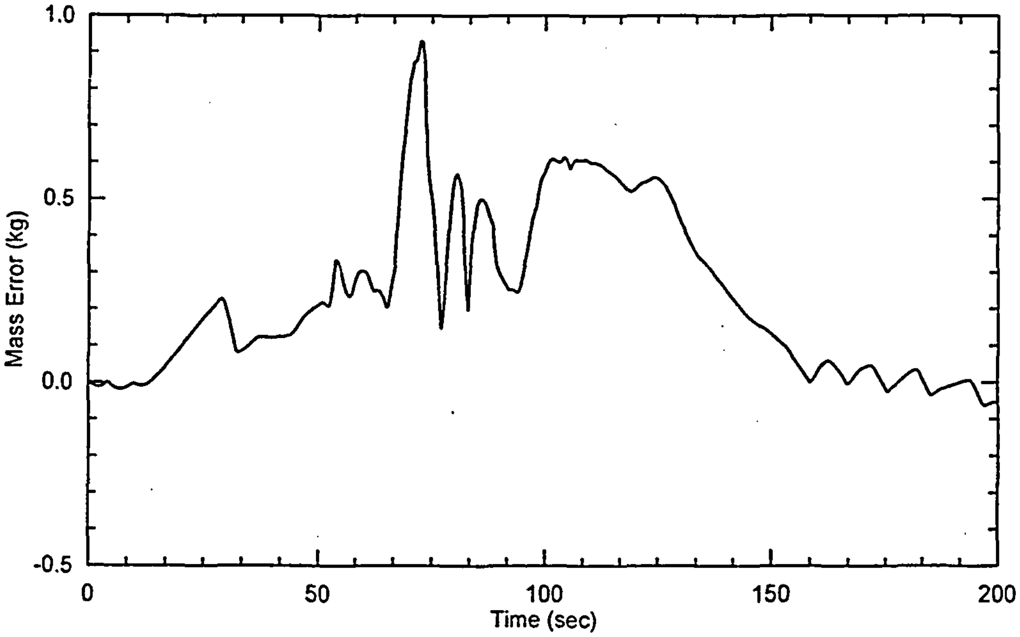

Fig. 16 The Mass Error of Base Case Calculation

Appendix A. Input Deck for Steady State Calculation of Base Case

```
=loft L9-3 ATWS experiment assessment calculation deck
*— —1— —1— —1— —1— —1— —1— —1—
*       initial conditions
*
*       core power = 48.7 MW
*       pcs flow = 467.6 kg/s
*       Pzr pressure = 14.98 MPa
*       thot = 576.4 k
*       tcold = 557.0 k
*
*— —1— —1— —1— —1— —1— —1— —1—
*
* SG U-tube 15 volumes with same discretizing in SG secondary
* SG separator flow path changed
*
*— —1— —1— —1— —1— —1— —1— —1—
0000100 new    stdy-st
0000101 run
0000102 si
0000105 5.    10.
0000110 nitrogen
*
*— —1— —1— —1— —1— —1— —1— —1—
* time step control cards
*          end time   min dt    max dt   optn mnr mjr     rst
0000201 400.0       1.e-4     0.1        2      5   1000 1000
*— —1— —1— —1— —1— —1— —1— —1—
*
************************************************************
*
*       minor edit variables
*
************************************************************
* pressure
************************************************************
0000308 cntrlvar    51        * pe-pc-2
0000309 cntrlvar    50        * porv inlet
0000314 cntrlvar    53        * pt-p4-10a
************************************************************
* temperatures
************************************************************
0000322 tempf   100010000    * te-pc-2a,2b,2c
0000323 tempf   185010000    * te-pc-1
0000326 tempf   505010000    * sg liq. temp.
0000330 tempf   415030000    * pzr liq. temp
0000331 tempf   300010000    * broken loop hot leg
0000332 tempf   335010000    * broken loop cold leg
************************************************************
* mass flow rates
************************************************************
0000360 mflowj   100010000     * ilhl nozzle
0000363 mflowj   400010000     * pres. surge line flow
0000364 mflowj   407000000     * pzr spray flow
0000367 mflowj   550000000     * steam flow control valve
0000369 mflowj   560000000     * main feed
0000370 mflowj   546000000     * steam bypass
************************************************************
* water level
************************************************************
0000371 cntrlvar   1          * s/g level
0000372 cntrlvar   2          * pzr level
************************************************************
* power
************************************************************
*0000376 cntrlvar 701       * moderator density
*0000377 cntrlvar 702       * doppler temp.
0000378 cntrlvar 54         * power
0000379 rkreac     0       * reactivity
0000380 cntrlvar 220       * steam discharge enthalpy
0000381 cntrlvar 320       * feedwater input enthanpy
0000382 cntrlvar 330       * pzr liquid volume
0000383 cntrlvar 340       * pzr vapor volume
```

```
************************************************************
*
*    trips
*
************************************************************
* variable trips
************************************************************
0000504 time   0      lt    null   0    0.0     l
0000508 time   0      ge   null   0    0.0     l
0000509 tempf 100010000   ge   null   0    597.0     l
0000530 time    0 lt null    0 0.0    l *exp. power curve turn on
*
************************************************************
* logical trips
************************************************************
0000609 504    or    504     l
0000626 504    or    504     l   * for porv open/close
0000634 504    or    504     l   * for srv open/close
*
************************************************************
*
************************************************************
*       intact loop components
*
************************************************************
* reactor vessel nozzle - intact loop hot leg
************************************************************
1000000 rvnilhl        branch
1000001 2    0
1000101 0.06414 1.4458   0.0     0.0     0.0   0.0
1000102 4.0e-5   0.0     00000
1000200 0     1.49719e+07 0.13440e+07   0.24606e+07 0.0
1001101 250000000 100000000 0.0634    0.0 0.0 000100
1002101 100010000 105000000 0.0     0.05    0.05    000100
1001201 10.308      10:308 0.0
1002201 10.309      10.309 0.0
************************************************************
* pressurizer connection tee reactor vessel side
************************************************************
1050000 pzrtrvs      branch
1050001 1     0
1050101 0.06414 1.0506     0.0     0.0    0.0       0.0
1050102 4.0e-5    0.0     00000
1050200 0     1.49672e+07 0.13440e+07    0.24607e+07    0.0
1051101 105010000 110000000 0.0       0.05      0.05    000000
1051201 13.438      13.438 0.0
************************************************************
* steam generator inlet piping
************************************************************
1100000 sginlp        branch
1100001 1     0
1100101 0.0      1.1061    0.064318    0.0     0.0     0.0
1100102 4.0e-5    0.0     00000
1100200 0     1.49304e+07 0.13440e+07    0.24615e+07 .0
1101101 110010000 115000000 0.0     0.1     0.1    000100
1101201 13.439    13.439    0.0
************************************************************
* steam generator plus piping
************************************************************
1150000 sgppip        pipe
1150001 19
1150101 0.0     3
1150102 0.151    15
1150103 0.0     18
1150104 0.0634    19
*
1150201 0.0     1
1150202 0.0512    2
1150203 0.0     15
1150204 0.0512    16
1150205 0.0     18
*
```

```
1150301 1.3889    1
1150302 0.70769 2
1150303 0.63    3
1150304 0.3556667 6
1150305 0.5335    8
1150306 0.45    10
1150307 0.5335    12
1150308 0.3556667 15
1150309 0.63    16
1150310 0.543      17
1150311 0.689      18
1150312 0.55    19
*
1150401 0.079697    1
1150402 0.057961    2
1150403 0.3227    3
1150404 0.0      15
1150405 0.335      16
1150406 0.0437    17
1150407 0.0462    18
1150408 0.0      19
*
1150501 0.0      19
1150601 0.0      1
1150602 90.0    9
1150603    -90.0    19
1150701 0.0      1
1150702 0.246      2
1150703 0.513      3
1150704 0.3556667 6
1150705 0.5335    8
1150706 0.45    9
1150707    -0.45    10
1150708    -0.5335    12
1150709    -0.3556667 15
1150710    -0.513      16
1150711    -0.498      17
1150712    -0.689      18
1150713    -0.356      19
*
1150801 4.0e-5    0.0      2
1150802 4.0e-5    0.0102    3
1150803 1.0e-5    0.01022 15
1150804 4.0e-5    0.0102    16
1150805 4.0e-5    0.0      19
*
1150901 0.15    0.15    1
1150902 0.05    0.05    2
1150903 0.0      0.0      6
1150904 0.05    0.05    8
1150905 0.2      0.2      9
1150906 0.1      0.1      10
1150907 0.0      0.0      15
1150908 0.05    0.05    17
1150909 0.1      0.1      18
*
1151001 00000      19
1151101 000100    3
1151102 000000    13
1151103 000100    18
1151201 0       1.49472e+07 0.13440e+07 0.24611e+07 0.0 0.0 01
1151202 0       1.49524e+07 0.13440e+07 0.24610e+07 0.0 0.0 02
1151203 0       1.48727e+07 0.13440e+07 0.24627e+07 0.0 0.0 03
1151204 0       1.48509e+07 0.13185e+07 0.24631e+07 0.0 0.0 06
1151205 0       1.48295e+07 0.12978e+07 0.24636e+07 0.0 0.0 08
1151206 0       1.48142e+07 0.12801e+07 0.24639e+07 0.0 0.0 09
1151207 0       1.48072e+07 0.12650e+07 0.24641e+07 0.0 0.0 10
1151208 0       1.48020e+07 0.12523e+07 0.24642e+07 0.0 0.0 12
1151209 0       1.47964e+07 0.12410e+07 0.24643e+07 0.0 0.0 15
1151210 0       1.47976e+07 0.12410e+07 0.24643e+07 0.0 0.0 16
1151211 0       1.47251e+07 0.12410e+07 0.24658e+07 0.0 0.0 17
1151212 0       1.47165e+07 0.12410e+07 0.24660e+07 0.0 0.0 18
```

```
1151213 0       1.47119e+07 0.12410e+07 0.24661e+07 0.0 0.0 19
1151300 0
1151301 10.447     10.447 0.0     01
1151302 8.1183     8.1183 0.0     02
1151303 4.3289     4.3290 0.0     03
1151304 4.2693     4.2693 0.0     06
1151305 4.2239     4.2240 0.0     08
1151306 4.1858     4.1858 0.0     09
1151307 4.1546     4.1546 0.0     10
1151308 4.1293     4.1293 0.0     12
1151309 4.1070     4.1070 0.0     15
1151310 7.7626     7.7626 0.0     16
1151311 9.2494     9.2495 0.0     17
1151312 9.7826     9.7826 0.0     18
***********************************************************
*
*      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      1.47085e+07 0.12410e+07    0.24662e+07    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 9.7826     9.7827 0.0
1202201 5.0746     5.0746 0.0
1203201 5.0735     5.0735 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      1.46957e+07 0.12410e+07    0.24664e+07 0.0
1251101 125010000 130000000 0.0    0.1      0.1    000100
1252101 125000000 155000000 0.0    0.0      0.0    000100
1251201 7.8657    7.8657    0.0
1252201    -0.24790    -0.24790 0.0
***********************************************************
* pump 1 inlet
***********************************************************
1300000 pmp1nlet     snglvol
1300101 0.0     0.457     0.0189    0.0     90.0    0.457
1300102 4.0e-5    0.0     00000
1300200 0      1.46736e+07 0.12410e+07    0.24669e+07    0.0
***********************************************************
* primary coolant pump 1
***********************************************************
1350000 pcpump1       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      1.48967e+07    0.12412e+07    0.24622e+07    0.0
1350201 0      8.8881      8.8882      0.0
1350202 0      8.8868      8.8868      0.0
1350301 0   0   0       -1     -1     519       0
1350302 369.0      0.88469 .3155000    96.000000 500.60000 1.431
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
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----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
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* head curve no. 2
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
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
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* head curve no. 3
*—— ——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——
* head curve no. 4
*—— ——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——
* head curve no. 5
*—— ——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——
* head curve no. 6
*—— ——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——
* head curve no. 7
*—— ——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
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——
* head curve no. 8
*—— ——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——
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——
* torque curve no. 2
*—— ——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——
* torque curve no. 3
*—— ——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——
* torque curve no. 4
*—— ——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
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
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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 I9-1 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
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——
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
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*---- ----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
**************************************************************
* pump 1 outlet pump side
**************************************************************
1400000 pmp1outp    snglvol
1400101 0.0366   0.502    0.0     0.0     0.0     0.0
1400102 4.0e-5   0.0     00000
1400200 0     1.51268e+07 0.12412e+07   0.24558e+07   0.0
**************************************************************
* pump1 outlet pipe tee side
**************************************************************
1450000 pmp1outt    branch
1450001 2    0
1450101 0.0     1.4084   0.0633   0.0     0.0     0.0
1450102 4.0e-5   0.0     00000
1450200 0     1.51312e+07 0.12412e+07   0.24557e+07   0.0
1451101 140010000 145000000 0.0    0.1     0.1     000100
1452101 145010000 150000000 0.0    0.0     0.0     000100
1451201 8.8843     8.8843 0.0
1452201 10.426     10.426 0.0
**************************************************************
* pump outlet tee
**************************************************************
1500000 pmpoutt     branch
1500001 3    0
1500101 0.0634   0.4966   0.0     0.0     0.0     0.0
1500102 4.0e-5   0.0     00000
1500200 0     1.51126e+07 0.12412e+07   0.24572e+07   0.0
1501101 170010000 150000000 0.0183   0.2   0.2     000100
1502101 150010000 175000000 0.0     0.1   0.1     000100
1503101 150010000 406000000 0.0     0.0   0.0     000100
1501201 4.1361     4.1361 0.0
1502201 9.7788     9.7788 0.0
1503201 2.66479e-07   2.66479e-07   0.0
**************************************************************
* pump 2 suction tee outlet
**************************************************************
1550000 pmp2sctt    branch
1550001 1    0
1550101 0.0     1.003    0.0613   0.0     90.0    0.521
1550102 4.0e-5   0.0     00000
1550200 0     1.46976e+07 0.12410e+07   0.24664e+07 0.0
1551101 155010000 160000000 0.0    0.1     0.1     000100
1551201 7.1313     7.1313 0.0
**************************************************************
* pump 2 inlet pipe
**************************************************************
1600000 pmp2inet    snglvol
1600101 0.0     0.457    0.0189   0.0     90.0   0.457
1600102 4.0e-5   0.0     00000
1600200 0     1.46788e+07 0.12410e+07   0.24668e+07   0.0
**************************************************************
* primary coolant pump 2
**************************************************************
1650000 pcpump2      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     1.49127e+07 0.12412e+07   0.24618e+07   0.0
1650201 0     8.0583     8.0583 0.0
1650202 0     8.0569     8.0569 0.0
1650301 135   135   135    -1      -1      519     0
1650302 369.00000 0.8599 .31550000 96.000000 500.60000   1.431
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1650303 613.6    0.0    207.433 0.004    19.5980 0.0
1650310 0.0    0.0    0.0
*************************************************************
* pump 2 outlet
*************************************************************
1700000 pmp2outt    branch
1700001 1    0
1700101 0.0366   0.514    0.0    0.0    0.0    0.0
1700102 4.0e-5   0.0    00000
1700200 0    1.51515e+07 0.12412e+07   0.24562e+07   0.0
1701101 145010000 170010000 0.0183   0.2    0.2    000100
1701201    -3.9184 -3.9184   0.0
*— —1— —1— —1— —1— —1— —1—
* cold leg pipe to ecc connection tee
*************************************************************
1750000 ilclpipe      pipe
1750001 2
1750101 0.0634   2
1750201 0.0    1
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      1.51081e+07 0.12412e+07 0.24573e+07 0.0 0.0 01
1751202 0      1.51017e+07 0.12412e+07 0.24574e+07 0.0 0.0 02
1751300 0
1751301 9.7789 9.7789   0.0    01
*************************************************************
* ecc connection tee pump side
*************************************************************
1800000 ecct        branch
1800001 1    0
1800101 0.06343 1.152   0.0    0.0    0.0    0.0
1800102 4.0e-5   0.0   00000
1800200 0    1.50985e+07   0.12412e+07   0.24575e+07   0.0
1801101 175010000 180000000 0.0    0.05    0.05 000100
1801201 9.7789    9.7789 0.0
*************************************************************
* cold leg pipe from ecc connection to reactor vessel
*************************************************************
1850000 rvnilcl       branch
1850001 3    0
1850101 0.06379 1.01    0.0    0.0    0.0   0.0
1850102 4.0e-5   0.0    00000
1850200 0    1.50967e+07 0.12412e+07   0.24576e+07 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 9.0375    9.0375 0.0
1852201 9.7790    9.7790 0.0
1853201 1.6149    1.6149 0.0
*************************************************************
*
* reactor vessel
*
*— —1— —1— —1— —1— —1— —1—
* inlet annulus top volume
*— —1— —1— —1— —1— —1— —1—
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    1.50826e+07 0.12412e+07   0.24579e+07   0.0
2001101 200000000 205000000 0.0    0.0    0.0    000100
2002101 200000000 245010000 0.001     1800.    1800. 000100
2001201 -2.99198e-02 -2.99198e-02   .0
2002201 6.79995e-02   6.79995e-02   0.0
*— —1— —1— —1— —1— —1— —1—
* inlet annulus bottom volume
*— —1— —1— —1— —1— —1— —1—
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    1.50837e+07 0.12412e+07   0.24579e+07 0.0
2051101 205010000 210000000 0.0    0.0    0.0   000100
2051201 3.9237   3.9237   0.0
*— —1— —1— —1— —1— —1— —1—
* downcomer
*— —1— —1— —1— —1— —1— —1—
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      1.50830e+07 0.12412e+07 0.24579e+07 0.0 0.0 01
2101202 0      1.50892e+07 0.12412e+07 0.24577e+07 0.0 0.0 02
2101203 0      1.50954e+07 0.12412e+07 0.24576e+07 0.0 0.0 03
2101204 0      1.51016e+07 0.12412e+07 0.24574e+07 0.0 0.0 04
2101300 0
2101301 3.9237     3.9237 0.0     01
2101302 3.9237     3.9237 0.0     02
2101303 3.9237     3.9237 0.0     03
*— —1— —1— —1— —1— —1— —1—
* lower plenum top volume
*— —1— —1— —1— —1— —1— —1—
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    1.51098e+07 0.12410e+07   0.24572e+07   0.0
2151101 210010000 215000000 0.0   0.0   0.0   000100
2152101 215010000 220000000 0.0   0.0   0.0   000100
2153101 215000000 225000000 0.15 0.0   0.0   000100
2151201 3.9236     3.9237 0.0
2152201 -6.34506e-02 -6.34506e-02    0.0
2153201 2.4164      2.4164      0.0
*— —1— —1— —1— —1— —1— —1—
* lower plenum bottom volume
*— —1— —1— —1— —1— —1— —1—
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    1.51125e+07 0.12387e+07   0.24572e+07    0.0
*— —1— —1— —1— —1— —1— —1—
* core filler bypass
*— —1— —1— —1— —1— —1— —1—
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      1.50887e+07 0.12410e+07 0.24578e+07 0.0 0.0 01
2231202 0      1.50937e+07 0.12405e+07 0.24576e+07 0.0 0.0 02
2231203 0      1.51007e+07 0.12401e+07 0.24575e+07 0.0 0.0 03
2231204 0      1.51078e+07 0.12396e+07 0.24573e+07 0.0 0.0 04
2231205 0      1.51148e+07 0.12392e+07 0.24571e+07 0.0 0.0 05
2231206 0      1.51196e+07 0.12390e+07 0.24570e+07 0.0 0.0 06
2231207 0      1.51223e+07 0.12388e+07 0.24569e+07 0.0 0.0 07
2231300 0
2231301 1.6148     1.6148 0.0    01
2231302 1.6144     1.6144 0.0    02
2231303 1.6141     1.6141 0.0    03
2231304 1.6137     1.6137 0.0    04
2231305 1.6133     1.6133 0.0    05
2231306 1.6132     1.6132 0.0    06
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* junction from filler gap to lower plenum
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
2240000 fllrgapp     sngljun
2240101 223010000 220010000 0.0   10.     10.   000100
2240201 0     1.6131     1.6131 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     1.50986e+07 0.12410e+07    0.24575e+07    .0
2251101 225010000 230000000 0.0975   0.3    0.3       000000
2252101 225010000 235000000 0.0      0.0    0.0       000000
2251201 3.3511      3.3511 0.0
2252201 2.1831      2.1831 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 0.66   0.66    2
2301001 00100     3
2301101 000100   2
2301201 0      1.50762e+07 0.12871e+07 0.24581e+07 0.0 0.0 01
2301202 0      1.50637e+07 0.13370e+07 0.24584e+07 0.0 0.0 02
2301203 0      1.50502e+07 0.13529e+07 0.24587e+07 0.0 0.0 03
2301300 0
2301301 3.4276     3.4276 0.0    01
2301302 3.5187     3.5187 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      1.50877e+07 0.12410e+07 0.24578e+07 0.0 0.0 01
2351202 0      1.50693e+07 0.12410e+07 0.24582e+07 0.0 0.0 02
2351203 0      1.50492e+07 0.12411e+07 0.24587e+07 0.0 0.0 03
2351300 0
2351301 2.1831     2.1831 0.0    01
2351302 2.1832     2.1832 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     1.50346e+07 0.13468e+07   0.24591e+07   0.0
2401101 230010000 240000000 0.12   0.3     0.3   000000
2402101 235010000 240000000 0.0     0.0     0.0   000000
2401201 3.5504     3.5504 0.0
2402201 2.1833     2.1833 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     1.50141e+07 0.13455e+07   0.24596e+07   0.0
2451101 240010000 245000000 0.0     0.0     0.0     000100
2451201 5.5952   5.5952   0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* dead end of fuel modules
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
2460000 fumodu        branch
2460001 1    0
2460101 0.183     0.7     0.0     0.0     90.0   0.7
2460102 4.0e-5   0.214     00000
2460200 0     1.50299e+07 0.13438e+07   0.24592e+07   0.0
2461101 240010000 246000000 0.0     0.0     0.0   000100
2461201    -8.22277e-07 -8.22277e-07   0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* upper plenum lower volume
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
2500000 upllvol      branch
2500001 1    0
2500101 0.268     1.566     0.0     0.0     90.0     1.566
2500102 4.0e-5   0.0     00000
2500200 0     1.50159e+07 0.13440e+07   0.24595e+07 0.0
2501101 245010000 250000000 0.0     0.0     0.0 000100
2501201 5.6629     5.6629 0.0
****************************************************************************
*
*   broken loop
*
****************************************************************************
* reactor vessel nozzle - broken loop hot leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
3000000 rvblhl        branch
3000001 2    0
3000101 0.0634    0.876     0.0     0.0     0.0     0.0
3000102 4.0e-5   0.0     00000
3000200 0     1.50214e+07 0.12349e+07   0.24594e+07   0.0
3001101 250000000 300000000 0.0634   0.0     0.0     000100
3002101 300010000 305000000 0.0     0.1     0.1     000000
3001201 -0.12677     -0.12677 0.0
3002201 -0.12680     -0.12680 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* hot leg pipe to reflood assist bypass tee
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
3050000 hlpras        branch
3050001 1    0
3050101 0.0634    0.698     0.0     0.0     0.0     0.0
3050102 4.0e-5   0.0     00000
3050200 0     1.50214e+07 0.12354e+07   0.24594e+07   0.0
3051101 305010000 310000000 0.0     0.1     0.1     000100
```

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3051201 -0.17141 -0.17141 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* broken loop hot leg contraction
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3100000 sgsii       branch
3100001 2    0
3100101 0.0     1.5001    0.06785    0.0     0.0    0.0
3100102 4.0e-5   0.0     00000
3100200 0     1.50214e+07 0.12358e+07   0.24594e+07    0.0
3101101 370010000 310000000 0.0     0.0     0.0     000100
3102101 310010000 315000000 0.0     0.0     0.0     000100
3101201 0.20738    0.20738      0.0
3102201 3.10704e-04    3.10704e-04    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam generator and pump simulatior
*---- ----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
3150901 0.2     0.2     1
3150902 0.0     0.0     2
3150903 93.9    93.9    4
3150904 0.4     0.4     5
3150905 93.9    93.9    7
```

```
3150906 0.0     0.0     8
3150907 0.2     0.2     9
3150908 4.1     4.1     10
3150909 0.4     0.4     11
3151001 00000     12
3151101 000000    1
3151102 000100    4
3151103 000000    5
3151104 000100    11
3151201 0       1.50209e+07 0.11839e+07 0.24594e+07 0.0 0.0 01
3151202 0       1.50186e+07 0.11694e+07 0.24595e+07 0.0 0.0 02
3151203 0       1.50153e+07 0.12058e+07 0.24595e+07 0.0 0.0 03
3151204 0       1.50077e+07 0.12176e+07 0.24597e+07 0.0 0.0 04
3151205 0       1.49996e+07 0.12206e+07 0.24599e+07 0.0 0.0 05
3151206 0       1.49996e+07 0.12220e+07 0.24599e+07 0.0 0.0 06
3151207 0       1.50076e+07 0.12245e+07 0.24597e+07 0.0 0.0 07
3151208 0       1.50153e+07 0.12198e+07 0.24596e+07 0.0 0.0 08
3151209 0       1.50209e+07 0.12237e+07 0.24594e+07 0.0 0.0 09
3151210 0       1.50277e+07 0.12236e+07 0.24592e+07 0.0 0.0 10
3151211 0       1.50258e+07 0.12244e+07 0.24593e+07 0.0 0.0 11
3151212 0       1.50212e+07 0.12233e+07 0.24594e+07 0.0 0.0 12
3151300 0
3151301 .0      .0      0.0     01
3151302 .0      .0      0.0     02
3151303 .0      .0      0.0     03
3151304 .0      .0      0.0     04
3151305 .0      .0      0.0     05
3151306 .0      .0      0.0     06
3151307 .0      .0      0.0     07
3151308 .0      .0      0.0     08
3151309 .0      .0      0.0     09
3151310 .0      .0      0.0     10
3151311 .0      .0      0.0     11
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* isolation valve hot leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3200000   isvhl     valve
3200101   315010000 325000000 0 0     0.0     0.0 000100
3200201   1     0.0     0.0     0.0
3200300   trpvlv
3200301   504
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pipe section between isolat
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3250000   vvolhl    snglvol
3250101   0.0525    0.823     0.0   0.0     0.0     0.0
3250102   4.0e-5    0.0     00000
3250200   0     1.47400e+07 0.12385e+07    0.24655e+07 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* quick opening blowdown valve hot leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3300000   qobvhl    valve
3300101   325010000 800000000    0.0466 0.0 0.0    000100
3300201   1       0.0       0.0   0.0
3300300   trpvlv
3300301   504
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* reactor vessel nozzle - broken loop cold leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3350000 rvnbl     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     1.50838e+07 0.12408e+07    0.24579e+07    0.0
3351101 205000000 335000000 0.0634    1.0     1.0     000100
3352101 335010000 340000000 0.0     0.1     0.1     000000
3351201 0.12722     0.12722 0.0
3352201 0.12719     0.12719 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* cold leg pipe to reflood assist bypass tee
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3400000 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    1.50838e+07 0.12404e+07   0.24579e+07   0.0
3401101 340010000 345000000 0.0    0.1    0.1    000000
3401201 0.12717 0.12717 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* broken loop cold leg contraction to break plane
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3450000 baoet    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    1.50838e+07   0.12398e+07   0.24579e+07 0.0
3451101 345000000 385000000 0.0    0.0    0.0    000100
3452101 345010000 350000000 0.0    0.0    0.0    000100
3451201 0.20769 0.20769 0.0
3452201 2.02355e-04   2.02355e-04   0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* ecc tee isolation valve cold leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3500000 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      1.50838e+07 0.10201e+07 0.24579e+07 0.0 0.0 01
3501202 0      1.50838e+07 0.11596e+07 0.24579e+07 0.0 0.0 02
3501300 0
3501301 .0     .0     0.0    01
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* isolation valve cold leg
*---- ----1---- ----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 504
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pipe section between isolation valve and qobv cold leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3600000   vvolcl    snglvol
3600101   0.0525    0.813 0.0   0.0   0.0   0.0
3600102   4.0e-5    0.0    00000
3600200   0     1.47400e+07 0.12385e+07   0.24655e+07   0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* quick opening blowdown cold leg
*---- ----1---- ----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   504
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* reflood assist bypass piping - cold leg side
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
3700000 rabsphl 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    1.50238e+07 0.12366e+07   0.24593e+07   0.0
3701101 375010000 370000000 0.0    0.0    0.0    000100
3701201 0.20747 0.20747 0.0
```

```
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* reflood assist bypass parrel pipes hot leg side
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
3750000 rabphl   snglvol
3750101 0.0776   0.0    0.0858   0.0    0.0   0.0
3750102 4.0e-5   0.0    00000
3750200 0    1.50262e+07 0.12375e+07   0.24593e+07 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* reflood assist bypass valves
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
3770000 rabsvlv sngljun
3770101 380010000 375000000 0.0    1.4e+4   1.4e+4   000000
3770201 0    0.10375 0.10375 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* reflood assist bypass parrel pipes cold leg side
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
3800000 rabppcl snglvol
3800101 0.0776   0.0    0.0855   0.0    0.0   0.0
3800102 4.0e-5   0.0    00000
3800200 0    1.50886e+07 0.12380e+07   0.24578e+07 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* reflood assist bypass single pipe cold leg side
*---- ----1---- ----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    1.50862e+07 0.12384e+07   0.24578e+07   0.0
3851101 385010000 380000000 0.0    0.0    0.0    000100
3851201 0.20755 0.20755 0.0
*************************************************************************
*
* pressurizer
*
*************************************************************************
* surge line pcs side
*---- ----1---- ----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    1.49932e+07 0.13445e+07   0.24601e+07   0.0
4001101 110000000 400000000 0.0    0.93 0.93   000100
4002101 400010000 405000000 0.0    0.93 0.93   000000
4001201 -1.76611e-03 -1.76611e-03    0.0
4002201 -1.76637e-03 -1.76637e-03    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
* surge line pressurizer vessel
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
4050000 slprv    snglvol
4050101 0.00145 3.45   0.0    0.0    90.0    0.60
4050102 4.0e-5   0.0    00000
4050200 0    1.49892e+07 0.13500e+07   0.24602e+07 0.0
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
*   spray line
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
4060000 spray    snglvol
4060101 0.000336   6.322    0.0    0.0    90.0
4060102 3.161     4.0e-5   0.0    00000
4060200 0    1.51369e+07 0.12441e+07   0.24566e+07 0.0
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
*   spray valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---.
4070000 sprvlv   valve
4070101  406010000  420010000  3.3451e-4   0.0     0.0     000100
0.93
4070201 0    .000000 .000000 0.0
4070300 trpvlv
4070301 690
*
```

```
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pressurizer surge line valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
4100000 slvalv   sngljun
4100101 405010000 415000000 0.0    0.93   0.93    000100
4100201 0      -1.78329e-03 -1.78229e-03   0.0
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pressurizer vessel
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
4150000 pzrve     pipe
4150001 8
4150101 0.362     1
4150102 0.565     5
4150103 0.466     7
4150104 0.13    8
4150201 0.0     7
4150301 0.224     1
4150302 0.403     3
4150303 0.207     5
4150304 0.1705    7
4150305 0.118     8
4150401 0.0     8
4150501 0.0     8
4150601 90.0   8
4150801 4.0e-5   0.0     8
4151001 00000     8
4151101 000000   7
4151201 0   1.49863e+07 0.14689e+07 0.24602e+07 .0    0.0 01
4151202 0   1.49844e+07 0.15556e+07 0.24603e+07 .0    0.0 02
4151203 0   1.49820e+07 0.15592e+07 0.24612e+07 0.10700 0.0 03
4151204 0   1.49808e+07 0.15853e+07 0.24604e+07 0.99997 0.0 04
4151205 0   1.49806e+07 0.15852e+07 0.24604e+07 0.99994 0.0 05
4151206 0   1.49805e+07 0.15853e+07 0.24604e+07 0.99995 0.0 06
4151207 0   1.49803e+07 0.15853e+07 0.24604e+07 0.99996 0.0 07
4151208 0   1.49802e+07 0.15851e+07 0.24604e+07 0.99995 0.0 08
4151300 0
4151301   -9.80221e-06   1.72291e-04   0.0    01
4151302   -1.00009e-05   0.29111   0.0    02
4151303   -0.26445    -1.27089e-05   0.0    03
4151304   -9.80199e-02 -2.35256e-05   0.0    04
4151305   -0.11938    -4.16312e-05   0.0    05
4151306   -9.40738e-02 -5.24284e-05   0.0    06
4151307   -0.16661    -2.26655e-04   0.0    07
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pressurizer top hat and relief connection
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
4200000 toppre    branch
4200001 1     0
4200101 0.13   0.118     0.0     0.0     90.0   0.118
4200102 4.0e-5   0.0     00000
4200200 0     1.49801e+07 0.15854e+07    0.24604e+07    0.99995
4201101 415010000 420000000    0.0     0.0     0.0     000000
4201201    -9.69743e-02 -2.46255e-04      0.0
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* porv
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
4250000 porv    valve
4250101 420010000 810000000 2.4784e-5   0.0     0.0     000100
4250201 0     .000000 .00000   0.0
4250300 trpvlv
4250301 626
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* experimental SRV
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
4300000 porv    valve
4300101 420010000 820000000    6.24e-5   0.0     0.0     000100
4300201 0     .000000 .00000   0.0
4300300 trpvlv
4300301 634
```

```
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* containment power operated relief valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
8100000 cporv     tmdpvol
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
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* containment power operated relief valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
8200000 cporv     tmdpvol
8200101 0.0     1.0     0.1     0.0     0.0     0.0
8200102 0.0     0.0     00000
8200200 2
8200201 0.0     0.107e+6    1.0
*
***********************************************************************
*
* steam generator secondary side
*
***********************************************************************
* primary separator
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5000000 sepaout branch
5000001 2     0
5000101 1.273      0.718     0.0     0.0    +90.0     +0.718
5000102 4.e-5      0.7874    01000
5000200 0      5.61017e+06 0.11842e+07    0.25930e+07    0.98167
5001101 500010000 525000000 0.0      5.0 5.0      000000
5002101 500000000 505000000 0.0      0.0 0.0      000000
5001201    -2.7011    0.70073 0.0
5002201 0.58921 -8.34267e-05    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* separator outlet region
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5050000 lwrsep    branch
5050001 1
5050101 1.273      0.718     0.0     0.0    -90.0    -0.718
5050102 4.e-5      0.7874    01000
5050200 0      5.61221e+06 0.11842e+07    0.25930e+07 0.30082
5051101 505010000    510000000    0.0     0.0     0.0     000000
5051201 0.17414      -9.48643e-02    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* feed inlet volume
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5100000 feedinl branch
5100001 1     0
5100101 0.7525    0.518     0.0     0.0    -90.0     -0.518
5100102 4.e-5      0.10796 01000
5100200 0      5.61615e+06 0.11030e+07    0.25930e+07 0.0000
5101101 510010000 515000000 0.0     0.0     0.0    000100
5101201 0.51954 0.51954 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam generator downcomer
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5150000 dwncmr     annulus
5150001 14
5150101 0.23226    6
5150102 0.258     14
5150201 0.0      5
5150202 0.0      6
5150203 0.0      13
5150301 0.7102     1
5150302 0.3551     3
5150303 0.2367333   6
5150304 0.61691667 9
5150305 0.925375 11
5150306 1.85075    13
5150307 0.718    14
```

```
5150401 0.0      14
5150601 -90.0   6
5150602 21.0     12
5150603 16.0     13
5150604 90.0     14
*
5150701 -0.7102   1
5150702 -0.3551   3
5150703 -0.2367333 6
5150704 0.2367333   9
5150705 0.3551     11
5150706 0.7102     12
5150707 0.518    13
5150708 0.718    14
*
5150801 4.e-5     0.10793 6
5150802 4.e-5     0.0305    13
5150803 4.e-5     0.0     14
5150901 0.0      0.0      5
5150902 17.5     17.5     6
5150903 0.0      0.0      8
5150904 2.1      2.1      9
5150905 4.2      4.2      12
5150906 4.4      4.4      13
*
5151001 0001000     6
5151002 0001100    12
5151003 0001000    14
5151101 000000     5
5151102 000000     6
5151103 000000     13
5151201  0   5.62080e+06  0.11038e+07  0.25929e+07  0.0000   0.0
01
5151202  0   5.62631e+06  0.11046e+07  0.25929e+07  0.0000   0.0
03
5151203  0   5.63182e+06  0.11053e+07  0.25929e+07  0.0000   0.0
06
5151204 0   5.63067e+06 0.11745e+07 0.25928e+07 0.32326 0.0 09
5151205 0   5.62614e+06 0.11839e+07 0.25929e+07 0.49171 0.0 11
5151206 0   5.62047e+06 0.11846e+07 0.25929e+07 0.60409 0.0 12
5151207 0   5.61560e+06 0.11844e+07 0.25930e+07 0.59935 0.0 13
5151208 0   5.61269e+06 0.11844e+07 0.25930e+07 0.51173 0.0 14
5151300 0
5151301 0.51971     0.51971 0.0     01
5151302 0.51987     0.51987 0.0     03
5151303 0.52002     0.83703 0.0     06
5151304 0.61397     2.5665   0.0     09
5151305 0.73514     4.0513   0.0     11
5151306 0.83034     5.2889   0.0     12
5151307 0.82057     5.3343   0.0     13
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* top of the riser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5200000 separin separatr
5200001 3    0
5200101 0.27871 0.718     0.0     0.0     90.0   0.718
5200102 4.e-5     0.0     01000
5200200 0     5.61107e+06 0.11843e+07   0.25930e+07    0.81644
5201101 520010000 525000000 0.0     3.7    3.7 000000
5202101 520000000 505000000 0.0     0.0    0.0 000000
5203101 515010000 520000000 0.0     4.4    4.4 000000
5201201 0.67331     6.2512    0.0
5202201 0.67331     6.2512    0.0
5203201 0.67331     6.2512    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* below mist extractor, above top of shroud in steam dome
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5250000 botstm    branch
5250001 1     0
5250101 1.5886    0.762     0.0     0.0     90.0     0.762
5250102 4.e-5     0.0     00000
5250200 0     5.60992e+06 0.11841e+07    0.25930e+07    1.0000
```

```
5251101 525010000 530000000 0.0     0.8     0.8     000100
5251201 0.66195 0.71981 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 0.8     0.8     1
5301001 00000     2
5301101 000100    1
5301201 3     5.61e+06    554.0   0.0    0.0    0.0    01
5301202 3     5.49e+06    554.0   0.0    0.0    0.0    02
5301300 0
5301301 10.500    19.767    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     2.12350e+06 0.92017e+06    0.25983e+07    0.99600
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* air cooled condenser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5400000 condnsr tmdpvol
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 tmdpvol
5450101 29.81     3.048     0.0     0.0     0.0     0.0
5450102 4.e-5     0.0     00000
5450200 1
5450201 -1.0    480.62    0.0
5450202 0.0     480.62    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam control valve bypass
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5460000 scvbyp    valve
5460101 530010000 547000000 4.48e-4    0.0    0.0    000000
5460201 0     .000000 .000000 0.0
5460300 trpvlv
5460301 504
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* air cooled condenser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5470000 conders tmdpvol
5470101 0.21677 17.67     0.0     0.0     0.0     0.0
5470102 4.e-5     0.0     00000
5470200 2
5470207 0.0     2.069e+6    1.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam flow control valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5500000 cv-p4-1 sngljun
5500101 530010000 535000000    0.00337 0.0    0 0    000100    0.93
5500201 0     18.585     20.163    0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* flow path to the air cooled condenser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
```

```
5550000 coacco    sngljun
5550101 535010000 540000000 0.0     0.0     0.0     000100
5550201 0     8.1357   35.082   0.0
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* main feed water valve
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
5600000 mnfeed    tmdpjun
5600101 545000000 510000000 0.05
5600200 1
5600201 0.0     25.7     0.0     0.0
*****************************************************************
*
*    containment
*
*****************************************************************
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* containment broken loop hot leg
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
8000000 cblhl     tmdpvol
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
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* containment broken loop cold leg
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
8050000   c805     tmdpvol
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
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
*
*     heat structure input data
*
*****************************************************************
*
* steam generator heat structures
*
*****************************************************************
* steam generator tubing
*****************************************************************
10060000   12     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    562.493667   3
10060502   115070000   10000    1    1    843.7405   5
10060503   115090000   10000    1    1    1687.481   7
10060504   115110000   10000    1    1    843.7405   9
10060505   115130000   10000    1    1    562.493667 12
*
10060601   515070000   10000    1    1    562.493667   3
10060602   515100000   10000    1    1    843.7405   5
10060603   515120000   0    1    1    1687.481   7
10060604   515110000   -10000   1    1    843.7405   9
10060605   515090000   -10000   1    1    562.493667 12
*
10060701   0    0    0    0       12
10060801   0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 12 * mod 3
10060901   0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 12 * 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 130000    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   115160000 0    1    1    0 1579621   2
11152601   515060000 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     0.178
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   115180000 0    1    1    0.689    5
11001506   115190000 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
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
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
```

```
* steam generator connections
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
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  115170000 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
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* .216 meter diameter piping
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
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
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  115160000 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
************************************************************
* 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    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
12050201  4     20
12050301  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    6
```

```
12100801  0.0   11.0   11.0 0.0   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     3
12110801  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 1   * mod 3
12110802  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 2   * mod 3
12110803  0.0   11.0   11.0 0.0   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     0.3600     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     5
12120801  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 1   * mod 3
12120802  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 3   * mod 3
12120803  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 4   * mod 3
12120804  0.0   11.0   11.0 0.0   0.0   0.0   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     1
12200801  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 1   * mod 3
12200901  0.0   11.0   11.0 0.0   0.0   0.0   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     7
12250801  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 1   * mod 3
12250802  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 3   * mod 3
12250803  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 4   * mod 3
12250804  0.0   11.0   11.0 0.0 · 0.0   0.0   0.0   1.0 5   * mod 3
12250805  0.0   11.0   11.0 0.0   0.0   0.0   0.0   1.0 6   * mod 3
12250806  0.0   11.0   11.0 0.0   0.0   0.0   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     1
12260801  0.0   11.0   11.0 0.0   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    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    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    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    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    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    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    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    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
************************************************************
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
************************************************************
* reflood 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
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
14172901   1.6764e-2 11.0 11.0 0.0   0.0   0.0   0.0   1.0 12   * mod
3
************************************************************
* pressurizer cycling heaters
*— —1— —1— —1— —1— —1— —1—
* pressurizer backup heaters
*— —1— —1— —1— —1— —1— —1—
14201000  1    11    2    1    0.2032
14201100  0    1
14201101  10    0.3683
14201201  5    10
14201301  0.0    10
14201401  617.   11
14201501  420010000 0    1    1    0.118    1
14201601  -939   0    3969   1    0.118    1
14201701  0    0    0    0    1
14201801  0.0    11.0    11.0    0.0    0.0 0.0    0.0    1.0    1    * mod 3
14202000  1    11    1    1    0.0
14202100  0    1
14202101  10    0.18415
14202201  5    10
14202301  0.0    10
14202401  617.   11
14202501  420010000 0    1    1    0.13    1
14202601  -939   0    3969   1    0.13    1
14202701  0    0    0    0    1
14202801  0.0    11.0    11.0 0.0    0.0    0.0    0.0    1.0 1 * mod 3
*
************************************************************
* steam generator heat structures
************************************************************
* shroud secondary side steam generator -upper section
*— —1— —1— —1— —1— —1— —1—
15000000  3    4    2    1    0.3048
15000100  0    1
15000101  3    0.3143
15000201  5    3
15000301  0.0    3
15000401  540.0    4
15000501  500010000 0    1    1    0.7725    1
15000502  505010000 0    1    1    0.7725    2
15000503  510010000 0    1    1    0.152     3
15000601  520010000 0    1    1    0.7725    1
15000602  515140000 0    1    1    0.7725    2
15000603  515130000 0    1    1    0.152     3
15000701  0    0.0    0.0    0.0    3
15000801  0.0    11.0    11.0 0.0    0.0    0.0    0.0    1.0 3    * mod 3
15000901  0.0    11.0    11.0 0.0    0.0    0.0    0.0    1.0 3    * mod 3
*— —1— —1— —1— —1— —1— —1—
* shroud - lower section
*— —1— —1— —1— —1— —1— —1—
15150000  7    4    2    1    0.6445
15150100  0    1
15150101  3    0.6572
15150201  5    3
15150301  0.0    3
15150401  540.0    4
15150501  510010000 0    1    1    0.152     1
15150502  515010000 0    1    1    0.7113    2
15150503  515020000 10000    1    1    0.35565 4
15150504  515040000 10000    1    1    0.2371    7
15150601  515130000 0    1    1    0.152    1
15150602  515120000 0    1    1    0.7113   2
15150603  515110000 -10000    1    1    0.35565 4
15150604  515090000 -10000    1    1    0.2371    7
15150701  0    0    0    0    7
15150801  0.0    11.0    11.0 0.0    0.0    0.0    0.0    1.0 7    * mod 3
15150901  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 wall
*— —1— —1— —1— —1— —1— —1—
15300000  11    10    2    1    0.7112
15300100  0    1
15300101  9    0.765165
15300201  5    9
15300301  0.0    9
15300401  530.0    10
*
15300501  530010000 0    1    1    0.762    1
15300502  525010000 0    1    1    0.762    2
15300503  500010000 0    1    1    0.718    3
15300504  505010000 0    1    1    0.718    4
15300505  510010000 0    1    1    0.518    5
15300506  515010000 0    1    1    0.7102   6
15300507  515020000 10000    1    1    0.3551    8
15300508  515040000 10000    1    1    0.23673 11
*
15300601  -939   0    3959   1    0.762    1
15300602  -939   0    3959   1    0.762    2
15300603  -939   0    3959   1    0.718    4
15300604  -939   0    3959   1    0.518    5
15300605  -939   0    3959   1    0.7102   6
15300606  -939   0    3959   1    0.3551   8
15300607  -939   0    3959   1    0.23673 11
*
15300701  0    0.0    0.0    0.0    11
15300801  0.0    11.0    11.0 0.0    0.0    0.0    0.0    1.0 11   * mod 3
************************************************************
*
* heat structure thermal property data
*
************************************************************
*— —1— —1— —1— —1— —1— —1—
20100100  tbl/fctn   1    1    * uo2
20100200  tbl/fctn   1    1    * gap
20100300  tbl/fctn   1    1    * zr
20100400  tbl/fctn   1    1    * s-steel
20100500  c-steel
20100600  tbl/fctn   1    1    * inconel 600
20100700  tbl/fctn   1    1    * mgo
20100800  tbl/fctn   1    1    * nicr
*— —1— —1— —1— —1— —1— —1—
* uo2 - thermal conductivity
*— —1— —1— —1— —1— —1— —1—
20100101  2.7315e2   8.44
20100102  4.1667e2   6.46
20100103  5.3315e2   5.782385
20100104  6.99817e2 4.633177
20100105  8.66483e2 3.880307
20100106  1.03315e3 3.357625
20100107  1.08871e3 3.155129
20100108  1.19982e3 2.983787
20100109  1.28315e3 2.836674
20100110  1.36648e3 2.713792
20100111  1.53315e3 2.521680
20100112  1.61648e3 2.448990
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
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
20100710   866.48   0.1987
20100711   922.04   0.1934
20100712   977.59   0.1882
20100713   1033.15 0.1830
20100714   1088.71 0.1777
20100715   1144.26 0.1725
20100716   1199.82 0.1673
20100717   1255.37 0.1621
20100718   1310.93 0.1568
20100719   1366.48 0.1516
20100720   1422.04 0.1464
20100721   1477.59 0.1412
20100722   1533.15 0.1359
20100723   1588.71 0.1307
20100724   1644.26 0.1255
20100725   1699.82 0.1203
20100726   1755.37 0.1150
20100727   1810.93 0.1098
20100728   1866.48 0.1046
20100729   1922.04 0.0993
20100730   5000.00 0.0993
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* magnesium oxide - volumetric heat capacity
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20100751   373.15   2033.52
20100752   422.04   2004.59
20100753   477.59   1917.74
20100754   533.15   1938.87
20100755   588.71   1906.01
20100756   644.26   1873.15
20100757   699.82   1840.29
20100758   755.37   1807.43
20100759   810.93   1774.56
20100760   866.48   1741.70
20100761   922.04   1708.84
20100762   977.59   1675.96
20100763   1033.15 1643.11
20100764   1088.71 1610.25
20100765   1144.26 1577.39
```

```
20100766   1199.82 1544.53
20100767   1255.37 1511.67
20100768   1310.93 1478.80
20100769   1366.48 1445.94
20100770   1422.04 1413.08
20100771   1477.59 1380.22
20100772   1533.15 1347.35
20100773   1588.71 1314.49
20100774   1644.26 1281.63
20100775   1699.82 1248.77
20100776   1755.37 1215.90
20100777   1810.93 1183.04
20100778   1866.48 1150.18
20100779   1922.04 1117.32
20100780   5000.00 1117.32
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* nichrome - thermal conductivity
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20100801   373.15   1.1163
20100802   1922.04 1.1163
20100803   5000.00 1.1163
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* nichrome - volumetric heat capacity
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20100851   373.15   2180.80
20100852   1922.04 2180.80
20100853   5000.00 2180.80
*
***********************************************************
*
*   general table
*
***********************************************************
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pressurizer cycling heaters
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20241700   power
20241701   0.0    0.0
20241702   60.    0.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pressurizer backup haters
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20241800   power
20241801   0.0    0.0
20241802   60.    0.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* scram reactivity data
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20260900   reac-t   609
20260901   0.0    0.0
20260902   0.5     -0.5
20260903   0.59    -3.13
20260904   0.65    -3.95
20260905   0.75    -6.27
20260906   0.83    -8.72
20260907   0.90    -12.00
20260908   0.97    -17.12
20260909   1.125   -20.67
20260910   1.213   -22.10
20260911   1.3     -22.78
20260912   1.4     -23.17
20260913   1.6     -23.32
20260914   60.0    -23.32
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* reactor power table
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20290000   power
20290001   0.0      48.7e6
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* environmental heat loss boundary temperature
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
```

```
20293900   temp
20293901   0.0      311.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* reactor vessel environmental loss heat xfer coefficient
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20294900   htc-t
20294901   0.0      13.450
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* steam generator environmental loss heat xfer coefficient
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20295900   htc-t
20295901   0.0      3.385
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pressurizer generator environmental loss heat xfer coefficient
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20296900   htc-t
20296901   0.0      3.019
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* blhl environmental loss heat xfer coefficient
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20297900   htc-t
20297901   -1.0    0.0
20297902   0.0      13.450
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* core collapsed liquid level
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20255000   normarea   0   1.0   1.0
20255001   0.0    9.25e-4
20255002   9.25e-4    9.25e-4
20255003   1.0    1.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* power curve (?)
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20290000   power   609
20290001   0.0     48.9e+6
20290002   0.15    43.032e6
20290003   0.3     37.164e6
20290004   0.6     28.362e6
20290005   0.85     8.6064e6
20290006   1.0    5.99538e6
20290007   1.3    4.89e6
20290008   2.0    4.274e6
20290009   4.0    3.7060332e6
20290010   7.0    3.1296e6
20290011   10.0     2.93458e6
20290012   25.0     2.28548e6
20290013   65.0     1.7115e6
20290014   100.0    1.5425994e6
20290015   250.0    1.232769e6
20290016   650.0    0.91932e6
20290017   1000.0   0.80196e6
20290018   1500.0   0.6846e6
20290019   3000.0   0.5379e6
20290020   5000.0   0.44988e6
*
***********************************************************
*
*      reactor kinetics data
*
***********************************************************
30000000 point
30000001 gamma-ac 48.7e+6 0.0    348.43   1.0    0.556
30000002 ans79-1
*--------- shoud not be changed for transient -----------
***********************************************************
* delayed neutron constants
***********************************************************
30000101 0.0349    0.01275
30000102 0.2035    0.03177
30000103 0.1848    0.1181
30000104 0.4046    0.3160
30000105 0.1401    1.402
```

```
30000106 0.0321     3.914
************************************************************
* power history
************************************************************
30000401 4.87e+7     70.     hr
*
************************************************************
* reactivity curve numbers
************************************************************
30000011 609
************************************************************
* moderator density reactivity table
************************************************************
30000501 0.62626e+3    -4.4769
30000502 0.66396e+3    -3.2923
30000503 0.71617e+3    -1.5692
30000504 0.76112e+3    -0.1692
30000505 0.76837e+3   0.04615
30000506 0.79157e+3   0.6923
30000507 0.81188e+3   1.2398
30000508 0.86263e+3   2.2415
30000509 0.93804e+3   3.9231
30000510 0.99749e+3   5.1077
*
************************************************************
* doppler reactivity table
************************************************************
30000601 293.16     1.375
30000602 338.72     1.125
30000603 422.05     0.682
30000604 477.60     0.419
30000605 505.38     0.274
30000606 570.72     0.000
30000607 588.72   -0.075
30000608 695.83   -0.526
30000609 922.05   -1.386
30000610    1310.94   -2.543
30000611    1810.94   -3.865
30000612    2088.72   -4.502
30000613    2499.83   -5.392
30000614    3027.60   -6.417
*
************************************************************
*    volume weighting factors
************************************************************
* moderator temperature feedback
************************************************************
*30000701 230010000    0    0.31493 0.0
*30000702 230020000    0    0.31493 0.0
*30000703 230030000    0    0.37014 0.0
************************************************************
* doppler feedback
************************************************************
*30000801 2300001    0    0.43153 0.0
*30000802 2300002    0    0.51686 0.0
*30000803 2300003    0    0.05161 0.0
*
*----- mtc curve monitor ------------------------------
*
20593300 mtcmon function 1.0 0.    0
20593301 rho    230020000    933
*
20293300 reac-t
20293301 0.62626e+3     -9.2
20293302 0.66396e+3     -3.8
20293303 684.0       -1.5
20293304 692.0       -0.7
20293305 707.0       -0.2
20293306 0.71819e+3    0.0
20293307 737.0         0.5
20293308 744.0         0.6
20293309 0.76112e+3    0.7
20293310 0.76837e+3    0.8
20293311 0.79157e+3    1.05
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* power from experimental data
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20270000 power    530
20270001 1.08400000e+00 4.878200307e+07
20270002 3.48400000e+00 4.886505087e+07
20270003 4.68400000e+00 4.890413219e+07
20270004 7.08400000e+00 4.895786901e+07
20270005 9.48400000e+00 4.909465363e+07
20270006 1.18840000e+01 4.874292175e+07
20270007 1.42840000e+01 4.845469701e+07
20270008 1.66840000e+01 4.843515635e+07
20270009 1.90840000e+01 4.822020909e+07
20270010 2.14840000e+01 4.790755853e+07
20270011 2.38840000e+01 4.788313271e+07
20270012 2.62840000e+01 4.768772610e+07
20270013 2.86840000e+01 4.751186016e+07
20270014 3.10840000e+01 4.708685081e+07
20270015 3.34840000e+01 4.712104696e+07
20270016 3.58840000e+01 4.690609970e+07
20270017 3.82840000e+01 4.695006619e+07
20270018 4.06840000e+01 4.672534860e+07
20270019 4.30840000e+01 4.704288432e+07
20270020 4.54840000e+01 4.659344914e+07
20270021 4.78840000e+01 4.664230079e+07
20270022 5.02840000e+01 4.659344914e+07
20270023 5.26840000e+01 4.620263594e+07
20270024 5.50840000e+01 4.571900460e+07
20270025 5.74840000e+01 4.442932104e+07
20270026 5.98840000e+01 4.379913475e+07
20270027 6.22840000e+01 4.278790559e+07
20270028 6.46840000e+01 4.149822202e+07
20270029 6.70840000e+01 4.057004067e+07
20270030 6.94840000e+01 3.890908456e+07
20270031 7.18840000e+01 3.757054935e+07
20270032 7.42840000e+01 3.564090916e+07
20270033 7.66840000e+01 3.282216895e+07
20270034 7.90840000e+01 3.039424193e+07
20270035 8.14840000e+01 2.798097041e+07
20270036 8.38840000e+01 2.556281373e+07
20270037 8.62840000e+01 2.344265211e+07
20270038 8.86840000e+01 2.193313611e+07
20270039 9.10840000e+01 2.060437123e+07
20270040 9.34840000e+01 1.918278821e+07
20270041 9.58840000e+01 1.834742499e+07
20270042 9.82840000e+01 1.717498538e+07
20270043 1.00684000e+02 1.594880896e+07
20270044 1.03084000e+02 1.494735014e+07
20270045 1.05484000e+02 1.385795834e+07
20270046 1.07884000e+02 1.279299236e+07
20270047 1.10284000e+02 1.198694013e+07
20270048 1.12684000e+02 1.132255769e+07
20270049 1.15084000e+02 1.072168239e+07
20270050 1.17484000e+02 1.011103676e+07
20270051 1.19884000e+02 9.471080147e+06
20270052 1.22284000e+02 8.943482324e+06
20270053 1.24684000e+02 8.489161978e+06
20270054 1.27084000e+02 8.059267456e+06
20270055 1.29484000e+02 7.595176779e+06
20270056 1.31884000e+02 7.277641052e+06
20270057 1.34284000e+02 6.906368511e+06
20270058 1.36684000e+02 6.554636629e+06
20270059 1.39084000e+02 6.305493213e+06
20270060 1.41484000e+02 6.046579467e+06
20270061 1.43884000e+02 5.699732751e+06
20270062 1.46284000e+02 5.470129995e+06
20270063 1.48684000e+02 5.318689879e+06
20270064 1.51084000e+02 5.030465143e+06
20270065 1.53484000e+02 4.810632717e+06
```

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20270066 1.55884000e+02 4.629881611e+06
20270067 1.58284000e+02 4.405164020e+06
20270068 1.60684000e+02 4.214642584e+06
20270069 1.63084000e+02 4.014350818e+06
20270070 1.65484000e+02 3.901992023e+06
20270071 1.67884000e+02 3.716355752e+06
20270072 1.70284000e+02 3.589341462e+06
20270073 1.73884000e+02 3.349968376e+06
20270074 1.75084000e+02 3.276690900e+06
20270075 1.77484000e+02 3.095939795e+06
20270076 1.79884000e+02 3.086169465e+06
20270077 1.81084000e+02 3.017777154e+06
20270078 1.83484000e+02 2.807715058e+06
20270079 1.85884000e+02 2.695356263e+06
20270080 1.87084000e+02 2.656274943e+06
20270081 1.89484000e+02 2.568341972e+06
20270082 1.91884000e+02 2.495064497e+06
20270083 1.94284000e+02 2.382705702e+06
20270084 1.95484000e+02 2.328968886e+06
20270085 1.96684000e+02 2.299657896e+06
20270086 1.97884000e+02 2.260576576e+06
20270087 1.99084000e+02 2.211724926e+06
20270088 2.00284000e+02 2.182413936e+06
*
*************************************************************
*   control variables
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* steam generator downcomer collapsed liquid level
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20500100   sglvl    sum    1.0    0.0    1
20500101   0.0    0.718    voidf    500010000
20500102      0.718    voidf    505010000
20500103      0.518    voidf    510010000
20500104      0.7102   voidf    515010000
20500105      0.3551   voidf    515020000
20500106      0.3551   voidf    515030000
20500107      0.2367333 voidf    515040000
20500108      0.2367333 voidf    515050000
20500109      0.2367333 voidf    515060000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* pressurizer collapsed liquid level
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20500200   pzrlvl   sum    1.0    0.0    1 3   0.0   1.83
20500201   0.0    0.224    voidf    415010000
20500202      0.403    voidf    415020000
20500203      0.403    voidf    415030000
20500204      0.207    voidf    415040000
20500205      0.207    voidf    415050000
20500206      0.1705   voidf    415060000
20500207      0.1705   voidf    415070000
20500208      0.118    voidf    415080000
20500209      0.118    voidf    420010000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* core collapsed liquid level
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20500300   rvlvl    sum    1.0    0.0    1
20500301   0.0    0.712    voidf    250010000
20500302      0.854    voidf    250010000
20500303      0.843    voidf    245010000
20500304      1.118    voidf    240010000
20500305      0.657    voidf    230030000
20500306      0.559    voidf    230020000
20500307      0.559    voidf    230010000
20500308      0.520    voidf    225010000
20500309      0.360    voidf    215010000
20500310      0.370    voidf    220010000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* hot leg intact loop
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20504100   pcsvol1 sum    1.0    0.0    1
20504101   0.0    .09746482 rho    100010000
```

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20504102      0.1035956 rho    105010000
20504103      3.0300e-2 rho    110010000
20504104      9.0000e-2 rho    115010000
20504105      5.7000e-2 rho    115020000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* steam generator
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20504200   pcsvol2 sum    1.0    0.0    1
20504201   0.0    0.3350000 rho    115030000
20504202      0.1611170 rho    115040000
20504203      0.1611170 rho    115050000
20504204      6.7950e-2 rho    115060000
20504205      6.7950e-2 rho    115070000
20504206      1.61117-1 rho    115080000
20504207      1.61117-1 rho    115090000
20504208      3.3500e-1 rho    115100000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* sg-pump piping
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20504300   pcsvol3 sum    1.0    0.0    1
20504301   0.0    4.37000-2 rho    115170000
20504302      4.62000-2 rho    115180000
20504303      3.54406-2 rho    115190000
20504304      4.81840-2 rho    120010000
20504305      6.13000-2 rho    125010000
20504306      1.89000-2 rho    130010000
20504307      6.13000-2 rho    155010000
20504308      1.89000-2 rho    160010000
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* cold leg intact loop
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
20500400   pcsvol4 sum    1.0    0.0    1
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—— ——1——
* reactor
*—— ——1—— ——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—— ——1——
* hot leg broken loop
*—— ——1—— ——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-------1---
* cold leg broken loop
*-------1-------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
20500704    5.41000-3 rho    350010000
20500705    8.55000-2 rho    380010000
20500706    1.18030-1 rho    385010000
*-------1-------1-------1-------1-------1-------1---
* pressurizer
*-------1-------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-------1---
* reactor vessel downcomer mass
*-------1-------1-------1-------1-------1-------1---
20500900 dwncrms   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-------1---
* pcs mass
*-------1-------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-------1---
* break energy computer
*-------1-------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
```

```
*
20542700   pvgstm   div    1.0    0.0    1
20542701   rhog   420010000 p     420010000
*
20542800   hgstm    sum    1.0    0.0    1
20542801   0.0    1.0    ug      420010000
20542802    1.0    cntrlvar   427
*
20542900   xhgstm   mult   1.0    0.0    1
20542901   quals    420010000 cntrlvar   428
*
20543000   xhfstm   mult   1.0    0.0    1
20543001   quals    420010000 cntrlvar   426
*
20543100   yhfstm   sum    1.0    0.0    1
20543101   0.0    1.0    cntrlvar   426
20543102    -1.0    cntrlvar   430
*
20543200   hsteam   sum    1.0    0.0    1
20543201   0.0    1.0    cntrlvar   429
20543202    1.0    cntrlvar   431
*
20543300   brkpwr   mult   1.0    0.0    1
20543301   mflowj   425000000 cntrlvar   432
*
20543400   brkflow integral   1.0    0.0    1
20543401   mflowj   425000000
*
*------ SRV ------------------------------------
*
20552500   pvfstm   div    1.0    0.0    1
20552501   rhof   420010000 p     420010000
*
20552600   hfstm    sum    1.0    0.0    1
20552601   0.0    1.0    uf      420010000
20552602    1.0    cntrlvar   525
*
20552700   pvgstm   div    1.0    0.0    1
20552701   rhog   420010000 p     420010000
*
20552800   hgstm    sum    1.0    0.0    1
20552801   0.0    1.0    ug      420010000
20552802    1.0    cntrlvar   527
*
20552900   xhgstm   mult   1.0    0.0    1
20552901   quals    420010000 cntrlvar   528
*
20553000   xhfstm   mult   1.0    0.0    1
20553001   quals    420010000 cntrlvar   526
*
20553100   yhfstm   sum    1.0    0.0    1
20553101   0.0    1.0    cntrlvar   526
20553102    -1.0    cntrlvar   530
*
20553200   hsteam   sum    1.0    0.0    1
20553201   0.0    1.0    cntrlvar   529
20553202    1.0    cntrlvar   531
*
20553300   brkpwr   mult   1.0    0.0    1
20553301   mflowj   430000000 cntrlvar   532
*
20553400   brkflow integral   1.0    0.0    1
20553401   mflowj   430000000
*
*-------1-------1-------1-------1-------1-------1---
* 011 - 031    heat transfer rate calculator
*-------1-------1-------1-------1-------1-------1---
* heat added to pcs from core
*-------1-------1-------1-------1-------1-------1---
20511100   corhttr sum    1.0    0.0    1
20511101   0.0    24.374   htrnr    230000101
20511102    24.374   htrnr    230000201
```

```
20511103     24.374   htrnr    230000301
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* heat removed from pcs at to s/g tubes
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20511200   sghttr   sum    1.0    0.0    1
20511201   0.0   14.2746667   htrnr    006000100
20511202      14.2746667   htrnr    006000200
20511203      14.2746667   htrnr    006000300
20511204      22.412       htrnr    006000400
20511205      22.412       htrnr    006000500
20511206      44.824       htrnr    006000600
20511207      44.824       htrnr    006000700
20511208      22.412       htrnr    006000800
20511209      22.412       htrnr    006000900
20511210      14.2746667   htrnr    006001000
20511211      14.2746667   htrnr    006001100
20511212      14.2746667   htrnr    006001200
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* heat loss from reactor vessel
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20511300   rvheat   sum    1.0    0.0    1
20511301   0.0    2.3244   htrnr    211000101
20511302      5.25183 htrnr    211000201
20511303      3.56335 htrnr    211000301
20511304      1.59598 htrnr    212000101
20511305      4.96411 htrnr    212000201
20511306      4.96411 htrnr    212000301
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----
* heat loss from pzr
*---- ----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----
* heat loss from s/g
*---- ----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----
* toal heat loss from major components
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20511600   totheat 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----
* heat loss from broken loop hot leg
*---- ----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----
* heat loss from broken loop cold leg
*---- ----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----
* heat loss from rabs piping
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20511900   rabheat sum    1.0    0.0    1
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---- ----1----
* heat loss from intact loop hot leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20512000   ilhlheat   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---- ----1----
* heat loss from intact loop cold leg
*---- ----1---- ----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---- ----1----
* toal heat loss to environment
*---- ----1---- ----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---- ----1----
* metal heating in pzr
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20512300   pzrmtht 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---- ----1----
```

```
* metal heating in reactor vessel (1st part)
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20525100  rv1   sum    1.0    0.0    1
20525101  0.0    1.05331 htmr    200000100
20525102     0.79000 htmr    200100101
20525103     1.01501 htmr    200100201
20525104     2.29335 htmr    200100301
20525105     2.29335 htmr    200100401
20525106     2.29335 htmr    200100501
20525107     2.29335 htmr    200100601
20525108     1.33475 htmr    205000100
20525109     1.93518 htmr    205000101
20525110     2.82907 htmr    210000100
20525111     2.82907 htmr    210000200
20525112     2.82907 htmr    210000300
20525113     2.82907 htmr    210000400
20525114     1.06311 htmr    210000500
20525115     1.09265 htmr    210000600
20525116     4.37241 htmr    210000101
20525117     4.37241 htmr    210000201
20525118     4.37241 htmr    210000301
20525119     4.37241 htmr    210000401
20525120     1.64308 htmr    210000501
*
20525200  rv2   sum    1.0    0.0    1
20525201  0.0    1.68872 htmr    210000601
20525202     1.95223 htmr    211000100
20525203     4.41094 htmr    211000200
20525204     2.99281 htmr    211000300
20525205     1.41813 htmr    212000100
20525206     4.41094 htmr    212000200
20525207     4.41094 htmr    212000300
20525208     1.65755 htmr    212000400
20525209     1.70360 htmr    212000500
20525210     1.6800   htmr    220000100
*
20525300  rv3   sum    1.0    0.0    1
20525301  0.0    0.695734   htmr    225000700
20525302     0.921366   htmr    226000100
20525303     1.98094 htmr    240000100
20525304     1.80000 htmr    246000100
20525305     1.80000 htmr    246000101
20525306     2.04439 htmr    250000100
20525307     1.00000 htmr    251000100
20525308     1.00000 htmr    251000200
20525309     1.70445 htmr    250100100
20525310     0.71200 htmr    255000100
20525311     1.68000 htmr    220000101
20525312     0.980177   htmr    225000100
20525313     1.05369 htmr    225000200
20525314     1.05369 htmr    225000300
20525315     1.23842 htmr    225000400
20525316     2.10738 htmr    225000500
20525317     0.791681   htmr    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   htmr    300000100
20512602     0.622764   htmr    300000200
20512603     1.27051 htmr    300000300
20512616     0.668713   htmr    335000100
20512617     0.622764   htmr    335000200
20512618     0.869015   htmr    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 htmr    370000100
20512702     0.771131   htmr    370000200
20512703     0.768435   htmr    370000300
20512704     2.12160 htmr    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  ilhlmht sum    1.0    0.0    1
20512801  0.0    1.3716   htmr    100100100
20512802     1.45787 htmr    100100200
20512803     0.55548 htmr    100100300
20512804     1.28345 htmr    100100400
20512805     0.72288 htmr    100200100
20512806     1.4772   htmr    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   htmr    100100500
20512902     0.498747   htmr    100100600
20512903     0.678081   htmr    100100700
20512904     0.443073   htmr    100100800
20512905     0.498747   htmr    100100900
20512906     0.546926   htmr    100101000
20512907     0.625441   htmr    100101100
20512908     1.30352 htmr    100101200
20512909     0.558497   htmr    100200200
20512910     0.678584   htmr    100300100
20512911     0.310113   htmr    100300200
20512912     0.340649   htmr    100300300
20512913     0.955718   htmr    100300400
20512914     0.680620   htmr    100300500
20512915     0.310113   htmr    100300600
20512916     0.348792   htmr    100300700
20512917     1.4772   htmr    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   htmr    315000100
20513002     0.1703   htmr    315000200
20513003     0.0042   htmr    315100100
20513004     0.00347 htmr    315200100
20513005     0.12452 htmr    315300100
20513006     0.12452 htmr    315300200
20513007     0.12452 htmr    315300300
20513008     0.12452 htmr    315300400
20513009     0.12452 htmr    315300500
20513010     0.12452 htmr    315300600
20513011     0.04239 htmr    315400100
20513012     0.04363 htmr    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 htmr    500000100
20555102     1.47943 htmr    500000200
20555103     0.291097   htmr    500000300
20555104     1.52566 htmr    500000101
20555105     1.52566 htmr    500000201
20555106     0.300194   htmr    500000301
20555107     0.615526   htmr    515000100
20555108     2.88042 htmr    515000200
20555109     1.44021 htmr    515000300
20555110     1.44021 htmr    515000400
20555111     0.96014 htmr    515000500
20555112     0.96014 htmr    515000600
20555113     0.96014 htmr    515000700
20555114     0.627655   htmr    515000101
20555115     2.93718 htmr    515000201
20555116     1.46859 htmr    515000301
20555117     1.46859 htmr    515000401
20555118     0.994572667 htmr    515000501
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20555119     0.994572667 htmr    515000601
20555120     0.994572667 htmr    515000701
*
20555200  sgmth2  sum    1.0    0.0    1
20555201  0.0    3.40507 htmr    530000100
20555202     3.40507 htmr    530000200
20555203     3.20846 htmr    530000300
20555204     3.30846 htmr    530000400
20555205     2.31474 htmr    530000500
20555206     3.17360 htmr    530000600
20555207     3.17360 htmr    530000700
20555208     3.17360 htmr    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 htmr    115100100
20513202     56.4226 htmr    115100200
20513203     0.157962  htmr    115200100
20513204     0.157962  htmr    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  htmr    115200101
20513302     0.157962  htmr    115200201
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* metal hx in rabs
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20517000  rabs  sum    1.0    0.0    1
20517001  0.0    1.39487 htmr    370000100
20517002     0.77113 htmr    370000200
20517003     0.77278 htmr    370000300
20517004     2.12160 htmr    370000400
*****************************************************************
* bl total metal hx
*****************************************************************
20517100  qbltotal  sum    1.0    0.0    1
20517101  0.0    1.0    cntrlvar 127
*20517102     1.0    cntrlvar 170
20517103     1.0    cntrlvar 130   * only for simula
*****************************************************************
* pcs stored energy excluding pressurizer
*****************************************************************
20557000  pcsqre sum    1.0    0.0    1
20557001  0.0    1.0    cntrlvar 253   * rv metal heat
20557002     1.0    cntrlvar 113   * rv ambloss
20557003     1.0    cntrlvar 171   * only for simula
20557004     1.0    cntrlvar 117   * blhl ambloss
20557005     1.0    cntrlvar 118   * blcl ambloss
20557006     1.0    cntrlvar 119   * rabv ambloss
20557007     1.0    cntrlvar 128   * ilhl heat
20557008     1.0    cntrlvar 120   * ilhl ambloss
20557009     1.0    cntrlvar 129   * ilcl heat
20557010     1.0    cntrlvar 121   * ilcl ambloss
20557011     1.0    cntrlvar 132   * pcs-tubesheet
20557012     1.0    cntrlvar 133   * tubesheet-scs
*****************************************************************
* scs stored energy
*****************************************************************
20557300  scsqse sum    1.0    0.0    1
20557301  0.0    1.0    cntrlvar 552   * sg heat
20557302     1.0    cntrlvar 115   * sg ambloss
*****************************************************************
* heat flow calculations
*****************************************************************
* ecc energy flow
*****************************************************************
*20515300  pvecc    div    1.0    0.0    1
*20515301     rhofj    630000000   p    600010000
*
*20515400  hecc   sum    1.0    0.0    1
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```
*20515401  0.0    1.0    ufj    630000000
*20515402     1.0    cntrlvar 153
*
*20515500  mdothecc  mult  1.0    0.0    1
*20515501          mflowj   630000000
*20515502          cntrlvar 154
*
*20515600  qecc/v   mult  0.126646 0.0    1
*20515601          cntrlvar 155
*
*20515700  mdotev mult    0.126646 0.0    1
*20515701          mflowj   630000000
*****************************************************************
* sg hx per unit pcs volume
*****************************************************************
20516000  qsg/v    mult  0.126646 0.0    1
20516001     cntrlvar   112
*****************************************************************
* core hx per unit pcs volume
*****************************************************************
20516100  qcore/v mult  0.126646 0.0    1
20516101     cntrlvar   111
*****************************************************************
* pump power
*****************************************************************
20516200  p1edotv mult  0.04136   0.0    1
20516201     voidgj   135020000
20516202     velgj    135020000
20516203     pmphead 135
20516300  p1edotl mult  0.04136   0.0    1
20516301     voidfj   135020000
20516302     velfj    135020000
20516303     pmphead 135
20516400  p2edotv mult  0.04136   0.0    1
20516401     voidgj   165020000
20516402     velgj    165020000
20516403     pmphead 165
20516500  p2edotl mult  0.04136   0.0    1
20516501     voidfj   165020000
20516502     velfj    165020000
20516503     pmphead 165
20516600  qpmp   sum    1.0    0.0    1
20516601  0.0    1.0    cntrlvar 162
20516602     1.0    cntrlvar 163
20516603     1.0    cntrlvar 164
20516604     1.0    cntrlvar 165
20516700  qpmp/v   mult   0.126646 0.0    1
20516701     cntrlvar   166
*****************************************************************
* energy to fluid in vessel from structures
*****************************************************************
20562000  rvhx   sum    6.2832   0.0    1
20562001  0.0    0.3080   htmr    205000101
20562002     0.6959   htmr    210000101
20562003     0.6959   htmr    210000201
20562004     0.6959   htmr    210000301
20562005     0.6959   htmr    210000401
20562006     0.2615   htmr    210000501
20562007     0.2688   htmr    210000601
20562008     0.3107   htmr    211000100
20562009     0.7020   htmr    211000200
20562010     0.7020   htmr    212000100
20562011     0.7020   htmr    212000200
20562012     0.7030   htmr    212000300
20562013     0.6    htmr    212000400
20562014     0.2    htmr    212000500
20562015     1.0    cntrlvar   253
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* total vessel hx/v
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
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
20562603      -1.0     cntrlvar 533     * srv
20562700   dtqf/v   mult   0.126646 0.0     1
20562701      cntrlvar    626
*
*   pressurizer pressure in MPa
*
20505000   pzrpres sum 1.0e-06 0.0 1
20505001   0.0     1.0    p       420010000
*
*   hot leg pressure in MPa
*
20505100   hlpres sum    1.0e-06 0.0 1
20505101   0.0     1.0    p       100010000
*
*   cold leg pressure in MPa
*
20505200   clpres sum    1.0e-06 0.0 1
20505201   0.0     1.0    p       185010000
*
*   sg steam pressure in MPa
*
20505300   sgpres sum    1.0e-06 0.0 1
20505301   0.0     1.0    p       530010000
*
*   reactor power in MWt
*
20505400   reacpor sum 1.0e-06 0.0 1
20505401   0.0     1.0 rktpow    0
*
*   PORV upstream density in Mg/m3
*
20505500   updensi sum 1.0e-03 0.0 1
20505501   0.0     1.0    rho    420010000
*
*   total dischrged flow
*
20505700   tdis    sum 1.0     0.0 1
20505701   0.0     1.0     mflowj   425000000
20505702      1.0     mflowj   430000000
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* inlet outlet energy computer
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20521100   pvfstm   div     1.0     0.0     1
20521101   rhof    530020000 p     530020000
*
20521200   hfstm    sum     1.0     0.0     1
20521201   0.0     1.0     uf      530020000
20521202      1.0     cntrlvar   211
*
20521300   pvgstm   div     1.0     0.0     1
20521301   rhog    530020000 p     530020000
*
20521400   hgstm    sum     1.0     0.0     1
20521401   0.0     1.0     ug      530020000
20521402      1.0     cntrlvar   213
*
20521500   xhgstm   mult   1.0     0.0     1
20521501   quals     530020000 cntrlvar   214
*
20521600   xhfstm   mult   1.0     0.0     1
20521601   quals     530020000 cntrlvar   212
*
20521700   yhfstm   sum     1.0     0.0     1
20521701   0.0     1.0     cntrlvar   212
20521702      -1.0     cntrlvar   216
*
20521800   hsteam   sum     1.0     0.0     1
20521801   0.0     1.0     cntrlvar   215
20521802      1.0     cntrlvar   217
*
20521900   stmms    sum     1.0     0.0     1
20521901   0.0     1.0     mflowj   550000000
20521902      1.0     mflowj   546000000
*
20522000   brkpwr   mult   1.0     0.0     1
20522001   cntrlvar   219     cntrlvar   218
*
************************************************************
*
20531100   pvfstm   div     1.0     0.0     1
20531101   rhof    545010000 p     545010000
*
20531200   hfstm    sum     1.0     0.0     1
20531201   0.0     1.0     uf      545010000
20531202      1.0     cntrlvar   311
*
20531300   pvgstm   div     1.0     0.0     1
20531301   rhog    545010000 p     545010000
*
20531400   hgstm    sum     1.0     0.0     1
20531401   0.0     1.0     ug      545010000
20531402      1.0     cntrlvar   313
*
20531500   xhgstm   mult   1.0     0.0     1
20531501   quals     545010000 cntrlvar   314
*
20531600   xhfstm   mult   1.0     0.0     1
20531601   quals     545010000 cntrlvar   312
*
20531700   yhfstm   sum     1.0     0.0     1
20531701   0.0     1.0     cntrlvar   312
20531702      -1.0     cntrlvar   316
*
20531800   hsteam   sum     1.0     0.0     1
20531801   0.0     1.0     cntrlvar   315
20531802      1.0     cntrlvar   317
*
20532000   brkpwr   mult   1.0     0.0     1
20532001   mflowj   560000000 cntrlvar   318
*
*   Pressurizer Liquid Volume
*
20533000   pzrliqv sum     1.0     0.0     1
20533001   0.0     8.10880-2 voidf    415010000
20533002      2.27695-1 voidf    415020000
20533003      2.27695-1 voidf    415030000
```

```
20533004      1.16955-1 voidf    415040000
20533005      1.16955-1 voidf    415050000
20533006      7.94530-2 voidf    415060000
20533007      7 94530-2 voidf    415070000
20533008      1.53400-2 voidf    415080000
20533009      0.01534 voidf    420010000
*
*   Pressurizer Vapor Volume
*
20534000   pzrliqv sum    1.0    0.0    1
20534001   0.0    8.10880-2 voidg    415010000
20534002      2.27695-1 voidg    415020000
20534003      2.27695-1 voidg    415030000
20534004      1.16955-1 voidg    415040000
20534005      1.16955-1 voidg    415050000
20534006      7.94530-2 voidg    415060000
20534007      7.94530-2 voidg    415070000
20534008      1.53400-2 voidg    415080000
20534009      0.01534 voidg    420010000
*
*****************************************************************
*
*    Steady State Controllers
*
*****************************************************************
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* primary coolant pump speed controllers
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* calculate mass flow error
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590100   msserr   sum    1.0    0.0    1
20590101   467.6    -1.0   mflowj   100010000
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pump 1 speed
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590200   pcp1spd integral   0.34482 333.7236   1
20590201   cntrlvar   901
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pcp1 pump velocity table
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
1356100 508    cntrlvar   902
1356101 0.0    0.0
1356102 369.0    369.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* modify pcp1 pump data
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
1350301 0   0   0    -1     0    504    0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pump 2 speed
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590300   pcp2spd integral   0.34482 331.9524   1
20590301   cntrlvar   901
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pcp2 pump velocity table
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
1656100 508    cntrlvar   903
1656101 0.0    0.0
1656102 369.0    369.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* modify pcp2 pump data
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
1650301   135 135   135    -1     0    504    0
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pressurizer spray valve controller
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* spray valve
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
4070000 sprvlv   valve
4070101 406010000 420010000 3.3451e-4   0.0    0.0    000100 0.93
4070201 0    .00000000 .00000000   0.0
```

```
4070300 srvvlv
4070301 904    999
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* spray valve position calculator
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590400   spray    sum    -0.0001   0.0    1 * cont n
+    3    0.0    1.0
20590401   14.98e+6 -1.0   p    420010000
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* position vs area table
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20299900   normarea
20299901   0.0    0.0
20299902   0.1    0.0
20299903   1.0    1.0
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* pressurizer level control using charging and letdown components
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* charging reservior
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
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
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* charging valve
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
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--- ---1--- ---1--- ---1---
* charging valve position calculator
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590500   charge   sum    7.7    0.0    1    *contin
+    3    0.0    1.0
20590501   1.0   -1.0    cntrlvar   2
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* letdown sink
*--- ---1--- ---1--- ---1--- ---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--- ---1--- ---1--- ---1---
* letdown valve
*--- ---1--- ---1--- ---1--- ---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--- ---1--- ---1--- ---1---
* letdown valve position calculator
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590600   letdown sum    -7.7   0.0    1    *contin
+    3    0.0    1.0
20590601   1.03   -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--- ---1--- ---1--- ---1---
*5500201 0    18.585   20.163   0.0
*5500300 srvvlv
*5500301 910    540
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
```

```
* srv 550 valve area table
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20254000   normarea
20254001   0.0     0.0
20254002   0.0001    0.0
20254003   0.9     0.6 * modi at 8/26 in base
20254004   1.0     0.6
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* GT 908
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
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--- ---1--- ---1--- ---1---
* compute delta t error
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590700   delta sum      1.0    0.0    1
20590701   557.0   -1.    tempf    185010000
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* filter delta t thru deadband
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590800   deadband   function   1.0    0.0    1
20590801   cntrlvar   907    908
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* integrate delta t error
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20590900   int integral   1.0    0.0    1
20590901   cntrlvar   908
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* steam valve position calculator
*--- ---1--- ---1--- ---1--- ---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   3.15   -1.0   cntrlvar   001
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20591200   feedflow   sum    1.0    0.0    1
20591201   0.0    1.0    mflowj   550000000
20591202      48.4   cntrlvar   911
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* junction quantities
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20800001   flenth   425000000
20800002   flenth   430000000
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* replace feed junction table
*--- ---1--- ---1--- ---1--- ---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
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* boundary volume intact loop hot leg
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
5920000 bvolum    tmdpvol
5920101 0.0    1.0    0.1    0.0    0.0    0.0
5920102 0.0    0.0    00000
5920200 2
5920201 0.0    5.47091e6 1.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* boundary valve for steam generator
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
5930000 bvalv     sngljun
5930101 530020002 592000000 0.001   0.0    0.0    000100
5930201 0    0.0    0.0     0.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* boundary valve intact loop hot leg
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
9000000 bvalv     sngljun
9000101 420010000 905000000 0.00001 0.0    0.0   000100
9000201 0    0.0    0.0    0.0
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* boundary volume intact loop hot leg
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
9050000 bvolum    tmdpvol
9050101 0.0    1.0    1.0    0.0    0.0    0.0
9050102 0.0    0.0    00000
9050200 2
9050201 0.0    14.98e6 1.0
*
```

Appendix B. Input Deck for Transient Calculation of Base Case

```
=loft L9-3 ATWS experiment assessment calculation deck
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*        initial conditions
*
*        core power = 48.7 MW
*        pcs flow = 467.6 kg/s
*        Pzr pressure = 14.98 MPa
*        thot = 576.4 k
*        tcold = 557.0 k
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*
* use reactor kinetics feedback
* change mscv area to 0.0052235 from 0.00337
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000100 restart transnt
0000101 run
0000102 si
0000105 5.     10.
0000103 2241 rst
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* time step control cards
*          end time min dt   max dt   optn mnr mjr   rst
0000201 600.0      1.e-4    0.1       2    5   1000 1000
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*
****************************************************************
*
*       minor edit variables
*
****************************************************************
* pressure
****************************************************************
0000308 cntrlvar   51       * pe-pc-2
0000309 cntrlvar   50       * porv inlet
0000314 cntrlvar   53       * pt-p4-10a
****************************************************************
* temperatures
****************************************************************
0000322 tempf   100010000    * te-pc-2a,2b,2c
0000323 tempf   185010000    * te-pc-1
0000326 tempf   505010000    * sg liq. temp.
0000330 tempf   415030000    * pzr liq. te,p
0000331 tempf   300010000    * broken loop hot leg
0000332 tempf   335010000    * broken loop cold leg
****************************************************************
* mass flow rates
****************************************************************
0000360 mflowj   100010000      * ilhl nozzle
0000363 mflowj   400010000      * pres. surge line flow
0000364 mflowj   407000000      * pzr spray flow
0000367 mflowj   550000000      * steam flow control valve
0000369 mflowj   560000000      * main feed
0000360 mflowj   546000000      * sg bypass flow
****************************************************************
* water level
****************************************************************
0000370 cntrlvar   1        * s/g level
0000375 cntrlvar   2        * pzr level
****************************************************************
* power
****************************************************************
*0000376 cntrlvar 701        * moderator density
*0000377 cntrlvar 702        * doppler temp.
0000378 cntrlvar 54         * power
0000379 rkreac    0         * reactivity
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* delete steady state component
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
```

```
20590100   msserr   delete
20590200   pcp1spd delete
20590300   pcp2spd delete
20590400   spray    delete
9800000    chrg   delete
9850000    chrg   delete
20590500   charge   delete
9900000    ltdwn     delete
9950000    ltdwn     delete
20590600   letdown delete
20590700   delta     delete
20590800   deadband   delete
20590900   int    delete
20591000   int    delete
20591100   sglvlerr   delete
20591200   feedflow   delete
5930000    bvalv     delete
5920000    bvolum   delete
9000000    bvalv     delete
9050000    bvolum   delete
*
****************************************************************
*
*    trips
*
****************************************************************
* variable trips
****************************************************************
0000504 time   0      lt   null   0    0.0      l
0000508 time   0      ge   null   0    0.0      l
0000509 tempf 100010000   ge   null   0    597.0      l
****************************************************************
* logical trips
****************************************************************
0000609 504    or     504    l
****************************************************************
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* Loss of Feedwater : 501
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000501 time   0   ge   null   0    0.0    l
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* experimental power curve turn on
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000530 time   0   ge   null   0    0.0    l
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* Reactor Trip : 529, 609
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000529 time   0   ge   null   0    10000.0    l
0000609 529    or     529    l
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* primary coolant pump running on : 519
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000519 time   0   lt   null   0    0.0      l
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* Pressurizer Spray Cycling : 690
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000551 time   0      ge   timeof   626    0.0    l
0000574 p      420010000   gt   null   0     1.532e7 n
0000575 p      420010000   lt   null   0     1.498e7 n
*
* -- changed close setpoint from 15.16 MPa
*
0000688 690    or      574    n
0000689   -575    and   -575    n
0000690 688    and     689    n
*
```

```
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* Pressurizer experimental PORV Cycling & Latch Open : 625
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
*
*  latch open at 612.6 and close at 14.98 MPa
*
0000581 time   0      ge   null   0    612.6    l
0000552 p    420010000   lt   null   0    1.498e7 l
*
*  cycling
*
0000570 p    420010000   gt   null   0    1.62e7 n
0000571 p    420010000   lt   null   0    1.59e7 n
*
* -- changed lower setpoint from 16.0 MPa
*
0000621 623    or     570    n
0000622  -571    and   -571     n
0000623 621    and    622     n
0000624 581    and   -552     n
0000625 623    or     624     n
*
*  exclude simultaneous open with SRV
*
0000626 625    and    -634    n
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* Pressurizer experimental SRV : 633
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
*
0000577 p    420010000   gt   null   0    1.724e7 n
0000578 p    420010000   lt   null   0    1.626e7 n
*
* -- lower setpoint changed from 16.46 MPa
*
0000631 633    or    577      n
0000632   -578   and   -578      n
0000633 631    and    632      n
*
*  exclude simultaneous open with PORV
*
0000634 633    and    633      n
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* Steam Control Valve Manual Close : 612
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
0000520 time   0    ge   null   0    67.3    l
0000616 520    or   520       n
0000612 504    or   504       n
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* MSCV Bypass Valve Open/Close
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
*
0000542 p    530010000   gt   null   0    6.5e6 n
0000543 p    530010000   lt   null   0    6.3e6 n
*
0000642    644    or    542     n
0000643   -543   and   -543     n
0000644    642   and    643      n
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* mscv bypass 2 from 30 sec
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
0000548 time   0     ge   null   0    30.0    l
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
*    transient components
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
*
**************************************************************
* primary coolant pump 1
**************************************************************
```

```
1350000 pcpump1 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     1.48950e+07   0.12394e+07   0.24622e+07 0.0
1350201 0     8.6588     8.6589 0.0
1350202 0     8.6575     8.6575 0.0
1350301 0   0   0    -1      -1    519   0
1350302 369.00000 0.87485 .31550000 96.0 500.60000 1.431
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
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---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
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* head curve no. 2
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
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
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* head curve no. 3
*--- ---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---
* head curve no. 4
*--- ---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---
* head curve no. 5
*--- ---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---
* head curve no. 6
*--- ---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---
* head curve no. 7
*---- ---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
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---
* head curve no. 8
*---- ---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---
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---
* torque curve no. 2
*---- ---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---
* torque curve no. 3
*---- ---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---
* torque curve no. 4
*---- ---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
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 I9-1 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
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----
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
*
****************************************************************
* primary coolant pump 2
****************************************************************

1650000 pcpump2      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    1.49088e+07 0.12394e+07   0.24619e+07 0.0
1650201 0    8.2731     8.2732 0.0
1650202 0    8.2717     8.2717 0.0
1650301 135   135   135    -1     -1      519    0
1650302 369.00000 0.87005 .31550000 96.000000 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 sprvlv   valve
*4070101   406010000 420010000 3.3451e-4 15.432 15.432 000100
4070101 406010000 420010000 3.3451e-4 0.0   0.0   000100
4070201 0    .000000 .000000 0.0
4070300 trpvlv
4070301 690
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* porv
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
4250000 porv   valve
4250101 420010000 810000000   2.4784e-5 0.0 0.0   000100
4250201 0    .000000 .00000    0.0
4250300 trpvlv
4250301 626
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* experimental SRV
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
4300000 porv   valve
4300101 420010000 820000000   6.24e-5   0.0   0.0   000100
4300201 0    .000000   .00000 0.0
4300300 trpvlv
4300301 634
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
```

```
* steam control valve bypass
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
5460000 scvbyp   valve
5460101 530010000 547000000   4.8e-4   0.0   0.0 0)0100
5460201 0    0.0      0.0    0.0
5460300 trpvlv
5460301 644
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* steam flow control valve
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
5500000 cv-p4-1 valve
5500101 530010000 535000000 0.0052235 0.0 0.0 0(0100
5500201 0     18.039   19.452   0.0
5500300 mtrvlv
5500301 612     616     0.05     0.6     550
*
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
* main feed water valve
*—— ——1—— ——1—— ——1—— ——1—— ——1—— ——1——
5600000 mnfeed   tmdpjun
5600101 545000000 510000000 0.05
5600200 0     501
5600201 0.0     0.67642 0.67642 0.0
5600202 5.0     0.0     0.0     0.0
*
****************************************************************
*
*      reactor kinetics data
*
****************************************************************

30000000 point
30000001 gamma-ac 48.7e+6 0.0     348.43     1.0   (.556
30000002 ans79-1
* ———— shoud not be changed for transient ———— ——
****************************************************************
* delayed neutron constants
****************************************************************

30000101 0.0349     0.01275
30000102 0.2035     0.03177
30000103 0.1848     0.1181
30000104 0.4046     0.3160
30000105 0.1401     1.402
30000106 0.0321     3.914
****************************************************************
* power history
****************************************************************

30000401 4.87e+7     70.     hr
****************************************************************
* reactivity curve numbers
****************************************************************

30000011 609
****************************************************************
* moderator density reactivity table (slope change)
****************************************************************

*30000501 0.62626e+3    -4.4769
*30000502 0.66396e+3    -3.2923
*30000503 0.71617e+3    -1.5692
*30000504 0.76112e+3    -0.1692
*30000505 0.76837e+3   0.04615
*30000506 0.79157e+3   0.6923
*30000507 0.81188e+3   1.2398
*30000508 0.86263e+3   2.2415
*30000509 0.93804e+3   3.9231
*30000510 0.99749e+3   5.1077
*

30000501 0.62626e+3    -5.7396
30000502 0.66396e+3    -4.2208
30000503 0.71617e+3    -2.0118
30000504 0.76112e+3    -0.1692
30000505 0.76837e+3   0.04615
30000506 0.79157e+3   0.6923
```

```
30000507 0.81188e+3   1.2398
30000508 0.86263e+3   2.2415
30000509 0.93804e+3   3.9231
30000510 0.99749e+3   5.1077
*
**************************************************************
* doppler reactivity table
**************************************************************
30000601 293.16     1.375
30000602 338.72     1.125
30000603 422.05     0.682
30000604 477.60     0.419
30000605 505.38     0.274
30000606 570.72     0.000
30000607 588.72   -0.075
30000608 695.83   -0.526
30000609 922.05   -1.386
30000610    1310.94   -2.543
30000611    1810.94   -3.865
30000612    2088.72   -4.502
30000613    2499.83   -5.392
30000614    3027.60   -6.417
*
**************************************************************
* volume weighting factors
**************************************************************
* moderator temperature feedback
**************************************************************
30000701 230010000   0   0.31493 0.0
30000702 230020000   0   0.31493 0.0
30000703 230030000   0   0.37014 0.0
**************************************************************
* doppler feedback
**************************************************************
30000801 2300001   0   0.43153 0.0
30000802 2300002   0   0.51686 0.0
30000803 2300003   0   0.05161 0.0
*
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* scram reactivity data
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20260900   reac-t   609
20260901   0.0     0.0
20260902   0.5      -0.5
20260903   0.59     -3.13
20260904   0.65     -3.95
20260905   0.75     -6.27
20260906   0.83     -8.72
20260907   0.90     -12.00
20260908   0.97     -17.12
20260909   1.125    -20.67
20260910   1.213    -22.10
20260911   1.3      -22.78
20260912   1.4      -23.17
20260913   1.6      -23.32
20260914   60.0     -23.32
*
*---- mtc curve monitor ----------------------------
*
20593100 mtcmon1   function   1.0 0.   0
20593101 rho   230010000 933
*
20593200 mtcmon2   function   1.0 0.   0
20593201 rho   230020000 933
*
20593300 mtcmon3   function   1.0 0.   0
20593301 rho   230030000 933
*
20593400 mtcmon sum     1.0 0.   0
20593401 0.0   0.31493    cntrlvar   931
20593402       0.31493    cntrlvar   932
20593403       0.37014    cntrlvar   933
```

```
*
20293300 reac-t
20293301 0.62626e+3    -5.7396
20293302 0.66396e+3    -4.2208
20293303 0.71617e+3    -2.0118
20293304 0.76112e+3    -0.1692
20293305 0.76837e+3   0.04615
20293306 0.79157e+3   0.6923
20293307 0.81188e+3   1.2398
20293308 0.86263e+3   2.2415
20293309 0.93804e+3   3.9231
20293310 0.99749e+3   5.1077
*
*---- dtc curve monitor ----------------------------
*
20597100 dtcmon1 function 1.0 0.   0
20597101 htvat    2300001   973
*
20597200 dtcmon2 function 1.0 0.   0
20597201 htvat    2300002   973
*
20597300 dtcmon3 function 1.0 0.   0
20597301 htvat    2300003   973
*
20597400 dtcmon   sum      1.0 0.   0
20597401 0.0     0.43153    cntrlvar   971
20597402         0.51686    cntrlvar   972
20597403         0.05161    cntrlvar   973
*
20297300 reac-t
20297301 293.16     1.375
20297302 338.72     1.125
20297303 422.05     0.682
20297304 477.60     0.419
20297305 505.38     0.274
20297306 570.72     0.000
20297307 588.72   -0.075
20297308 695.83   -0.526
20297309 922.05   -1.386
20297310    1310.94   -2.543
20297311    1810.94   -3.865
20297312    2088.72   -4.502
20297313    2499.83   -5.392
20297314    3027.60   -6.417
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* power from experimental data
*--- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
20270000 power      530
20270001 1.08400000e+00 4.878200307e+07
20270002 3.48400000e+00 4.886505087e+07
20270003 4.68400000e+00 4.890413219e+07
20270004 7.08400000e+00 4.895786901e+07
20270005 9.48400000e+00 4.909465363e+07
20270006 1.18840000e+01 4.874292175e+07
20270007 1.42840000e+01 4.845469701e+07
20270008 1.66840000e+01 4.843515635e+07
20270009 1.90840000e+01 4.822020909e+07
20270010 2.14840000e+01 4.790755853e+07
20270011 2.38840000e+01 4.788313271e+07
20270012 2.62840000e+01 4.768772610e+07
20270013 2.86840000e+01 4.751186016e+07
20270014 3.10840000e+01 4.708685081e+07
20270015 3.34840000e+01 4.712104696e+07
20270016 3.58840000e+01 4.690609970e+07
20270017 3.82840000e+01 4.695006619e+07
20270018 4.06840000e+01 4.672534860e+07
20270019 4.30840000e+01 4.704288432e+07
20270020 4.54840000e+01 4.659344914e+07
20270021 4.78840000e+01 4.664230079e+07
20270022 5.02840000e+01 4.659344914e+07
20270023 5.26840000e+01 4.620263594e+07
20270024 5.50840000e+01 4.571900460e+07
```

```
20270025 5.74840000e+01 4.442932104e+07
20270026 5.98840000e+01 4.379913475e+07
20270027 6.22840000e+01 4.278790559e+07
20270028 6.46840000e+01 4.149822202e+07
20270029 6.70840000e+01 4.057004067e+07
20270030 6.94840000e+01 3.890908456e+07
20270031 7.18840000e+01 3.757054935e+07
20270032 7.42840000e+01 3.564090916e+07
20270033 7.66840000e+01 3.282216895e+07
20270034 7.90840000e+01 3.039424193e+07
20270035 8.14840000e+01 2.798097041e+07
20270036 8.38840000e+01 2.556281373e+07
20270037 8.62840000e+01 2.344265211e+07
20270038 8.86840000e+01 2.193313611e+07
20270039 9.10840000e+01 2.060437123e+07
20270040 9.34840000e+01 1.918278821e+07
20270041 9.58840000e+01 1.834742499e+07
20270042 9.82840000e+01 1.717498538e+07
20270043 1.00684000e+02 1.594880896e+07
20270044 1.03084000e+02 1.494735014e+07
20270045 1.05484000e+02 1.385795834e+07
20270046 1.07884000e+02 1.279299236e+07
20270047 1.10284000e+02 1.198694013e+07
20270048 1.12684000e+02 1.132255769e+07
20270049 1.15084000e+02 1.072168239e+07
20270050 1.17484000e+02 1.011103676e+07
20270051 1.19884000e+02 9.471080147e+06
20270052 1.22284000e+02 8.943482324e+06
20270053 1.24684000e+02 8.489161978e+06
20270054 1.27084000e+02 8.059267456e+06
20270055 1.29484000e+02 7.595176779e+06
20270056 1.31884000e+02 7.277641052e+06
20270057 1.34284000e+02 6.906368511e+06
20270058 1.36684000e+02 6.554636629e+06
20270059 1.39084000e+02 6.305493213e+06
20270060 1.41484000e+02 6.046579467e+06
20270061 1.43884000e+02 5.699732751e+06
20270062 1.46284000e+02 5.470129995e+06
20270063 1.48684000e+02 5.318689879e+06
20270064 1.51084000e+02 5.030465143e+06
20270065 1.53484000e+02 4.810632717e+06
20270066 1.55884000e+02 4.629881611e+06
20270067 1.58284000e+02 4.405164020e+06
20270068 1.60684000e+02 4.214642584e+06
20270069 1.63084000e+02 4.014350818e+06
20270070 1.65484000e+02 3.901992023e+06
20270071 1.67884000e+02 3.716355752e+06
20270072 1.70284000e+02 3.589341462e+06
20270073 1.73884000e+02 3.349968376e+06
20270074 1.75084000e+02 3.276690900e+06
20270075 1.77484000e+02 3.095939795e+06
20270076 1.79884000e+02 3.086169465e+06
20270077 1.81084000e+02 3.017777154e+06
20270078 1.83484000e+02 2.807715058e+06
20270079 1.85884000e+02 2.695356263e+06
20270080 1.87084000e+02 2.656274943e+06
20270081 1.89484000e+02 2.568341972e+06
20270082 1.91884000e+02 2.495064497e+06
20270083 1.94284000e+02 2.382705702e+06
20270084 1.95484000e+02 2.328968886e+06
20270085 1.96684000e+02 2.299657896e+06
20270086 1.97884000e+02 2 260576576e+06
20270087 1.99084000e+02 2.211724926e+06
20270088 2.00284000e+02 2.182413936e+06
*
*   reactor power in MWt
*
20505400   reacpor sum    1.0e-06 0.0 1
20505401   0.0     1.0   rktpow    0
*
* end of input
.
```

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3201, 3202

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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The present work is to assess the capability of RELAP5/MOD3.2.2 gamma to predict the system response following an Anticipated Transient Without Scram (ATWS) event. The experiment L9-3 which is a unique nuclear experiment simulating an ATWS event induced by loss of feedwater accident in Loss-of-Fluid-Test (LOFT) is calculated. The experimental condition and sequence are reviewed and a calculation modeling is developed with the important test specific features. The result of RELAP5 calculation is compared with the experimental data, and the predictability of the system response of the primary coolant system (PCS), the reactor power, and the steam generator (SG) secondary system is discussed. The base case showed a good agreement for the RCS pressure, temperature and reactor power with the experimental data. Therefore, it is shown that the RCS thermal-hydraulic response, the reactor power response, and the secondary system response following the LOFT L9-3 experiment can be reasonably predicted by the RELAP5 code under the current modeling scheme, and thus, that the code can be reasonably applied to the analysis of the system thermal-hydraulic response during the ATWS event in real plant. In addition, four parameters such as subcooled discharge coefficient of PORV, loss coefficient of spray valve, steam generator nodalization and moderator density coefficient (MDC) were selected and the effect of those parameters on the total discharged energy through the pressurizer safety relief valves is evaluated.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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LOFT

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ASSESSMENT OF RELAP5/MOD3.2.2 GAMMA WITH THE LOFT L9-3 EXPERIMENT
SIMULATING AN ANTICIPATED TRANSIENT WITHOUT SCRAM

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