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International Agreement Report

Assessment of RELAP5/MOD3.3Beta Code for the LOFT Experiment L9-1/L3-3

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ABSTRACT

The purpose of this report is to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3. The Experiment L9-1/L3-3 was a simulation of the total loss-of-feedwater accident and its recovery modes. Experiment L9-1 simulated a loss-of-feedwater accident with delayed reactor scram and no auxiliary feedwater injection. The loss-of-feedwater accident led to a loss-of-coolant accident through the PORV cycling operation.

Generally, the RELAP5/MOD3.3Beta calculation results were in good agreement with the L9-1 experimental data. The discrepancies between the calculation and the experiment were also identified in the temperature behaviors of the SG secondary side after dryout of the SG. However, these discrepancies were not considered to be significant, since the SG was in a de-coupled state from the PCS after the dryout of the SG secondary side.

Experiment L3-3 simulated two recovery modes from the loss-of-feedwater accident L9-1 without the aid of the emergency core coolant system. The first recovery mode consisted of turning off the primary coolant pumps and latching open the PORV to depressurize the primary system. The second mode consisted of refilling the SG to restore the secondary heat sink and removing decay heat through the feed-and-bleed operation using the secondary side of the SG.

The general trends observed in Experiment L3-3 were similar to those of the RELAP5/MOD3.3Beta code calculations. In addition, some differences between the code calculations and the L3-3 experimental data were observed. The code predicted excessive swelling of the PCS fluid during the first recovery mode, and predicted excessive cooling during the second recovery mode. The differences during the first recovery mode were due to the code's under-estimation of total discharged energy through the PORV. For the discrepancies during the second recovery mode, the code modeling deficiency of the SG secondary side was presumed to be one of the reasons. However, it is concluded that further investigation into the deviation sources are needed to enhance the code's predictability, since the specific reasons for the deviation were not clearly identified in this assessment.

Sensitivity studies show that several parameters have significant effect on the predicted thermal-hydraulic behaviors. These parameters include the pressurizer spray system loss coefficient, nodalization of the SG secondary side, SG U-tube heat transfer area, heat transfer coefficient from the LOFT main components to the environment, and the PORV discharge coefficient. The first three parameters are significant during the short-term transient phase, while the last two are significant during the long-term transient phase. Therefore, the five parameters listed above should be carefully modeled to obtain appropriate calculation results for transient types such as the total-loss-of feedwater accident and its recovery modes.

FOREWORD

This report is prepared to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3. The RELAP5 computer code has been developed as a highly generic best-estimate code to be used for simulation of a wide variety of hydraulic and thermal transients in LWR systems. As one of the new code version, RELAP5/MOD3.3Beta was released in June 2001 with several new models and improvements to existing models.

The Loss-of-Fluid Test (LOFT) integral experimental facility was a scaled model of a commercial pressurized water reactor (PWR) to model the nuclear, and thermal-hydraulic phenomena expected to occur primarily during a loss-of-coolant accident (LOCA). The Experiment L9-1/L3-3 was performed in 1981 as a part of the LOFT Experimental Program to simulate total loss-of-feedwater accident and its recovery modes.

The code-predicted results were compared with experimental data to assess the code predictability. From the comparisons, it is concluded that the RELAP5/MOD3.3Beta computer code has sufficient capability in predicting the thermal hydraulic phenomena occurred in the LOFT Experiment L9-1/L3-3 because the code-predicted results were generally in agreement with the measured data. However, some discrepancies between the calculation and the experiment were also observed. In addition, major parameters having significant effect on the predicted thermal-hydraulic behaviors were identified through sensitivity studies.

Regarding this report, the authors acknowledge the financial support of the National Research Foundation under the national mid- and long-term nuclear research and development program of the Ministry of Education, Science and Technology of the Republic of Korea. Also, we especially would like to thank Professor M. Ishii of Purdue University and Dr. Won-Jae Lee of the Korea Atomic Energy Research Institute for their comments and review of this report.

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EXECUTIVE SUMMARY

The RELAP5 computer code has been developed as a highly generic best-estimate code to be used for simulation of a wide variety of hydraulic and thermal transients in LWR systems. As one of the new code version of the RELAP5, RELAP5/MOD3.3Beta was released with several new models and improvements to existing models. The purpose of this report is to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3.

The Experiment L9-1/L3-3 was a simulation of the total loss-of-feedwater accident and its recovery modes. In Experiment L9-1, the pressure increase in the primary system due to the power-cooling mismatch was controlled by the cycling operation of the pressurizer spray valve and by the coolant discharge through the power-operated relief valve (PORV). In the subsequent Experiment L3-3, two independent recovery procedures for the removal of the core decay heat during the total loss-of-feedwater accident were investigated. The first recovery procedure was the PORV latching open to depressurize the primary coolant system. The second one was accomplished by refilling the steam generator to restore the secondary side heat sink and removing the decay heat through a feed-and-bleed operation using the steam generator secondary side.

For the assessment calculation, the base input decks were prepared by incorporating the major parameters which were identified through sensitivity studies to have significant effect on the code calculation results. The code-predicted results were compared with the experimental data to assess the code predictability. Major conclusions through this assessment are summarized as follows:

- From the comparisons presented with Figures and Tables, it was shown that the code-predicted results were generally in agreement with the measured data. Therefore, it is concluded that the RELAP5/MOD3.3Beta computer code has sufficient capability in predicting the thermal hydraulic phenomena occurred in the LOFT Experiment L9-1/L3-3.
- However, the discrepancies between the calculation and the experiment were also identified. In Experiment L9-1, the code over-estimated temperature behaviors of the SG secondary side after dryout of the SG. However, these discrepancies were not considered to be significant, since the SG was in a de-coupled state from the PCS after the dryout of the SG secondary side. In Experiment L3-3, the code predicted excessive swelling of the PCS fluid during the first recovery mode, and predicted excessive cooling during the second recovery mode. The differences during the first recovery mode were due to the code's under-estimation of total discharged energy through the

PORV. For the discrepancies during the second recovery mode, the code modeling deficiency of the SG secondary side was presumed to be one of the reasons. However, it is concluded that further investigation into the deviation sources are needed to enhance the code's predictability, since the specific reasons for the deviation were not clearly identified in this assessment.

- Through sensitivity studies, the major parameters were identified to have significant effect on the predicted thermal-hydraulic behaviors. These parameters include the pressurizer spray system loss coefficient, nodalization of the SG secondary side, SG U-tube heat transfer area, heat transfer coefficient from the LOFT main components to the environment, and the PORV discharge coefficient. The first three parameters are significant during the short-term transient phase, while the last two are significant during the long-term transient phase. Therefore, the five parameters listed above should be carefully modeled to obtain appropriate calculation results for transient types such as the total-loss-of feedwater accident and its recovery modes.

1. INTRODUCTION

The RELAP5 computer code has been developed as a highly generic best-estimate code to be used for simulation of a wide variety of hydraulic and thermal transients in LWR systems. As one of the new code version of the RELAP5, RELAP5/MOD3.3Beta was released in June 2001 with several new models and improvements to existing models [1]. The purpose of this report is to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3.

The Loss-of-Fluid Test (LOFT) integral experimental facility was a scaled model of a commercial pressurized water reactor (PWR). The purpose of this facility was to model the nuclear, and thermal-hydraulic phenomena expected to occur primarily during a loss-of-coolant accident (LOCA). In general, coolant volumes and flow areas in the LOFT were scaled using the ratio of the core power of 50 MWth in the LOFT to 3,000 MWth in a commercial PWR.

The Experiment L9-1/L3-3 was performed in 1981 as a part of the LOFT Experimental Program. It was a simulation of the total loss-of-feedwater accident and its recovery modes. The total loss-of-feedwater (TLOFW) accident is a beyond-design-basis-accident initiated by a loss-of-feedwater due to the failure of the main feedwater pump and subsequent no auxiliary feedwater injection. During the total loss-of-feedwater accident, heat removal capability in the secondary side of the steam generator (SG) is completely degraded and pressure and temperature of the primary coolant system (PCS) are increased to the reactor scram set point. Following the reactor scram, the core decay heat should be removed by proper controlling methods to prevent severe core damage. The role of core decay heat removal during the total loss-of-feedwater accident was considered important since it was identified as one of the major contributors to the severe core damage frequency in previous studies such as WASH-1400 [2].

The LOFT Experiment L9-1/L3-3 provided experimental data for several methods of removing the decay heat during the total loss-of-feedwater accident and its recovery phases. In Experiment L9-1, the pressure increase in the primary system due to the power-cooling mismatch was controlled by the cycling operation of the pressurizer spray valve and by the coolant discharge through the power-operated relief valve (PORV). In the subsequent Experiment L3-3, two independent recovery procedures for the removal of the core decay heat during the total loss-of-feedwater accident were investigated. The first recovery procedure was the PORV latching open to depressurize the primary coolant system. The second one was accomplished by refilling the steam generator to restore the secondary side heat sink and removing the decay heat through a feed-and-bleed operation using the steam generator secondary side. During the second procedure, the primary system pressure decreased rapidly after the reestablishment of the steam generator heat removal capability, and the heat generated in the reactor core was transferred to the steam generator by two-phase natural circulation [3]. In short, the LOFT L9-1/L3-3 was an experiment to evaluate the effectiveness of the PORV and the feed-and-bleed operation using the secondary side for removal of decay heat. This experiment has also been used as a means to evaluate the ability of a thermal-hydraulic computer code in predicting major phenomena.

For the assessment calculation, the base input decks were prepared based on available RELAP5 assessment [4] for this experiment. The major parameters, which were identified through sensitivity studies to have the most significant effect on the predicted thermal hydraulic behaviors, were incorporated into the base calculation to improve the code predictability. The code calculation results were then compared with the measured data to assess the code capability of predicting major phenomena.

2. FACILITY AND TEST DESCRIPTION

2.1 Facility Description

The LOFT integral experimental facility was a scale model of a commercial PWR. The purpose of this facility is to model the nuclear, and thermal-hydraulic phenomena expected to occur primarily during a LOCA. In general, coolant volumes and flow areas in the LOFT were scaled with a ratio of the 50 MWth LOFT core to a commercial 3,000 MWth PWR core. Also, components used in the LOFT are similar to those of a commercial PWR [3]. The experimental facility included five major subsystems which had been instrumented such that system variables could be measured and recorded throughout the experiment. The subsystems include (a) the reactor vessel, (b) the intact loop, (c) the broken loop, (d) the blowdown suppression system, and (e) the emergency core cooling system (ECCS) [5]. The major components of the LOFT facility are shown in Figure 1, and a detailed system description is presented in Reference [6].

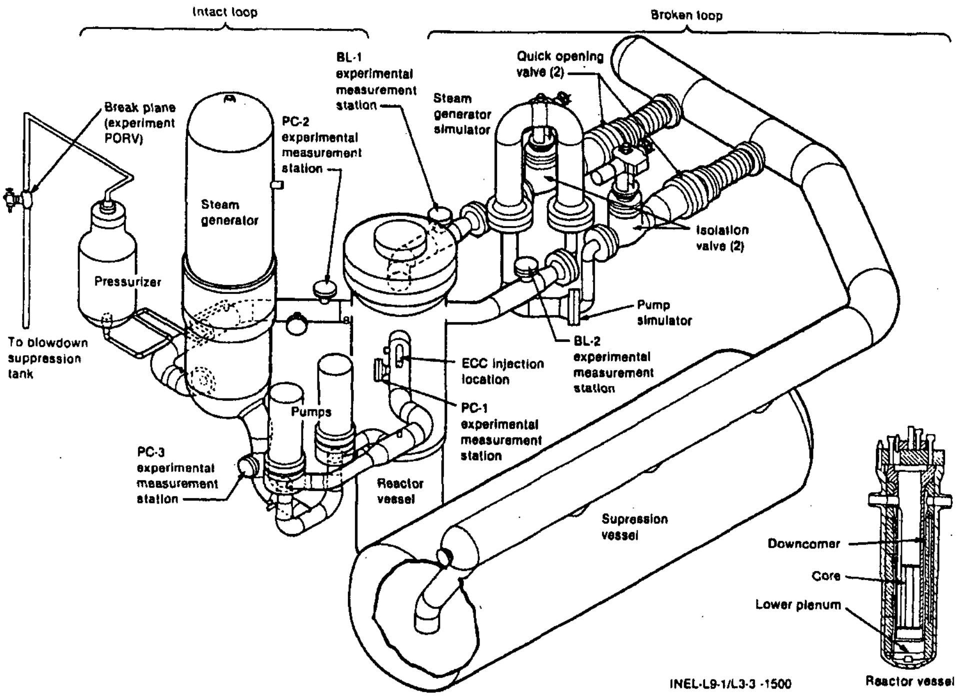


Figure 1. Configuration of LOFT System for Experiment L9-1/L3-3

2.2 Test Description

Since 1976, 43 non-nuclear and nuclear experiments have been performed in the LOFT facility

[3]. The Experiment L9-1/L3-3 [3,5,7] conducted on April 15, 1981, consisted of two sequential tests. Experiment L9-1 was performed as part of the LOFT Experiment Series L9 (anticipated transient with multiple failure), and Experiment L3-3 was performed as part of the LOFT Experiment Series L3 (small break LOCA).

Experiment L9-1 was the first anticipated transient with multiple failures performed in the LOFT, and simulated a loss-of-feedwater accident with delayed reactor scram and no auxiliary feedwater injection. The loss-of-feedwater accident led to a loss-of-coolant accident through the PORV. In Experiment L9-1, the transient was initiated by loss-of-feedwater due to the failure of the main feedwater pump. The reactor scrammed on the indication of high pressure (15.745 MPa) in the intact loop hot leg approximately 65 seconds after the main feedwater pump was tripped. The auxiliary feedwater injection into the steam generator was prevented, as was scram on the indication of low liquid level in the steam generator. The main steam control valve (MSCV) of the steam generator started to close automatically on the reactor scram and finished closing 12.2 seconds later (at 77.2 sec). The pressurizer spray valve cycled automatically at its close (15.05 MPa) and open (15.338 MPa) set points from 30 seconds until it was closed by the operators at the 1,246.0 seconds to allow the PCS pressure to increase to the PORV set point. The PORV started cycling operation at 1,467.9 seconds to control primary system pressure, until it was manually latched open at 3,270 seconds. The open and close set points of the PORV were 16.20 MPa and 16.06 MPa, respectively.

Experiment L3-3 simulated two recovery modes from the loss-of-feedwater accident L9-1 without the aid of emergency core coolant (ECC). The first recovery mode consisted of turning off the primary coolant pumps and latching open the PORV to depressurize the primary system. The second mode consisted of refilling the steam generator to restore the secondary heat sink and removing decay heat through the feed-and-bleed operation using the secondary side of the steam generator. Experiment L3-3 began when the PORV was secured in the open position. The primary coolant pumps were tripped 15 seconds later, with pump coastdown lasting about 20 seconds. Saturation occurred in the upper plenum about 60 seconds after the beginning of Experiment L3-3 at the 3,329.4 seconds. The primary pressure decreased to the saturation pressure of 12.3 MPa. This pressure was below the high pressure safety injection system (HPSI) set point of 13.2 MPa, which would have initiated ECCS injection had it not been purposely locked out. After closing the PORV at 4,849.7 seconds, steam generator refill began at 5,114.6 seconds. Natural circulation was established during steam generator refill which was completed at 5,746.4 seconds. Alternating secondary coolant system feed-and-bleed operations began at the 6,712.2 seconds. The experiment was complete at 9,517.4 seconds. The initial plant operating conditions and the major sequence of events for Experiment L9-1/L3-3 are presented in Table 1 and 2, respectively.

The objectives of the L9-1/L3-3 Experiment were specified as follows [5]:

2.2.1.1 Experiment L9-1 Objectives

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

2.2.1.2 *Experiment L3-3 objectives*

- To investigate uncertainties in system response during a PORV imposed small break with loss of secondary heat sink,
- To assess uncertainties in small break performance predictions identified in NUREG-0623 [8],
- To assess the effectiveness of steam generator refill on loss-of-feedwater accidents following reestablishment of auxiliary feedwater availability,
- To assess the relative magnitude of the change in reactor vessel mixture level as a result of primary coolant system shrink during steam generator refill,
- To contribute to the NRC relief and safety valve testing program by providing experimental data on PORV performance characteristics over a range of PORV inlet fluid conditions.

3. CODE AND MODELING

3.1 Code Description

The code version of RELAP5/MOD3.3Beta, into which several new models and improvements were incorporated, was used for this assessment calculation. Some models recommended in the previous RELAP5 versions such as a new steam table and the Henry-Fauske choked flow model were used as default models in this version. In addition, improved or modified models in the RELAP5/MOD3.3Beta include non-condensable gas treatment, wall friction term modification, time-dependent volume correction, CANDU model updates, etc. The descriptions of the RELAP5/MOD3.3Beta code are presented in detail in the code manuals [1].

3.2 Base Input Modeling

For the purpose of the RELAP5/MOD3.3Beta assessment, input decks for the base calculation were prepared based on the reference calculation [4] which was the recent RELAP5 assessment for the LOFT Experiment L9-1/L3-3. The modifications were made to the reference input decks to incorporate the major parameters which were identified through sensitivity studies to have significant effect on the code calculation results. These parameters include loss coefficient of the pressurizer spray system, nodalization of the secondary side of the steam generator, heat transfer area of the steam generator U-tube, heat transfer coefficient from the LOFT main components to the environment, and discharge coefficient of the PORV. The results of the sensitivity studies for the parameters listed above are presented in Section 4.2.

The modifications made to the reference input decks for base input modeling are summarized as follows:

- The mass flow rate into the pressurizer through the pressurizer spray valve was increased by reducing the loss coefficient of the pressurizer spray system

- The bottom node of the steam generator secondary side and associated nodes of the U-tube of the reference calculation were subdivided into four, which implies that the number of nodes of the SG secondary side associated with the U-tube changed into six.

- The heat transfer area of all the nodes of the steam generator U-tube increased by 20% to improve the code-predicted heat transfer phenomena through the SG U-tube.

- The heat transfer coefficient to the environment from the LOFT main components (the reactor vessel, the steam generator, the pressurizer, and primary coolant system) was increased by 40% to have the PCS temperature match with the experimental data during the long-term phase of the transient.

- The discharge coefficient and the thermal non-equilibrium constant of the PORV were set to 0.8 and 0.03 respectively to make the code-calculated mass flow rate through the PORV be in agreement with test data.

- The counter current flow limitation (CCFL) model was applied to the junctions (components 115-3, 400-1, 410-0) for which the flooding phenomena was presumed to occur.

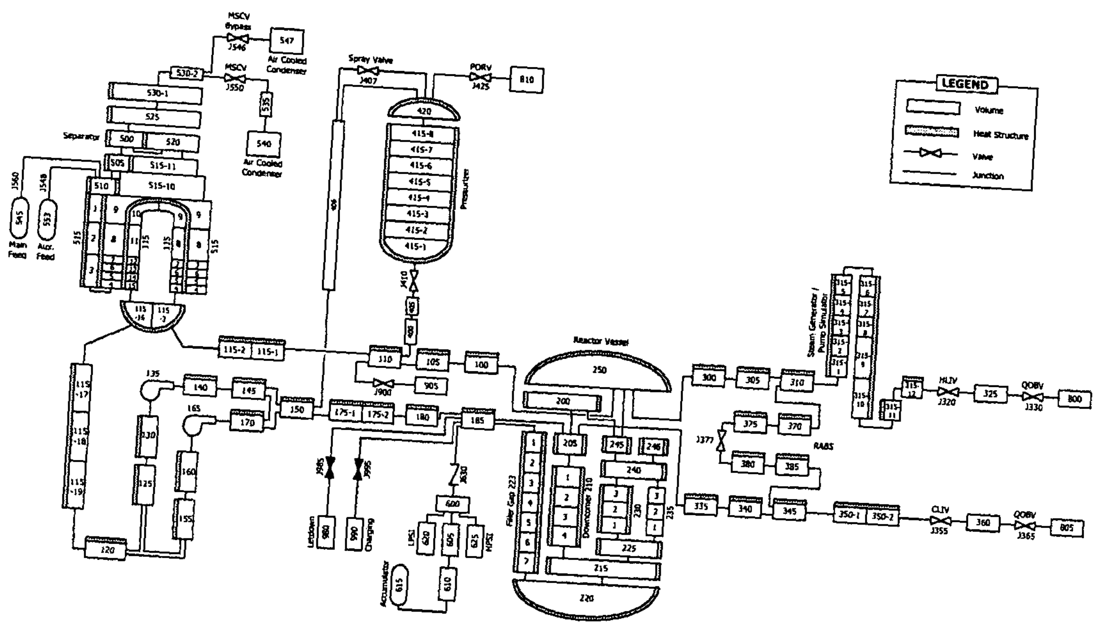
- The additional junction connected to the accumulator was removed, because it was not allowed in the code version of RELAP5/MOD3.3Beta. Since the emergency core cooling system (ECCS) was not injected during Experiment L9-1/L3-3, the junction removal from the accumulator does not affect the calculation results.

- The initial conditions in the reference input decks for some volumes were slightly modified to make the base input decks compatible with the RELAP5/MOD3.3Beta code.

As shown in Figure 2, the LOFT facility was composed of 134 volumes, 143 junctions, and 142 heat structures in the RELAP5 modeling for the base calculation. The intact loop was modeled with 31 hydrodynamic volumes. Environmental heat losses from all the piping metal structures exposed to atmosphere were simulated using the heat structure components. The broken loop was composed of a hot leg, a cold leg, a SG-pump simulator, a reflood assist bypass system (RABS), and quick opening blowdown valves (QOBVs). The volume and junction modeling options were set to the default options. The active core, the downcomer and the filler gap were composed of three volumes, six, and seven vertically stacked volumes, respectively. The rod bundle interphase friction model option was applied to the active core volumes. The fuel rods were modeled using 3 heat structures representing the central fuel assembly and 2 heat structures representing the peripheral fuel assemblies of the LOFT core. The pressurizer system was modeled with a surge line, a pressurizer vessel, a spray line from the cold leg, a spray valve and a PORV. Two volumes for the surge line, nine volumes for the pressurizer vessel and one volume for the spray line were used. The spray valve and the PORV were simulated with two trip valves. The associated trip logic was prepared according to the experimental specification. The SG was modeled using 12 volumes in the primary coolant system and 8 volumes in the SG riser. Heat was exchanged between the primary and secondary sides of the SG through the U-tube, which was modeled using 12 heat structures. The rod bundle interfacial friction option was used for the volumes in contact with the U-tubes heat structures. The emergency core cooling system in the LOFT was also modeled. However, it is not used in the transient calculation. The containment was modeled using a time-dependent volume with constant pressure.

A steady state run was performed to obtain initial conditions of the whole system prior to running the transient case. The initial conditions obtained from the steady state run are presented in Table 1 and compared to the measured data. The RELAP5 results for the steady state run agree well with the experimental initial conditions except for the hot leg temperature of the broken loop. The hot leg temperature of the broken loop deviated from the range of the experimental uncertainty. However, considering that the broken loop does not play an important role from the perspective of the heat removal and the temperature deviation was not significant, it was concluded that the out-of-range value for the broken hot leg temperature would not adversely affect the overall transient calculation.

The boundary conditions and the control trips used in the base calculation were identical to those used in the reference calculation. The information for the boundary conditions and the control trips can be found in the attached input decks. The steady state and the transient input decks for the base calculation are presented in Appendix A and B, respectively.



INTACT LOOP

BROKEN LOOP

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

Table 1. Initial Condition for Experiment L9-1/L3-3

Parameter	Measured	Calculated
Primary Coolant System		
Mass flow rate (kg/s)	479.1±2.6	479.4
Hot leg pressure (MPa)	14.9±0.10	14.91
Cold leg temperature (K)	558.9±1.3	557.7
Hot leg temperature (K)	578.2±1.8	577.0
Reactor		
Power level (MW)	49.6±0.9	49.6
Steam Generator Secondary Side		
Water level (m)	0.14±0.08	0.14
Water temperature (K)	545.0±0.8	546.1
Pressure (MPa)	5.67±0.08	5.70
Mass flow rate (kg/s)	27.0±1.0	26.1
Broken Loop		
Hot leg temperature (K)	563.3±2.6	556.9
Cold leg temperature (K)	557.6±2.6	557.6
Pressurizer		
Steam Volume (m^3)	0.43±0.05	0.48
Liquid volume (m^3)	0.50±0.05	0.48
Water temperature (K)	614.9±1.3	614.7
Pressure (MPa)	14.93±0.25	14.93
Liquid level (m)	0.92±0.1	0.92

4. RESULTS AND DISCUSSION

4.1 Base Calculation

The results of the base calculation with the RELAP5 modeling described in the previous section are compared with the experimental data in Figures 3 through 13. Figures 3 to 7 are comparisons for short-term responses up to 300 seconds, while Figures 8 to 13 are comparisons for the long-term transient up to 10,000 seconds. In addition, the chronology of the major events for the base calculation is compared with the measured data in Table 2 for the LOFT Experiment L9-1/L3-3.

4.1.1 Short-term Responses

The major thermal-hydraulic phenomena which can be observed during the short-term phase of the transient include, dryout of the SG secondary side, PCS pressurization, PCS pressure controlby the pressurizer spray valve, and decay heat removal following reactor trip, etc.

The pressure trend of the PCS together with that of the SG secondary side is compared with experimental data in Figure 3. As the heat removal capability in the SG secondary side degraded due to the trip of the main feedwater pump, the pressure of the PCS gradually increased. When the PCS pressure reached the set pressure of 15.338 MPa, it was controlled by the pressurizer spray valve activation. As the heat generation in the reactor core exceeded the heat removal capability by both the SG secondary side and the pressurizer spray valve actuation, the PCS pressure continued to increase up to the reactor scram set pressure of 15.745 MPa. Following the scram, the PCS pressure decreased because the power input to the PCS dropped sharply to the decay power level. After that, the pressurization of the PCS due to decay heat was controlled by pressurizer spray actuation and subsequent steam condensation. The pressure of the SG secondary side rose gradually following initiation of the transient due to heating from the primary side. As the secondary side of the SG was drying out, however, the reduced heat removal capability decreased the pressure in the SG. The SG pressure increased again as the main steam control valve (MSCV) started to close on the reactor scram signal. As shown in Figure 3, the code pressure results calculated for both the PCS and the SG secondary side were in agreement with the experimental data.

The temperature comparisons of the calculated and experimental results for the PCS and the SG secondary side are shown in Figure 4. It is shown in the figure that the temperature behavior is predicted well by the code, even though minor discrepancies are shown. However, these differences are not considered significant to affect the later calculation results.

Figure 5 shows a comparison of the calculated reactor power to the experimental data. It is apparent that the predicted behavior of the reactor power is very similar to the experimental data. This implies that the code-predicted heat addition to the PCS during the transient matched well with the experiment.

A comparison of the experimental and calculated mass flow rate through the MSCV is presented in Figure 6. As the pressure in the SG secondary side increased, the mass flow rate through the MSCV increased until the MSCV started to close on the reactor scram signal. From this comparison, it can be stated that the mass flow rate behavior through the MSCV can be predicted very well by the code.

Figure 7 shows a comparison of the calculated and experimental results for the SG collapsed liquid level. The SG secondary collapsed water level is a good indication of SG secondary conditions changing. The water level of the SG secondary side dropped monotonically due to evaporation without feed. As the water level decreased, the heat transfer rate through the SG U-tube degraded and this forced the PCS pressure to increase up to the reactor scram set point. After dryout of the SG secondary side, the heat transfer to the SG secondary side through the U-tube was by vapor natural circulation with a small wall heat transfer coefficient. This implies that the secondary system was de-coupled from the primary side and therefore it could no longer control the PCS pressurization. The calculated dryout rate of the SG secondary side closely resembled the test data as shown in Figure 7.

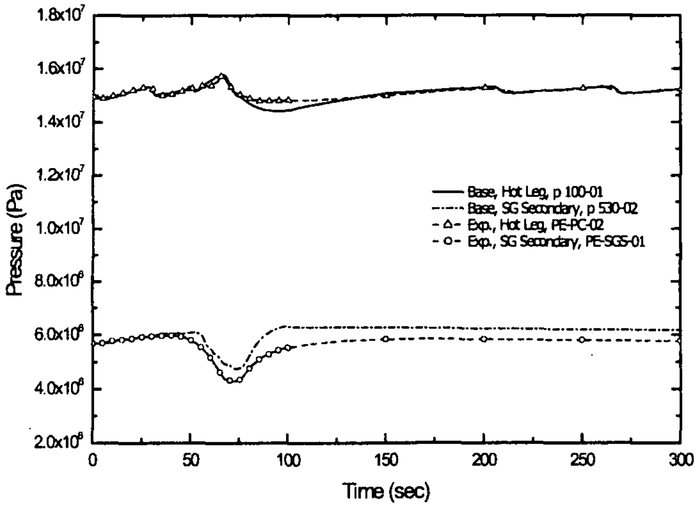


Figure 3. Comparison of Pressure for Short-term Response

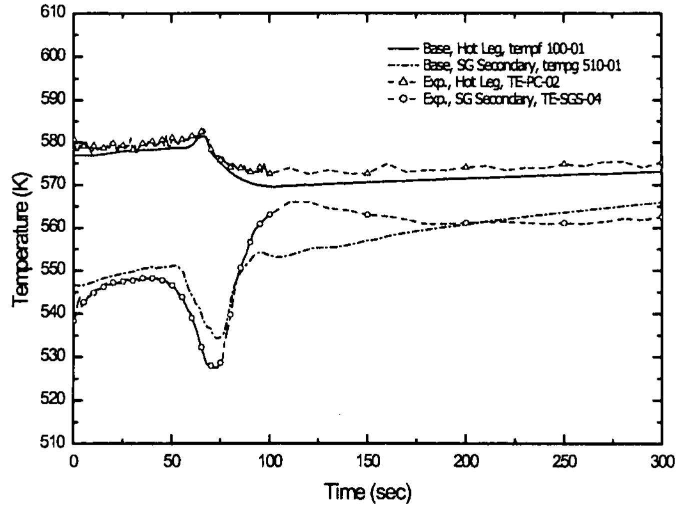


Figure 4. Comparison of Temperature for Short-term Response

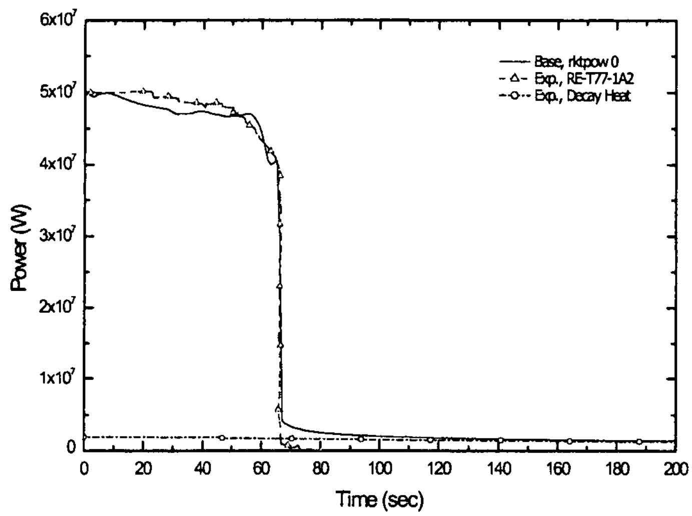


Figure 5. Comparison of Reactor Power for Short-term Response

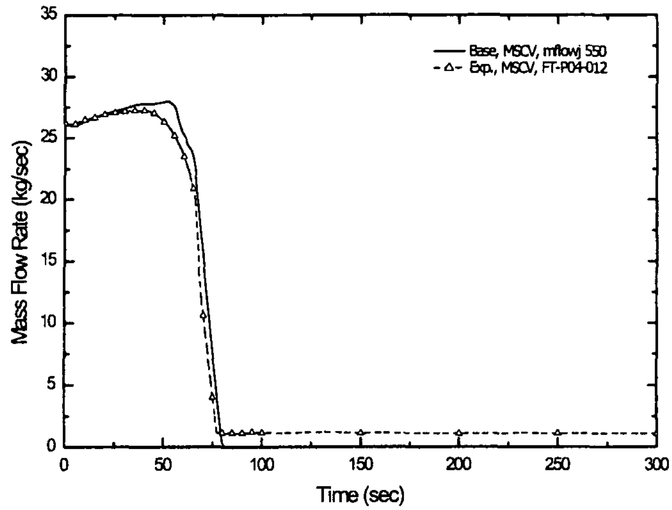


Figure 6. Comparison of Mass Flow Rate through MSCV for Short-term Response

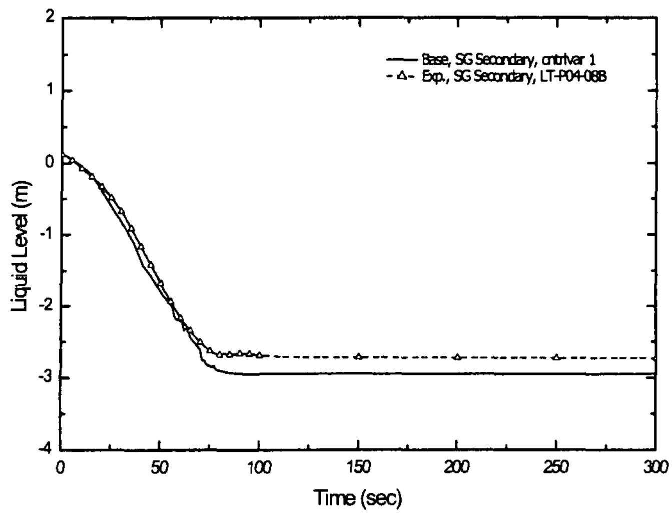


Figure 7. Comparison of SG Liquid Level for Short-term Response

Table 2. Major Sequence of Events for Experiment L9-1/L3-3

Event	Measured (sec)	Calculated (sec)
L9-1		
Main feedwater pump tripped off	0.0	0.0
Pressurizer spray activated	30.0±0.1	29.0
Reactor scram	65.4±0.2	65.0
Steam generator main steam control valve closed	77.2±0.2	80.0
Steam generator liquid level reached bottom of indicating range (0.25 m, above tube sheet)	190	71.0
Pressurizer spray valve cycling initiated	208.9±0.1	205.0
Pressurizer liquid level reached top of indicating range (1.83 m, above bottom)	1089.7±30	1365.0
Pressurizer spray valve cycling ended	1246.0±0.1	1785.0
PORV cycling initiated	1467.9±0.1	1785.0
L3-3		
PORV latched open	3269.9±0.1	3295.1
Primary coolant pumps tripped off	3284.8±0.2	3295.1
Primary coolant pump coastdown completed	3304.2±0.8	3330.1
Upper plenum fluid reached saturation pressure	3329.4±0.2	3405.3
PORV closed	4849.7±0.1	4880.4
Steam generator secondary refill initiated	5114.6±0.2	5145.4
Natural circulation initiated	5205±10	-
Steam generator secondary refill completed	5746.4±0.2	6255.5
Pressurizer liquid level reached bottom of indicating range (0.06 m, above bottom)	5915±5	5570.5
Steam generator secondary feed-and-bleed initiated	6712.2±0.2	7230.4
Experiment completed	9517.4±0.2	-

4.1.2 Long-term Responses

Most of the thermal-hydraulic phenomena during the long-term phase occurred following sub-sequences such as PCS pressure control by PORV cycling and latched open, plant recovery by refilling the SG secondary side, and removing decay heat through a feed-and-bleed operation using the secondary side.

Figure 8 presents a comparison of calculated and experimental pressure value during the long-term transient phase for both the PCS and SG secondary side. The cycling operation of the pressurizer spray valve controlled the PCS pressure from the 30 seconds. In the experiment, the pressurizer spray was closed by an operator at 1,246.0 seconds. For the RELAP5 model, the pressurizer spray was modeled to be terminated on the indication of the PORV actuation. As decay heat added to the PCS exceeded the cooling capability of the pressurizer spray, the PORV cycling operation started to regulate the PCS pressure. The PORV cycling operation continued for about 1,800 seconds until the PORV was latched open. During the cycling operation by both the pressurizer spray valve and the PORV, the pressure of the SG secondary side was decreased monotonously. Figure 8 shows that the code-predicted pressure behavior during this period matched very well with test data.

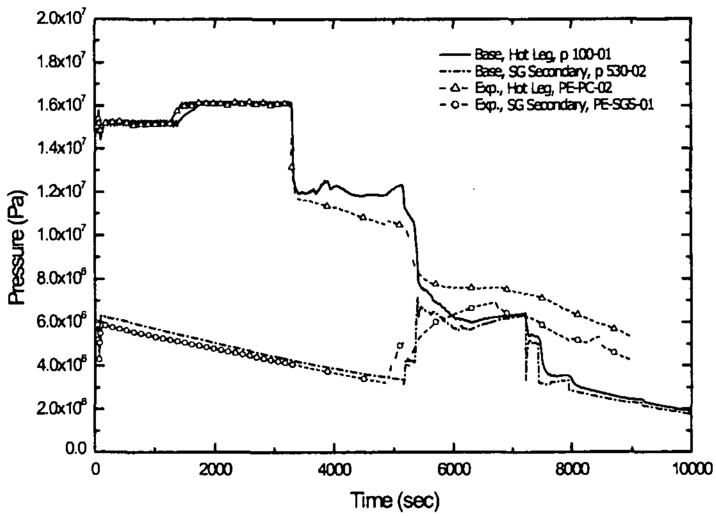


Figure 8. Comparison of Pressure for Long-term Response

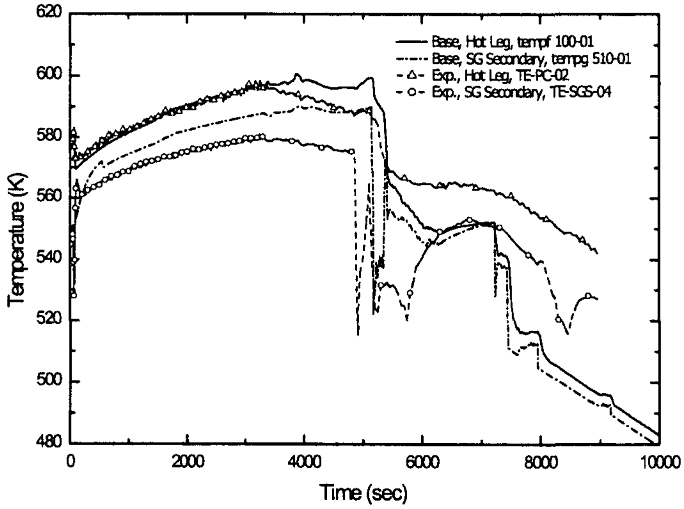


Figure 9. Comparison of Temperature for Long-term Response

The temperature for both the PCS and the SG secondary side during the cycling operation of the pressurizer spray valve and the PORV was increased gradually as presented in Figure 9. The calculated temperature of the PCS was in agreement with test data. The temperature of the SG secondary side, however, was over-estimated by the code. Since the SG was still in a de-coupled state from the PCS, the conservative prediction of the PCS behavior was not considered to be significant.

Figure 10 shows a comparison of pressurizer collapsed liquid level. It appears that the code-calculated liquid level is higher than the level in the experiment, especially during the PORV cycling operation. However, the difference is believed to be due to the fact that the differential pressure detector for water level calculation could not measure the water level over the upper detector location (1.83m, above bottom), while the code calculated the water level at the top of the pressurizer (2.0m, above bottom).

Experiment L3-3 was initiated by the PORV latched open. The LOFT plant recovery during this experiment was by two subsequent recovery procedures. The first recovery procedure was the PORV latched open to depressurize the primary coolant system. The second recovery procedure was by refilling the SG and removing decay heat through a feed-and-bleed operation using the SG secondary side.

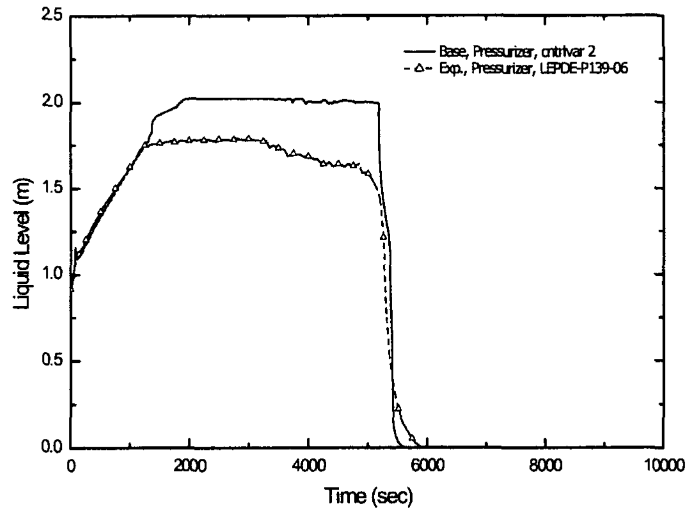


Figure 10. Comparison of Pressurizer Collapsed Liquid Level

The PORV was latched open at the 3,269.9 seconds, and maintained its state to 4849.7 seconds. The PCS pressure and temperature during the PORV latched open period was over-estimated by the code as seen in Figures 8 and 9, respectively. One of the reasons for this discrepancy was that the code-predicted excessive swelling of the PCS fluid during the time the PORV was latched open as noted in the reference calculation [4]. The excessive swelling of the code prediction can be confirmed from the behavior of the pressurizer water level in Figure 10.

The predicted water level during this period remained nearly constant, while the measured level decreased gradually as the fluid discharged through the PORV. This implies that the top of the pressurizer was filled with lower steam quality in the code calculation than in the experiment. Considering that water has much lower enthalpy than steam, the total discharged energy through the PORV would be under-estimated in the code, while the code-predicted mass flow rate through the PORV agreed well with the test data as shown in Figure 11. Therefore, it is concluded that over-estimation of the PCS pressure and temperature during the PORV latched open period is due to the code's under-estimation of total discharged energy through the PORV.

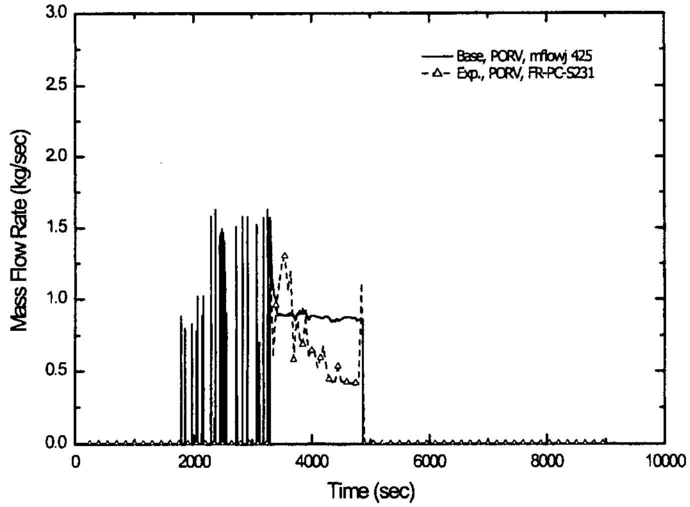


Figure 11. Mass Flow Rate through PORV for Long-term Response

Other important phenomena occurring during the period when the PORV was latched open were the changes in the fluid condition and the mass of the PCS. Figure 12 shows that the PCS fluid rapidly reached saturation conditions when the PORV was latched open, and, as a result, the steam started to be generated. In Figure 13, the change to the PCS system mass during this period is presented. It is apparent from Figure 13 that the code-calculated PCS mass behavior such as the total mass and the decreasing slope were very close to the measured data.

The second recovery procedure was initiated by refilling the SG secondary side through the auxiliary feedwater line, and the plant recovery was completed through feed-and-bleed operation. As the PCS was coupled again with the SG secondary side during the second recovery period, the PCS pressure and temperature decreased rapidly. It can be seen from Figures 8 and 9 that the code-predicted trends of the system pressure and temperature generally agree well with the experimental data, even though the excessive cooling by the code was also shown.

For the code-predicted excessive cooling during the second recovery procedure, the code modeling deficiency of the SG secondary side was presumed to be one of the reasons. However, the specific reasons for the deviation were not clearly identified in this assessment. Therefore, further investigations into the deviation sources are needed to enhance the code's predictability.

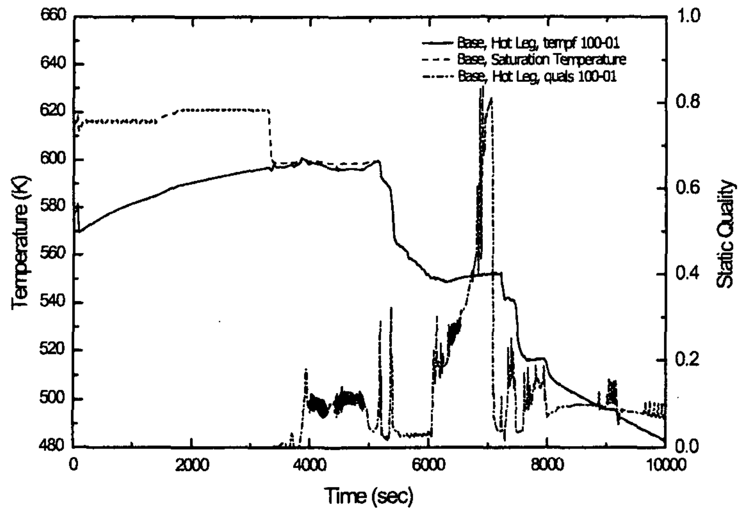


Figure 12. Fluid Conditions of Hot Leg for Long-term Response

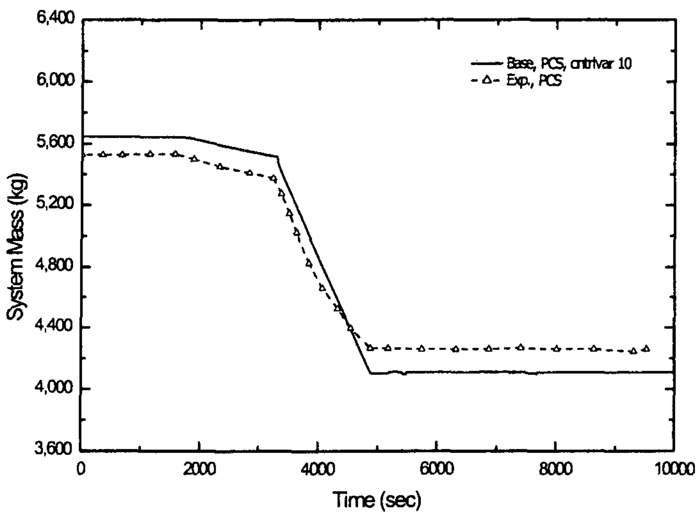


Figure 13. System Mass of PCS for Long-term Response

4.2 Sensitivity Studies

The sensitivity studies were performed to identify parameters having significant effect on the predicted thermal hydraulic behaviors. The cases and the parameters for the sensitivity studies are presented in Table 3. The first three parameters were selected as short-term parameters, while the last two were chosen as parameters which affect the long-term transient behavior. The code-predicted results for each case are compared with both the base calculation and the experimental data in Figures 14 through 17.

Table 3. Matrix for Sensitivity Studies

PARAMETERS \ CASES		Base	Case 1	Case 2	Case 3	Case 4	Case 5
Short-term Parameters	Pressurizer Spray Valve Loss Coefficient	1.0	15.432 (Note 1)	Base	Base	Base	Base
	SG Nodalization	6	Base	3 (Note 1)	Base	Base	Base
	SG U-tube Heat Trans. Area (Cylinder Height)	12149.9 m^2	Base	Base	10124.9 m^2 (Note 1)	Base	Base
Long-term Parameters	Heat Transfer Coefficient to Environment	(Note 2)	Base	Base	Base	(Note 1)	Base
	PORV Discharge Coefficient	0.8	Base	Base	Base	Base	1.0 (Note 1)

Notes:

1. These values are identical to those in NUREG/IA-0114 [4]. The environmental loss heat transfer coefficients for components are as follows:
   Reactor Vessel and Pipe: 13.450 W/m^2K
   Steam Generator: 3.385 W/m^2K
   Pressurizer: 3.019 W/m^2K
2. Compared to those in the NUREG/IA-0114, the environmental loss heat transfer coefficients for these cases are increased by 40% as follows:
   Reactor Vessel and Pipe: 18.830 W/m^2K
   Steam Generator: 4.739 W/m^2K
   Pressurizer: 4.227 W/m^2K

4.2.1 Pressurizer Spray System Loss Coefficient (Case 1)

The pressurizer spray in the LOFT facility was used to regulate the PCS pressure by condensing steam at the top of the pressurizer. The loss coefficient of the pressurizer spray system which determines the amount of the spray flow was known to have a remarkable effect on the RCS pressure behavior [9]. In this sensitivity study, the effect of the mass flow rate through the spray valve was investigated. The mass flow rate was reduced from 1.7 kg/sec to 1.0 kg/sec by increasing the loss coefficient of the spray valve from 1.0 to 15.432 [4]. From the comparison in Figure 14, it is seen that the pressure before reactor scram increased more rapidly than for the base calculation, as the reduced mass flow rate was not sufficient to suppress the pressure increase. The pressure increase after the reactor scram, however, was slower than that for the base calculation because the heat added to the PCS was smaller than in the base calculation due to the earlier reactor trip.

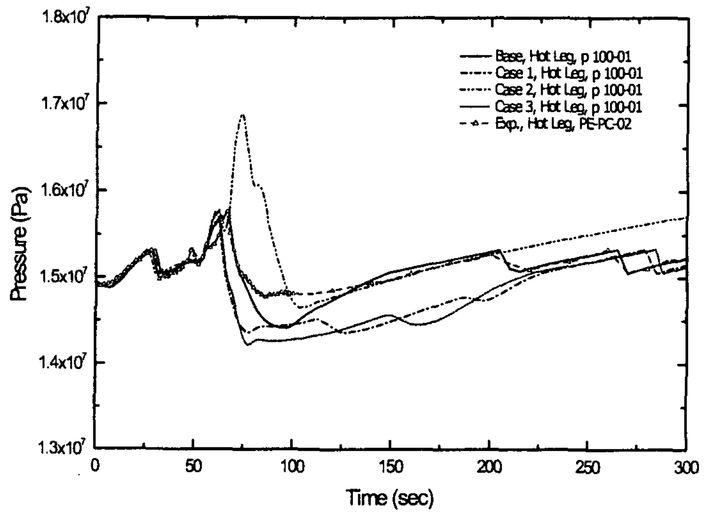


Figure 14. Sensitivity Studies for Short-term Parameters

4.2.2 Steam Generator Nodalization (Case 2)

The heat transfer phenomena through the SG U-tube plays a very important role in this type of transient, because the heat generated in the reactor is mainly removed by the SG secondary side until it is de-coupled after a complete depletion. The SG nodalization is one of the most important parameters which affect the heat transfer phenomena through the SG [9, 10]. The effect of coarse nodalization of the SG was examined for this case. The nodes of the SG U-tube and the SG secondary side associated with the U-tube were reduced from 6 to 3 nodes, which implied that the subdivided four nodes in the base calculation were merged into one node as in the reference calculation [4]. As shown in Figure 14, this modeling change caused completely different results from the base calculation. The PCS pressure surge was not controlled, even though the reactor trip was accomplished on indication of the PCS high pressure. The pressure was not suppressed until it had increased sharply to the PORV actuation set pressure. The reason for this can be deduced from a comparison of the heat transfer rate through the U-tube.

Figure 15 shows that the heat transfer rate during the period of the steep pressure increase after the reactor trip was lower for this case than for the base calculation, which led to the PCS over-pressurization. Therefore, the PCS over-pressurization can be attributed to the coarse nodalization of the SG U-tube and the associated SG secondary side.

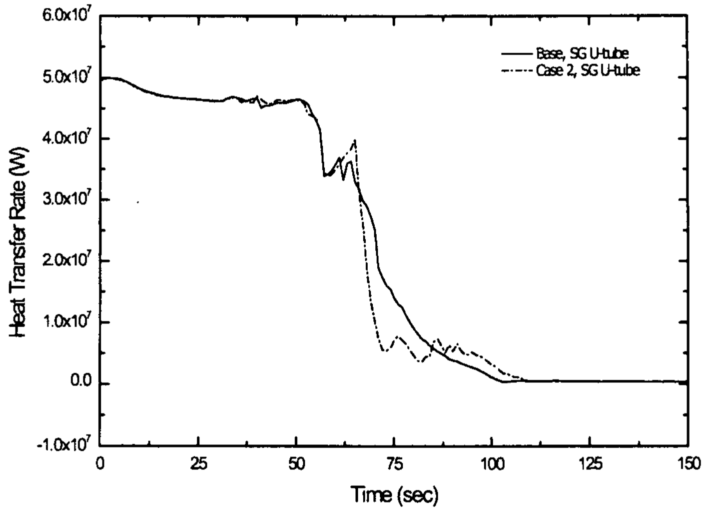


Figure 15. Comparison of Heat Transfer Rate through SG U-tube

4.2.3 Steam Generator U-tube Heat Transfer Area (Case 3)

The heat transfer area of the SG U-tube was generally identified as a factor to have an impact on the initial conditions in the SG secondary side [4, 11]. This implies that the SG U-tube heat transfer area may also affect the SG heat transfer phenomena during the transient phase. Therefore, the SG U-tube heat transfer area also selected as a sensitivity parameter. In this sensitivity study, the heat transfer area of all the nodes of the SG U-tube was reduced to 10,124.886 m^2 [4] from 12,149.864 m^2 in the base calculation. From Figure 14, the PCS pressure behavior for Case 3 is very similar to that in the Case 1, i.e., reduction of the pressurizer spray valve loss coefficient. The reactor tripped earlier due to the reduced heat transfer to the SG secondary side, and the pressure increase after the reactor trip was slower than for the base calculation due to the reduced heat added to the PCS from the reactor core as in Case 1.

4.2.4 Heat Transfer Coefficient to Environment (Case 4)

Generally, the heat losses to the environment from the plant main components after a reactor trip can affect the long-term trend of the transient since the amount of the heat loss to the environment is not negligible compared to the decay heat level. In the previous calculation using RELAP5/MOD1, the PCS fluid heatup rate during the PORV cycling operation was much faster than in the experiment, and the amount of the discharged coolant through the PORV was greater in the calculation than in the experiment [3,7]. This difference was considered due to higher environmental heat losses from the primary system than assumed [3]. In this sensitivity study, the effect of the environmental heat loses was investigated. The values from reference calculation [4] were used as heat transfer coefficients of the major components such as the reactor vessel, the steam generator, the pressurizer, and primary coolant system, as shown in Table 3. This implies that the total heat loss to the environment from the plant main components was decreased by about 40% in this sensitivity study. As shown in Figure 16, the environmental heat loss mainly affected the PCS temperature behavior during the cycling operation period of both the pressurizer spray and the PORV. During this period, the temperature increased more rapidly than for the base calculation as the total heat loss to the environment was reduced. In addition, the steeper temperature increase resulted in the successive key events such as the PORV latched open, the SG refill, and the feed-and-bleed operation to occur earlier than for the base calculation.

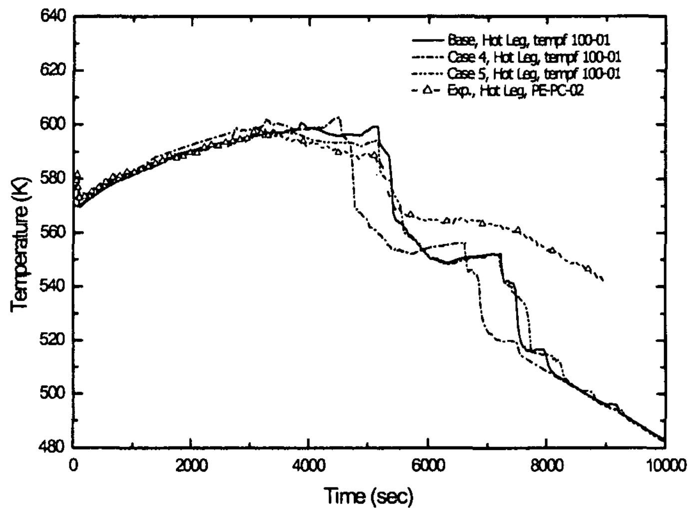


Figure 16. Sensitivity Studies for Long-term Parameters

4.2.5 PORV Discharge Coefficient (Case 5)

The effect of the discharge coefficient and the thermal nonequilibrium constant of the PORV were checked by setting them at 1.0 and 0.14, respectively. The calculated mass flow rates using these setting are compared in Figure 17. Compared to the base calculation, the mass flow rate through the PORV for this sensitivity increased up to 50% during the PORV latched open period as shown in Figure 17. This increased mass flow resulted in a more rapid PCS cooling during the PORV latched open period. However, the PCS temperature behavior during the cycling operation of the PORV was not influenced by the increased mass flow rate through the PORV as shown in Figure 16.

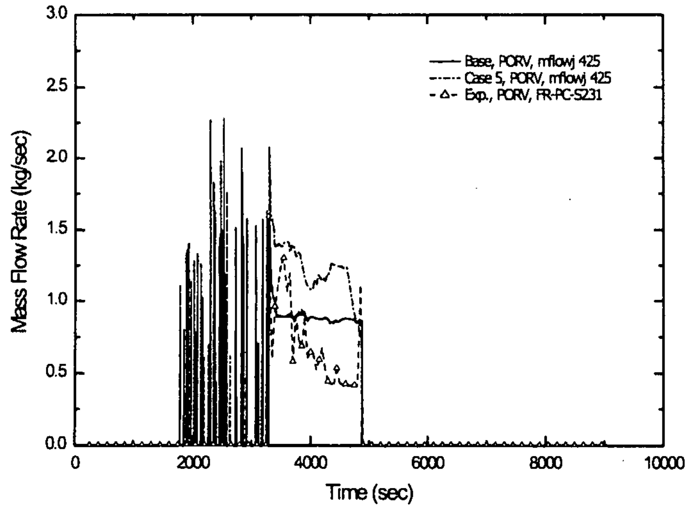


Figure 17. Sensitivity Study for Mass Flow Rate through PORV

4.3 Run Statistics

An IBM Personal Computer (Pentium III 933 MHz) was used for the present calculations with a DOS operating system. The required CPU time and the time step size with respect to the real transient times for the base calculation are presented in Figures 18 and 19, respectively. Figure 18 shows that the required CPU time up to the real transient time of 10,000 seconds is 2,427.76 seconds, including the input processing time of 3.46 seconds. Therefore, the grind time for the base calculation is calculated as follows:

CPU time, CPU = 2,427.76 - 3.46 = 2424.3 sec

Number of time steps, DT = 125,092

Number of volumes, C = 134

Grind time = CPU $\times$1,000 / (C $\times$DT) = 0.14463 CPU msec/vol/step

In Figure 19, the advanced time step size is compared with the Courant time step size. The maximum time steps specified in the base input decks were 1.0 second up to 1,000 seconds, 0.1 second up to 2,000 seconds, 0.5 second up to 4,000 seconds, 0.1 second up to 8,000 seconds, and 0.5 second up to 10,000 seconds of the real transient time. It is shown in Figure 19 that the advanced time step sizes were below the Courant time step sizes throughout the transient.

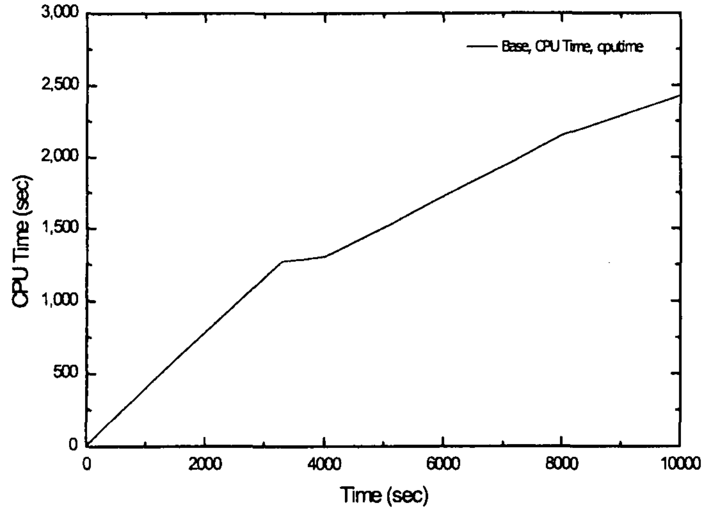


Figure 18. Required CPU Time of Base Calculation

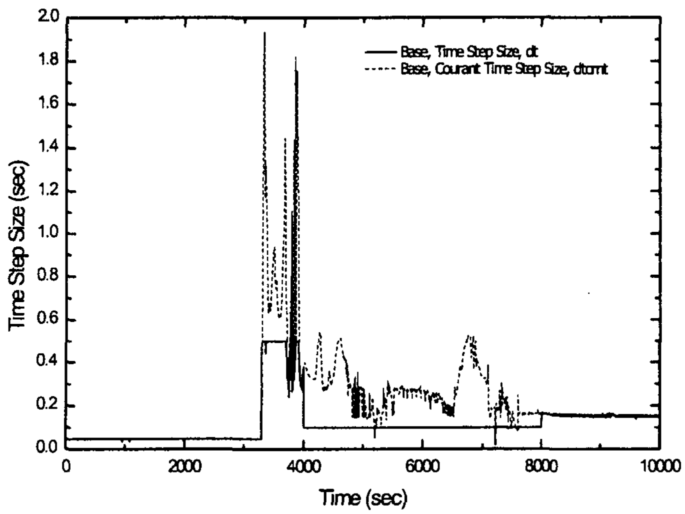


Figure 19. Time Step Size of Base Calculation

5. CONCLUSIONS

The purpose of this report is to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3. For this purpose, major parameters identified through sensitivity studies to have the most significant effect on the predicted thermal-hydraulic behaviors were incorporated into the base calculation to improve the code predictability. The code-predicted results were compared with the experimental data to assess the code predictability. Major conclusions through this assessment are summarized as follows:

From the comparisons presented with Figures and Tables, it was shown that the code-predicted results were generally in agreement with the measured data. Therefore, it is concluded that the RELAP5/MOD3.3Beta computer code has sufficient capability in predicting the thermal hydraulic phenomena occurred in the LOFT Experiment L9-1/L3-3.

However, the discrepancies between the calculation and the experiment were also identified. In Experiment L9-1, the code over-estimated temperature behaviors of the SG secondary side after dryout of the SG. However, these discrepancies were not considered to be significant, since the SG was in a de-coupled state from the PCS after the dryout of the SG secondary side. In Experiment L3-3, the code predicted excessive swelling of the PCS fluid during the first recovery mode, and predicted excessive cooling during the second recovery mode. The differences during the first recovery mode were due to the code's under-estimation of total discharged energy through the PORV. For the discrepancies during the second recovery mode, the code modeling deficiency of the SG secondary side was presumed to be one of the reasons. However, it is concluded that further investigation into the deviation sources are needed to enhance the code's predictability, since the specific reasons for the deviation were not clearly identified in this assessment.

Through sensitivity studies, the major parameters were identified to have significant effect on the predicted thermal-hydraulic behaviors. These parameters include the pressurizer spray system loss coefficient, nodalization of the SG secondary side, SG U-tube heat transfer area, heat transfer coefficient from the LOFT main components to the environment, and the PORV discharge coefficient. The first three parameters are significant during the short-term transient phase, while the last two are significant during the long-term transient phase. Therefore, the five parameters listed above should be carefully modeled to obtain appropriate calculation results for transient types such as the total-loss-of feedwater accident and its recovery modes.

6. REFERENCES

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Appendix A

Steady State Input Deck for Base Case

```
=loft l9-1 post test analysis deck
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*            initial conditions
*
*            core power = 50. mw
*            pcs flow = 479.3 kg/s
*            thot = 578. k
*            tcold = 559.0 k
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000100   new     stdy-st
0000101   run
0000102   si
0000105   5.      10.
0000110   nitrogen
* time step control cards
*        end time  min dt    max dt  optn mnr  mjr  rst
0000201   1000.0    1.e-6     0.5      3   4    500  200
***********************************************************
*
*             minor edit variables
*
***********************************************************
* pressure
***********************************************************
0000301   p       345010000     * pe-bl-1
0000302   p       310010000     * pe-bl-2
0000303   p       315110000     * pe-bl-3
0000304   p       350010000     * pe-bl-4
0000305   p       315090000     * pe-bl-6
0000306   p       350020000     * pe-bl-8
0000307   p       185010000     * pe-pc-1
0000308   p       100010000     * pe-pc-2
0000309   p       420010000     * porv inlet
0000310   p       110010000     * pt-139-2,3,4
0000311   p       245010000     * pe-1up-1a,1b
0000312   p       215010000     * pe-1st-1a,b/pe-2st-1a,b
0000313   p       200010000     * pe-1st-3a,3b
0000314   p       530020000     * pt-p4-10a
0000315   p       535010000     * pt-p4-85
***********************************************************
* temperatures
***********************************************************
0000320   tempf   406010000     * spray tempf
0000321   tempf   310010000     * te-bl-2a,2b,2c
0000322   tempf   100010000     * te-pc-2a,2b,2c
0000323   tempf   185010000     * te-pc-1
0000324   tempf   115030000     * te-sg-1
0000325   tempf   115100000     * te-sg-2
0000326   tempf   515040000     * te-sg-3
0000328   tempf   415050000     * pzr volume 5
0000329   tempf   415040000     * te-139-19
0000330   tempf   415030000     * te-139-20
0000331   tempf   315120000     * te-p138-171
0000332   tempf   350020000     * te-p138-170
0000333   tempf   205010000     * te-1st-1/te-2st-1
0000334   tempf   210010000     * te-1st-2/te-2st-2
0000335   tempf   345010000     * te-bl-1
0000336   tempf   210030000     * te-1st-14/te-2st-14
0000337   tempf   210040000     * te-3up-2
0000338   tempf   245010000     * te-1up-6
0000339   tempf   246010000     * te-2up-4
0000340   tempf   250010000     * te-1up-3
***********************************************************
* densities
***********************************************************
0000341   rho     345010000     * de-bl-1
0000342   rho     310010000     * de-bl-2
0000343   rho     185010000     * de-pc-1
0000344   rho     100010000     * de-pc-2
0000345   rho     115120000     * de-pc-3
0000346   voidgj  400010000     * surge line density
0000347   rho     115040000     * s/g tubes
0000348   rho     115050000     * s/g tubes
0000349   rho     115060000     * s/g tubes
0000350   rho     115070000     * s/g tubes
***********************************************************
* velocities
***********************************************************
0000351   voidf   100010000     * ilhl nozzle
0000352   velf    100010000     * ilhl nozzle
0000353   velf    115030000     * s/g inlet
0000354   velf    400010000     * surge line
0000355   velfj   425000000     * porv liq vel
0000356   velg    100010000     * ilhl nozzle
0000357   velg    115030000     * s/g inlet
0000358   velg    400010000     * surge line
0000359   velgj   425000000     * porv vap vel
***********************************************************
* mass flow rates
***********************************************************
0000360   mflowj  100010000     * ilhl nozzle
0000361   mflowj  150010000     * pump outlet
0000362   mflowj  185020000     * dtt-rake ilcl
0000363   mflowj  400010000     * pres. surge line flow
0000364   mflowj  407000000     * pzr spray flow
0000366   mflowj  425000000     * pres. relief valve flow
0000367   mflowj  550000000     * steam flow control valve
0000368   mflowj  548000000     * aux feed
0000369   mflowj  560000000     * main feed
0000370   cntrlvar 1            * s/g level
***********************************************************
* cladding temperatures center module
***********************************************************
0000371   httemp  230000110     * te-5h5-015
0000372   httemp  230000210     * te-5h5-034
0000373   httemp  230000310     * te-5h5-049
***********************************************************
* peak centerline temperatures
***********************************************************
0000374   httemp  230000101     * core lower region
0000375   httemp  230000201     * core middle region
0000376   httemp  230000301     * core upper region
***********************************************************
* reactor kinetic parameters
***********************************************************
0000377   rktpow   0            * total reactor power
0000378   rkfipow  0            * fission decay power
0000379   rkgapow  0            * gamma decay power
0000380   rkreac   0            * reactivity
```

```
0000381   pmphead   135                  * pcp1 head
0000382   pmphead   165                  * pcp2 head
0000384   cntrlvar  2                    * pzr level
0000385   cntrlvar  3                    * rx vessel level
0000386   mflowj    185010000
0000387   mflowj    185030000
0000388   mflowj    200020000
0000389   pmpvel    135
0000390   pmpvel    165
*************************************************************
*
*    trips
*
*************************************************************
*    variable trips
*************************************************************
0000501   p      100010000  le  null    0         14.193103e6  l
*         ecc check valve
0000502   p      600010000  ge  p       185010000 20.e6        n
*         accumulator check valve
0000503   p      615010000  ge  p       185010000 20.e6        n
*         isolation valve hot leg
0000504   time   0          lt  null    0         0.0          l
*         isolation valve cold leg
0000505   time   0          lt  null    0         0.0          l
*         qobv hot leg
0000506   time   0          lt  null    0         0.0          l
*         qobv cold leg
0000507   time   0          lt  null    0         0.0          l
*         check valve surge line pressurizer
0000508   time   0          ge  null    0         0.0          l
*         pressurizer relief valve
0000509   tempf  100010000  ge  null    0         597.0        l
*         steam control valve
0000510   time   0          lt  null    0         0.0          l
*         boundary system valve
0000511   time   0          lt  null    0         0.0          l
*         lpis trip
0000512   time   0          ge  null    0         10000.0      l
*         hpis trip
0000513   time   0          ge  null    0         10000.0      l
*
0000520   p      530020000  gt  null    0         7.103448e6   n
0000521   p      530020000  lt  null    0         7.0344827e6  n
0000522   p      530020000  gt  null    0         6.3448275e6  n
0000523   p      530020000  lt  null    0         6.4137931e6  n
0000530   time   0          ge  null    0         3600.0       n
0000531   p      530020000  gt  p       547010000 0.0          n
0000536   time   0          ge  null    0         10000.0      n
0000540   tempf  100010000  gt  null    0         583.16       l
0000541   p      100010000  gt  null    0         1.574553e7   l
0000550   time   0          ge  null    0         10000.0      l
0000551   time   0          ge  timeof  625       0.0          l
0000552   time   0          ge  timeof  509       1580.        l
0000560   p      100010000  le  null    0         13.15862e6   n
0000561   time   0          ge  timeof  552       265.0        l
0000562   time   0          gt  null    0         5400.0       n
0000563   cntrlvar 1        lt  null    0         2.1844       n
0000564   cntrlvar 1        gt  null    0         2.9464       n
0000565   time   0          ge  timeof  669       966.         l
0000570   p      420010000  gt  null    0         1.620058e7   n
0000571   p      420010000  lt  null    0         1.606269e7   n
0000572   p      420010000  lt  null    0         1.486300e7   n
0000573   p      420010000  gt  null    0         1.506980e7   n
0000574   p      420010000  gt  null    0         1.533874e7   n
0000575   p      420010000  lt  null    0         1.505000e7   n
0000576   p      420010000  lt  null    0         1.482853e7   n
0000577   p      420010000  gt  null    0         1.495950e7   n
*************************************************************
* logical trips
*************************************************************
0000600   670
0000601   563    and   561    n
0000602   -563   and   -564   n
0000603   655    and   602    n
0000604   609    or    609    l
0000605   572    and   -509   n
0000606   -572   and   -573   n
0000607   608    and   606    n
0000608   605    or    607    n
0000609   504    or    504    l
0000610   612    or    520    n
0000611   -521   and   -616   n
0000612   611    and   610    n
0000613   616    or    523    n
0000614   -522   and   613    n
0000615   -612   and   609    n
0000616   615    and   614    n
0000617   612    or    616    n
0000618   605    or    607    n
0000621   623    or    570    n
0000622   -571   and   -571   n
0000623   621    and   622    n
0000624   509    and   -552   n
0000625   623    or    624    n
0000626   576    and   -509   n
0000627   -576   and   -577   n
0000628   629    and   627    n
0000629   626    or    628    n
0000635   504    and   504    n
0000636   509    and   -536   n
0000650   -652   and   550    n
0000651   650    or    652    n
0000652   -509   and   651    n
0000655   601    or    603    n
0000656   508    or    609    n
0000659   561    or    562    n
0000660   504    or    504    n
0000669   561    and   564    l
0000670   565    and   -655   n
0000680   530    or    530    n
0000688   690    or    574    n
0000689   -575   and   -551   n
0000690   688    and   689    n
*************************************************************
*
*          intact loop
*
*************************************************************
* reactor vessel nozzle - intact loop hot leg
```

```
************************************************************
1000000   rvnilhl          branch
1000001   2        0
1000101   0.0634   1.5373   0.0     0.0     0.0     0.0
1000102   4.0e-5   0.0      00000
1000200   0        14901000. 1346300.0 2462060.0 0.0
1001101   250000000 100000000 0.0634  0.0     0.0     000100
1002101   100010000 105000000 0.0     0.05    0.05    000100
1001201   10.582000 11.005000 0.0
1002201   10.582000 10.625000 0.0
************************************************************
* pressurizer connection tee reactor vessel side
************************************************************
1050000   pzrtrvs          branch
1050001   1        0
1050101   0.0634   1.634    0.0     0.0     0.0     0.0
1050102   4.0e-5   0.0      00000
1050200   0        14896100. 1346300.  2462190.0  0.0
1051101   105010000 110000000 0.0     0.05    0.05    000100
1051201   13.795000 13.974000 0.0
************************************************************
* steam generator inlet piping
************************************************************
1100000   sginlp           branch
1100001   1        0
1100101   0.0      0.623    0.0303  0.0     0.0     0.0
1100102   4.0e-5   0.0      00000
1100200   0        14857200. 1346340. 24629400.0 .0000000
1101101   110010000 115000000 0.0     0.1     0.1     000100
1101201   13.801000 13.692000 0.0
************************************************************
* steam generator plus piping
************************************************************
1150000   sgppip           pipe
1150001   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   1.4385   1
1150302   0.708    2
1150303   0.63     3
1150304   0.26675  7
1150305   1.067    8
1150306   0.45     10
1150307   1.067    11
1150308   0.26675  15
1150309   0.63     16
1150310   0.547    17
1150311   0.689    18
1150312   0.559    19
1150401   0.09     1
1150402   0.057    2
1150403   0.335    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   0.26675  7
1150705   1.067    8
1150706   0.2865   9
1150707   -0.2865  10
1150709   -1.067   11
1150710   -0.26675 15
1150711   -0.513   16
1150712   -0.498   17
1150713   -0.689   18
1150714   -0.356   19
1150801   4.0e-5   0.0      2
1150802   4.0e-5   0.0102   3
1150803   1.0e-5   0.0103   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      7
1150904   0.1      0.1      8
1150905   0.2      0.2      9
1150906   0.1      0.1      10
1150907   0.0      0.0      15
1150908   0.05     0.05     16
1150909   0.1      0.1      18
1151001   00000    19
1151101   000100   2
1151102   100100   3
1151103   000000   14
1151104   000100   18
1151201   0        14871600. 1346350.   2462710.0  0.0  0.0 01
1151202   0        14877200. 1346350.   2462600.0  0.0  0.0 02
1151203   0        14793300. 1346370.   2464340.0  0.0  0.0 03
1151204   0        14770000. 1321980.   2464840.0  0.0  0.0 07
1151205   0        14746400. 1301720.   2465340.0  0.0  0.0 08
1151206   0        14729700. 1283950.   2465690.0  0.0  0.0 09
1151207   0        14721700. 1268380.   2465870.0  0.0  0.0 10
1151208   0        14715000. 1254890.   2466020.0  0.0  0.0 11
1151209   0        14707300. 1242570.   2466180.0  0.0  0.0 15
1151210   0        14707600. 1242600.   2466180.0  0.0  0.0 16
1151211   0        14631100. 1242600.   2467720.0  0.0  0.0 17
1151212   0        14621800. 1242600.   2467980.0  0.0  0.0 18
1151213   0        14616700. 1242600.   2468100.0  0.0  0.0 19
1151300   0
1151301   10.728000 10.670000 0.0     01
1151302   8.3370000 8.4284000 0.0     02
1151303   4.4456000 4.7693000 0.0     03
1151304   4.3865000 4.2164000 0.0     07
1151305   4.3407000 4.6700000 0.0     08
1151306   4.3009000 4.6296000 0.0     09
```

```
1151307   4.2676000 4.5954000 0.0       10
1151308   4.2398000 4.5671000 0.0       11
1151309   4.2249000 4.5338000 0.0       15
1151310   7.9665000 8.1922000 0.0       16
1151311   9.4925000 9.9460000 0.0       17
1151312   10.040000 10.505000 0.0       18
1151401   1.0224e-2   0.   1.   1.    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        14613100. 1242600.  2468180.0  0.0
1201101   115010000 120000000 0.0     0.1     0.1     000000
1202101   120010000 125000000 0.0317  0.2     0.2     000100
1203101   120010000 155000000 0.0317  0.2     0.2     000100
1201201   10.040000 10.505000 0.0
1202201   5.2077000 5.2983000 0.0
1203201   5.2071000 5.2944000 0.0
*****************************************************************
* pump1 suction tee outlet
*****************************************************************
1250000   pmp1sctt       branch
1250001   2      0
1250101   0.0      1.003    0.0613   0.0     90.0    0.521
1250102   4.0e-5   0.0      00000
1250200   0        14600300. 1242600.  2468180.0  0.0
1251101   125010000 130000000 0.0     0.1     0.1     000100
1252101   125000000 155000000 0.0     0.0     0.0     000100
1251201   7.8711000   8.2528000 0.0
1252201   -.11855000  -.13539000 0.0
*****************************************************************
* pump 1 inlet
*****************************************************************
1300000   pmp1nlet       snglvol
1300101   0.0      0.457    0.0189   0.0     90.0    0.457
1300102   4.0e-5   0.0      00000
1300200   0        14578200. 1242600.  2468900.0  0.0
*****************************************************************
* primary coolant pump 1
*****************************************************************
1350000   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        14818100. 1242890.  2463900.0  0.0
1350201   0    ,   8.8943000 9.2942000 0.0
1350202   0        8.8928000 8.1177000 0.0
1350301   0   0   0       -1      -1      504     0
1350302   369.00 .90178860 .315500 96.00 500.600 1.43100
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 l9-1 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
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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
**********************************************************
* pcp1 pump velocity table
**********************************************************
*1356100  536
*1356101  0.0         0.0
*1356102  1.0         220.
**********************************************************
* 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        15165000. 1242900.  2458470.  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        15069300. 1242900.  2458230.0  0.0
1451101   140010000 145000000 0.0    0.1      0.1      000100
1452101   145010000 150000000 0.0    0.0      0.0      000100
1451201   8.8901000 8.6110000 0.0
1452201   10.611000 10.694000 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        15048800. 1242900.  2458680.0  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   4.3528000 5.2611000 0.0
1502201   10.035000 10.103000 0.0
1503201   .08890000 .02735000 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
```

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1550200   0          14601200. 1242600.  2468430.0  0.0
1551101   155010000 160000000 0.0      0.1       0.1       000100
1551201   7.5199000 7.8923000 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          14580700. 1242600.  2468050.0  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          14832700. 1242890.  2463590.0  0.0
1650201   0          8.4974000 8.8872000 0.0
1650202   0          8.4959000 6.6507000 0.0
1650301   135  135  135       -1        -1        504       0
1650302   369.00 .89699187 .315500 96.00 500.600 1.431
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          15089900. 1242900.  2457860.0  0.0
1701101   145010000 170010000 0.0183   0.2       0.2       000100
1701201   -4.140400 -4.242200  0.0
************************************************************
* 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          15044100. 1242900.   2458830.0 0.0  0.0 01
1751202   0          15037400. 1242900.   2458990.0 0.0  0.0 02
1751300   0
1751301   10.035000 10.106000 0.0       01
************************************************************
* ecc connection tee pump side
************************************************************
1800000   ecct                branch
1800001   1         0
1800101   0.0634    1.152     0.0       0.0       0.0       0.0
1800102   4.0e-5    0.0       00000
1800200   0          15034000. 1242910.  2259090.0  0.0
1801101   175010000 180000000 0.0      0.05      0.05      000100
1801201   10.035000 10.083000 0.0
************************************************************
* cold leg pipe from ecc connection to reactor vessel
************************************************************
1850000   rvnild              branch
1850001   3         0
1850101   0.0634    1.01      0.0       0.0       0.0       0.0
1850102   4.0e-5    0.0       00000
1850200   0          15032100. 1242910.  2459140.0  0.0
1851101   185010000 205000000 0.0634   1.0       1.0       000100
1852101   180010000 185000000 0.0      0.0       0.0       000100
1853101   185010000 223000000 0.0      45.0      45.0      000100
1851201   9.2743000 9.3795000 0.0
1852201   10.035000 10.064000 0.0
1853201   1.6570000 1.7271000 0.0
************************************************************
*
*   reactor vessel
*
*--- ---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          15017400. 1243540.  2459500.0  0.0
2001101   200000000 205000000 0.0      0.0       0.0       000100
2002101   200000000 245010000 0.001    1800.     1800.
000100
2001201   -.0306700 -.03023076  .0
2002201   .06975000 .07019300  0.0
*--- ---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          15018400. 1242920.  2459460.0  0.0
2051101   205010000 210000000 0.0      0.0       0.0       000100
2051201   4.0266000 4.3312000 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          15017400. 1242940.  2459500.0  0.0  0.0  01
2101202   0          15023500. 1242960.  2459350.0  0.0  0.0  02
2101203   0          15029700. 1242980.  2459200.0  0.0  0.0  03
2101204   0          15035800. 1243000.  2459050.0  0.0  0.0  04
2101300   0
2101301   4.0266000 4.3398000 0.0      01
2101302   4.0266000 4.3397000 0.0      02
2101303   4.0266000 4.3396000 0.0      03
*----- ----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          15044100. 1242880.  2458850.0  0.0
2151101   210010000 215000000 0.0        0.00      0.00      000100
2152101   215010000 220000000 0.0        0.00      0.00      000100
2153101   215000000 225000000 0.15       0.0       0.0       000100
2151201   4.0265000 4.3184000 0.0
2152201   -.0651070 -.0771765 0.0
2153201   2.4798000 2.5728000 0.0
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
* lower plenum bottom volume
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
2200000   lwrplot          sngivol
2200101   0.79       0.37      0.0       0.0       -90.0     -0.37
2200102   4.0e-5     0.0       00000
2200200   0          15046800. 1241150.  2458780.0  0.0
*----- ----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          15023600. 1242730.  2459340.0  0.0  0.0  01
2231202   0          15028700. 1242320.  2459220.0  0.0  0.0  02
2231203   0          15035700. 1241930.  2459050.0  0.0  0.0  03
2231204   0          15042700. 1241540.  2458880.0  0.0  0.0  04
2231205   0          15049700. 1241160.  2458710.0  0.0  0.0  05
2231206   0          15054500. 1241010.  2458600.0  0.0  0.0  06
2231207   0          15057200. 1240860.  2458530.0  0.0  0.0  07
2231300   0
2231301   1.6569000 1.8115000 0.0      01
2231302   1.6565000 1.8111000 0.0      02
2231303   1.6561000 1.8107000 0.0      03
2231304   1.6558000 1.8103000 0.0      04
2231305   1.6554000 1.8099000 0.0      05
2231306   1.6553000 1.8097000 0.0      06
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
* junction from filler gap to lower plenum
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
2240000   flrgapp          sngljun
2240101   223010000 220010000 0.0      10.       10.       000100
2240201   0          1.6552000 1.7051000 0.0
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
* lower core support structure
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
2250000   lcoreup          branch
2250001   2          0
2250101   0.25       0.52      0.0       0.0       90.0      0.52
2250102   4.0e-5     0.095     00000
2250200   0          15032600. 1242900.  2459120.0  .0
2251101   225010000 230000000 0.0975   0.3       0.3       000100
2252101   225010000 235000000 0.0      0.0       0.0       000100
2251201   3.3398000 3.6043000 0.0
2252201   2.2306000 2.3976000 0.0
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
* active core
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
2300000   core             pipe
2300001   3
2300101   0.1705     3
2300201   0.1440     2
2300301   0.559      2
2300302   0.657      3
2300401   0.0        3
2300501   0.0        3
2300601   90.0       3
2300801   4.0e-5     0.012     3
2300901   0.5        0.5       2
2301001   00100      3
2301101   000100     2
2301201   0          15009300. 1289110.  2459680.  0.0 0.0  01
2301202   0          14996400. 1339030.  2459990.  0.0 0.0  02
2301203   0          14982500. 1354980.  2460310.  0.0 0.0  03
2301300   0
2301301   3.5187000 3.5227000 0.0      01
2301302   3.6127000 3.6166000 0.0      02
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
* core bypass volume
*----- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---
2350000   corebyps         pipe
2350001   3
2350101   0.015      3
2350201   0.0        2
2350301   0.559      2
2350302   0.657      3
2350401   0.0        3
2350501   0.0        3
2350601   90.0       3
2350801   4.0e-5     0.003     3
2350901   0.0        0.0       2
2351001   00000      3
2351101   000000     2
2351201   0          15021500. 1242940.  2459390.0  0.0  0.0  01
```

```
2351202   0          15002400. 1242980.  2459850.0  0.0  0.0  02
2351203   0          14981700. 1243020.  2460330.0  0.0  0.0  03
2351300   0
2351301   2.2307000 2.3978000 0.0        01
2351302   2.2307000 2.3980000 0.0        02
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* upper core support structure
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
2400000   ucosst              branch
2400001   2          0
2400101   0.297      1.118      0.0        0.0        90.0       1.118
2400102   4.0e-5     0.145      00000
2400200   0          14966500. 1348980.  2460680.0  0.0
2401101   230010000 240000000 0.12       0.3        0.3        000100
2402101   235010000 240000000 0.0        0.0        0.0        000100
2401201   3.6456000 3.6509000 0.0
2402201   2.3080000 2.3981000 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* upper flow skirt region
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
2450000   ufosre              branch
2450001   1          0
2450101   0.114      0.843      0.0        0.0        90.0       0.843
2450102   4.0e-5     0.131      00000
2450200   0          14945200. 1347660.  2461140.0  0.0
2451101   240010000 245000000 0.0        0.0        0.0        000100
2451201   5.7436     6.0742     0.0
*---- ----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          14961800. 1343000.  2460790.  0.0
2461101   240010000 246000000 0.0        0.0        0.0        000100
2461201   -.74932e-5 -.74932e-5 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          14947600. 1346300.  2461140.0  0.0
2501101   245010000 250000000 0.0        0.0        0.0        000100
2501201   5.8130000 6.1784000 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          14953100. 1239820.  2460990.0  0.0
3001101   250000000 300000000 0.0634     0.0        0.0        000100
```

```
3002101   300010000 305000000 0.0        0.1        0.1        000000
3001201   -.1303100 -.1795200 0.0
3002201   -.1303200 -.1304000 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          14953100. 1239750.  2460990.0  0.0
3051101   305010000 310000000 0.0        0.1        0.1        000100
3051201   -.1761300 -.1768800 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        1.424      0.0668     0.0        0.0        0.0
3100102   4.0e-5     0.0        00000
3100200   0          14953100. 1239700.  2460990.0  0.0
3101101   370010000 310000000 0.0        0.0        0.0        000100
3102101   310010000 315000000 0.0        0.0        0.0        000100
3101201   .21294000 .26136000 0.0
3102201   .00000000 .00320000 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       14952600. 1227510.  2461000.0 0.0 0.0 01
3151202  0       14950300. 1216950.  2461050.0 0.0 0.0 02
3151203  0       14947100. 1209830.  2461120.0 0.0 0.0 03
3151204  0       14939500. 1218490.  2461280.0 0.0 0.0 04
3151205  0       14931400. 1222380.  2461450.0 0.0 0.0 05
3151206  0       14931400. 1223780.  2461450.0 0.0 0.0 06
3151207  0       14939400. 1225430.  2461280.0 0.0 0.0 07
3151208  0       14947100. 1223910.  2461120.0 0.0 0.0 08
3151209  0       14952700. 1224050.  2461000.0 0.0 0.0 09
3151210  0       14959500. 1224450.  2460840.0 0.0 0.0 10
3151211  0       14957600. 1224730.  2460910.0 0.0 0.0 11
3151212  0       14953000. 1224840.  2460990.0 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  3       14.74e6   558.0
*---- ----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  506
*---- ----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        15018600. 1242920.  2459470.0  0.0
3351101  205000000 335000000 0.0634   1.0    1.0    000100
3352101  335010000 340000000 0.0      0.1    0.1    000000
3351201  .13054000 .15185000 0.0
3352201  .13051000 .13063000 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* cold leg pipe to reflood assist bypass tee
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
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        15018600. 1242870.  2459470.0  0.0
3401101  340010000 345000000 0.0      0.1    0.1    000000
3401201  .13049000 .13005000 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* broken loop cold leg contraction to break plane
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
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        15018600. 1242530.  2459470.0  0.0
3451101  345000000 385000000 0.0      0.0    0.0    000100
3452101  345010000 350000000 0.0      0.0    0.0    000100
3451201  .21311000 .19053000 0.0
3452201  .0       .0       0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* ecc tee isolation valve cold leg
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
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        15018600. 1067100.  2459470.0  0.0  0.0  01
3501202  0        15018600. 1173730.  2459470.0  0.0  0.0  02
3501300  0
3501301  .0       .0      0.0     01
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---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  505
*---- ---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  3        14.74e6 558.
*---- ---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  507
*---- ---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        14755500. 1239680.0 2460930.0  0.0
3701101  375010000 370000000 0.0      0.0     0.0     000100
3701201  .21294000 .24585000 0.0
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---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        14957900. 1239760.0 2460880.0   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        .106460   .25646    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        15023400. 1240020.0 2459350.0   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        15021000. 1240850.0 2459410.0  0.0
3851101  385010000 380000000 0.0     0.0     0.0     000100
3851201  .212920  .260740  0.0
*************************************************************
*
*   pressurizer
*
*************************************************************
* surge line pcs side
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
4000000  slpcs            branch
4000001  2        0
4000101  0.00145  3.45    0.0     0.0     90.0    0.54
4000102  4.0e-5   0.0     00000
4000200  0        14923700. 1458370.  2461610.0  0.0
4001101  110000000 400000000 0.00145  0.93    0.93
100100
4001110  0.       0.      1.      1.
4002101  400010000 405000000 0.0     0.93    0.93    000000
4001201  -.17675e-4  -.17772e-4 0.0
4002201  -.17696e-5  -.17696e-5 0.0
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---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        14920000. 1494210.0 2461690.0  0.0
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
* spray line
*---- ---1--- ---1--- ---1--- ---1--- ---1--- ---1---
4060000  spray    branch
4060001  1        0
4060101  0.0003363 6.322  0.0     0.0     90.0
4060102  3.161    4.0e-5  0.0     00000
4060200  0        15075000. 1244040.0 2458090.0  0.0
4061101  406010000 420010000 2.40e-6  1.039242  1.039242
000100
4061201  .08890000 .08890000 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 1.5432e1 1.5432e1 000100
*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    valve
4100101   405010000 415000000 0.00145   0.93    0.93    100100
4100110   0.        0.        1.        1.
4100201   0         -.17704000 -.1770400 0.0
4100300   trpvlv
4100301   508
*---- ---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     14917400. 1511010.  2461750.0 .0          0.0 01
4151202   0     14915500. 1568180.  2461790.0 .18395e-3   0.0 02
4151203   0     14913200. 1558810.  2463620.0 .15145      0.0 03
4151203   0     14913200. 1558810.  2463620.0 .15145      0.0 03
4151204   0     14912100. 1582630.  2461930.0 .9996500    0.0
04
4151205   0     14911900. 1582620.  2461840.0 .9996400    0.0
05
4151206   0     14911700. 1582560.  2461840.0 .9996000    0.0
06
4151207   0     14911500. 1582300.  2461840.0 .9995300    0.0
07
4151208   0     14911400. 1575760.  2461840.0 1.0         0.0 08
4151300   0
4151301   -.716473e-3 .05388    0.0      01
4151302   -.62376e-3  .3445     0.0      02
4151303   -.27965     .12293e-2 0.0      03
4151304   -.27030     .17636e-3 0.0      04
4151305   -.30526     .20283e-3 0.0      05
4151306   -.28127     .19339e-3 0.0      06
4151307   -.58439     .64379e-3 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         14911300. 1541380.  2461830.0 .99907000
4201101   415010000 420000000 0.0       0.0       0.0       000000
4201201   -.38729   5.44472e-4 0.0
*---- ---1---- ----1---- ----1---- ----1---- ----1---- ----1----
*  porv
*---- ---1---- ----1---- ----1---- ----1---- ----1---- ----1----
4250000   porv      valve
4250101   420010000 810000000 2.4784-5  0.0       0.0       000100
4250102   0.8       0.03
4250201   0         .000000   .00000    0.0
4250300   trpvlv
4250301   625
*****************************************************************
*
*  steam generator secondary side
*
*****************************************************************
* primary separator
*---- ---1---- ----1---- ----1---- ----1---- ----1---- ----1----
5000000   sepaout        separatr
5000001   3         0
5000101   1.273     0.718     0.0       0.0       +90.0     +0.718
5000102   4.e-5     0.7874    00010
5000200   0         5670640.  1187483.  2592802.0 .19415000
5001101   500010000 525000000 1.272800  0.0   0.0   001100  0.5
5002101   500000000 505000000 0.000000  0.0   0.0   001100
0.15
5003101   520000000 500000000 0.19600   0.4   0.4   001100
5001201   -0.4175   .75723    0.0
5002201   0.8006    -9.39768e-2 0.0
5003201   1.9086    4.4093    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    00000
5050200   0         5672780.0 1187580. 2592788.0 .01138160
5051101   505010000  510000000 0.0      0.0       0.0 000100
5051201   0.21828   -.30041   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   00000
5100200   0         5676840.0 1187774. 2592801.0 .408589e-5
5101101   510010000 515000000 0.0       0.0       0.0       000100
5101201   0.6328700 0.632870 0.0
*---- ---1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam generator downcomer
*---- ---1---- ----1---- ----1---- ----1---- ----1---- ----1----
5150000   dwncmr         annulus
5150001   11
5150101   0.23226   3
5150102   0.27871   11
```

```
5150201  0.0      10
5150301  0.7102   3
5150302  0.46269  7
5150303  1.85075  10
5150304  0.718    11
5150401  0.0      11
5150601  -90.0    3
5150602  21.0     9
5150603  16.0     10
5150604  90.0     11
5150701  -0.7102  3
5150702  0.17755  7
5150703  0.7102   9
5150704  0.518    10
5150705  0.718    11
5150801  4.e-5    0.10796  3
5150802  4.e-5    0.0305   10
5150803  4.e-5    0.0      11
5150901  0.0      0.0      2
5150902  17.5     17.5     3
5150903  0.0      0.0      6
5150904  4.2      4.2      7
5150905  8.8      8.8      8
5150906  4.2      4.2      9
5150907  0.0      0.0      10
5151001  00000    3
5151002  00100    9
5151003  00000    11
5151101  000000   2
5151102  000100   3
5151103  000000   10
5151201  0    5681540.0  1110180.0  2500000.0  0.0  0.0  11
5151300  0
5151301  .4952    .62274   0.0   01
5151302  .49535   .62294   0.0   02
5151303  .49550   .93962   0.0   03
5151304  .60219   2.772    0.0   07
5151305  1.2396   3.4916   0.0   08
5151306  1.6096   4.6784   0.0   09
5151307  1.5003   4.8023   0.0   10
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* top of the riser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5200000  separin            branch
5200001  1        0
5200101  0.27871  0.718    0.0      0.0      90.0     0.718
5200102  4.e-5    0.0      00000
5200200  0        5671640.0 1324220.  2600000.0  .1100800
5201101  515010000 520000000 0.00000  0.0    0.     000100
5201201  0.67145  9.3678   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        5670220.0 1150000.  2591710.0  .9999800
5251101  525010000 530000000 0.0     0.8      0.8     000100
5251201  .7175    .78659   0.0

*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* mist extractor and steam generator outlet pipe to scv
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5300000  stmpipe            pipe
5300001  2
5300101  1.2728   1
5300102  0.04635  2
5300201  0.01365  1
5300301  0.762    1
5300302  25.074   2
5300401  0.0      2
5300601  90.0     1
5300602  0.0      2
5300801  4.e-5    0.0      2
5300901  0.4      0.4      1
5301001  00000    2
5301101  000100   1
5301201  0     5670000.0 1148038.0  2591620.0 .9997400  0.0  01
5301202  0     5548250.0 1148038.0  2591620.0 .9989700  0.0  02
5301300  0
5301301  20.365   21.619   0.0      01
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pipe downstream of steam control valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5350000  condint            snglvol
5350101  0.06557  54.44    0.0      0.0      0.0      0.0
5350102  4.e-5    0.0      00000
5350200  0        2079110.0 914598.0  2598620.0  1.00000
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* air cooled condenser
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5400000  condnsr            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        656
5450201  -1.0     479.62   0.0
5450202  0.0      479.62   0.0
5450203  10.0     479.62   0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*  steam control valve bypass
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5460000  scvbyp   valve
5460101  530010000 547000000 0.0    0.0      0.0      000000
5460201  0        .000000  .000000  0.0
5460300  trpvlv
5460301  670
*---- ----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   1         680
5470201   0.0       559.15    0.999
*5470202   18000.    334.15    0.999
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* aux feed water
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5480000   auxfeed             tmdpjun
5480101   553000000 510000000 0.10
5480200   1         655
5480201   -1.0      0.0       0.0       0.0
5480202    0.0      0.0       0.0       0.0
*5480203   0.0      2.5207    0.0       0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam flow control valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5500000   cv-p4-1             valve
5500101   530010000 535000000 0.0043266 0.0     0.0       000100
5500201   0         19.758    22.082    0.0
5500300   mtrvlv
5500301   612       616       0.05      0.70    550
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* makeup feed tank
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5530000   demin               tmdpvol
5530101   3.0       10.0      0.0       0.0       0.0       0.0
5530102   3.33e-5   1.0       00011
5530200   1
5530201   0.0       366.5     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         13.171    36.498    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         656
5600201   0.0       26.533    26.533    0.0
*************************************************************
*
*   ecc system
*
*************************************************************
*   piping pcs hpis injection point
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6000000   ppchp     branch
6000001   0         1
6000101   0.009099  8.8776    0.0       0.0       -90.0     -3.2
6000102   4.0e-5    0.0       00000
6000200   0         14081300. 128835.00  2400000.0 .000000
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*   piping accumulator
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6050000   piac1     branch
6050001   2         0
6050101   0.014582  9.4891    0.0       0.0       0.0       0.0
6050102   4.0e-5    0.0       00000
6050200   0         14065600. 131740.00  260000.0 .000000
6051101   605010000 600000000 0.0       0.8       0.8       000100
6052101   610010000 605000000 0.0       0.7       0.7       000100
6051201   .98481-14 .98481-14 0.0
6052201   -.1251-13 -.1251-13 0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* accumulator pipe
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6100000   piac2               snglvol
6100101   0.018638  7.55998   0.0       0.0       0.0       0.0
6100102   4.0-5     0.0       00000
6100200   0         14065600. 131744.  2600000.0  0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* accumulator vessel
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6150000   accumlr             accum
6150101   1.254     2.33      0.0       0.0       90.0      2.33
6150102   4.0-5     0.0       00000
6150200   4.37+6    304.7     0.0
6151101   610000000 0.016817  24.6      24.6      000000
6152200   1.97      0.0       75.13     0.0   0.04445   0 0 0 503
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* bwst lpis
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6200000   bwstlps             tmdpvol
6200101   20.44     5.0       0.0       0.0       90.0      5.0
6200102   4.0e-5    0.0       00000
6200200   3
6200201   0.0       1.0e+5    305.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* bwst hpis
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6250000   bwsthps             tmdpvol
6250101   20.44     5.0       0.0       0.0       90.0      5.0
6250102   4.0e-5    0.0       00000
6250200   3
6250201   0.0       1.0e+5    305.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* ecc check valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6300000   eccvlv              valve
6300101   600010000 185000000 0.0       0.0       0.0       000100
6300201   0         .00000000 .00000000 0.0
6300300   trpvlv
6300301   502
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* low pressure injection system
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
6350000   lpis                tmdpjun
6350101   620000000 600000000 0.0
6350200   1         635       p         205010000
6350201   -1.0      0.0       0.0       0.0
6350202   8.483+4   7.045     0.0       0.0
6350203   4.297+5   6.091     0.0       0.0
6350204   7.745+5   5.045     0.0       0.0
6350205   9.448+5   4.313     0.0       0.0
6350206   1.119+6   3.454     0.0       0.0
6350207   1.186+6   3.173     0.0       0.0
6350208   1.257+6   2.673     0.0       0.0
6350209   1.326+6   2.159     0.0       0.0
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6350210   1.395+6   1.536    0.0     0.0
6350211   1.464+6   0.7182   0.0     0.0
6350212   1.517+6   0.0      0.0     0.0
*----1----1----1----1----1----1----1----
* high pressure injection system
*----1----1----1----1----1----1----1----
6400000   hpis              tmdpjun
6400101   625000000 600000000 0.0
6400200   1         660      p       100010000
6400201   -1.0      0.0      0.0     0.0
6400202   0.0       0.0      0.0     0.0
6400203   0.0       .75687272 0.0    0.0
6400204   .7725144+6 .75687272 0.0   0.0
6400205   8.3597+6  .31536281 0.0    0.0
6400206   17.2436+6 .31536281 0.0    0.0
*----1----1----1----1----1----1----1----
* accumulator valve
*----1----1----1----1----1----1----1----
*6450000  accumvl           valve
*6450101  615010000 610000000 0.003167  1.6   1.6    000100
*6450201  0         0.0      0.0     0.0
*6450300  trpvlv
*6450301  503
*************************************************************
*
*         containment
*
*************************************************************
*  containment broken loop hot leg
*----1----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----1----
*  containment broken loop cold leg
*----1----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----1----
*  containment power operated relief valve
*----1----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
8100201   10000.0   0.107e+6  1.0
*----1----1----1----1----1----1----1----
*  boundary valve intact loop hot leg
*----1----1----1----1----1----1----1----
9000000   bvalv    valve
9000101   110010000 905000000 0.0     0.0     0.0     000100
9000201   0         0.0      0.0     0.0
9000300   trpvlv
9000301   511
*----1----1----1----1----1----1----1----
*   boundary volume intact loop hot leg
*----1----1----1----1----1----1----1----
9050000   bvolum    tmdpvol
9050101   0.0    1.0    0.1     0.0     0.0     0.0
9050102   0.0    0.0    00000
9050200   3
9050201   0.0      14.9664e6 577.86
9050202   10000.0  14.9664e6 577.86
*************************************************************
*
*         heat structure input data
*
*************************************************************
*
* steam generator heat structures
*
*************************************************************
* steam generator tubing
*************************************************************
10060000  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     627.124   4
10060502  115080000      0    1     1    2508.496   5
10060503  115090000  10000    1     1    1057.940   7
10060504  115110000      0    1     1    2508.496   8
10060505  115120000  10000    1     1     627.124  12
10060601  515040000  10000    1     1     627.124   4
10060602  515080000      0    1     1    2508.496   5
10060603  515090000      0    1     1    1057.940   7
10060604  515080000      0    1     1    2508.496   8
10060605  515070000 -10000    1     1     627.124  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 515030000 0     1     1     0.1579621  2
11152701 0        0.0    0.0   0.0   2
11152801 0.0 11.0 11.0  0.0 0.0 0.0 0.0 1.0  2  * mod 3
11152901 0.0 11.0 11.0  0.0 0.0 0.0 0.0 1.0  2  * mod 3
************************************************************
* intact loop piping
************************************************************
11001000 12       11     2     1     0.142
11001100 0        1
11001101 10       0.1780
11001201 4        10
11001301 0.0      10
11001401 540.0    11
11001501 100010000 0     1     1     1.5373   1
11001502 105010000 0     1     1     1.634    2
11001503 110010000 0     1     1     0.623    3
11001504 115010000 0     1     1     1.4385   4
11001505 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---- ----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---- ----1----
* vessel sides - large diameter section
*---- ----1---- ----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          0.314325
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  515110000 0        1       1       0.7725   2
15000603  515100000 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  4          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 10000    1       1       0.7113   4
15150601  515100000 0        1       1       0.152    1
15150602  515090000 0        1       1       0.7113   2
15150603  515080000 0        1       1       0.7113   3
15150604  515060000 0        1       1       0.7113   4
15150701  0          0        0       0       4
15150801  0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0  4  * mod 3
15150901  0.0  11.0  11.0  0.0  0.0  0.0  0.0  1.0  4  * mod 3
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* vessel wall
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
15300000  8          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 10000    1      1       0.7102   8
15300601  -939     0     3959     1       0.762    2
15300602  -939     0     3959     1       0.718    4
15300603  -939     0     3959     1       0.518    5
15300604  -939     0     3959     1       0.7102   8
15300701  0        0.0     0.0     0.0     8
15300801  0.0  11.0  11.0   0.0  0.0  0.0  0.0  1.0   8  * 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
```

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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
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pressurizer cycling heaters
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20241700  power    608
20241701  0.0      0.0
20241702  60.      4.e3
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* pressurizer backup haters
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20241800  power    629
20241801  0.0      0.0
20241802  60.      4.e3
*---- ----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
```

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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       48.9e6
*----- ----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       18.83
*----- ----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       4.739
*----- ----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       4.2266
*----- ----1----- ----1----- ----1----- ----1----- ----1----- ----1-----
* blhl environmental loss heat xfer coefficient
*----- ----1----- ----1----- ----1----- ----1----- ----1----- ----1-----
20297900  htc-t     509
20297901  -1.0      0.0
20297902  0.0       18.83
***********************************************************
* core collapsed liquid level
***********************************************************
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
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  49.6e+6  0.0  348.43  1.0  0.556
30000002  ans79-1
***********************************************************
* 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  4.96e+7   70.   hr
***********************************************************
* reactivity curve numbers
***********************************************************
30000011  609
***********************************************************
* moderator density reactivity table
***********************************************************
*30000501  0.818    -4.428
*30000502  0.905    -2.249
*30000503  0.955    -1.032
*30000504  1.000     0.000
*30000505  1.044     0.926
*30000506  1.095     1.853
*30000507  1.139     2.589
*30000508  1.213     3.689
*30000509  1.270     4.489
*30000510  1.316     5.212
***********************************************************
* 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
***********************************************************
* moderator density reactivity table
***********************************************************
30000501   0.818  0.0
30000502   0.905  0.0
30000503   0.955  0.0
30000504   1.000  0.0
30000505   1.044  0.0
30000506   1.095  0.0
30000507   1.139  0.0
30000508   1.213  0.0
30000509   1.270  0.0
30000510   1.316  0.0
***********************************************************
* doppler reactivity table
***********************************************************
30000601   293.16  0.0
30000602   338.72  0.0
30000603   422.05  0.0
30000604   477.60  0.0
30000605   505.38  0.0
30000606   570.72  0.0
30000607   588.72  0.0
30000608   695.83  0.0
30000609   922.05  0.0
30000610  1310.94  0.0
30000611  1810.94  0.0
30000612  2088.72  0.0
30000613  2499.83  0.0
30000614  3027.60  0.0
* -------  no reactivity feedback for steadt state run
* -------  shuold be replaced by original one for transient
***********************************************************
* 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
***********************************************************
*
*       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            0.7102    voidf     515020000
20500106            0.7102    voidf     515030000
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*   pressurizer collapsed liquid level
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20500200  pzrlvl    sum       1.0       0.0       1
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
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            0.0402793 rho       115040000
20504203            0.0402793 rho       115050000
20504204            0.0402793 rho       115060000
20504205            0.0402793 rho       115070000
20504206            1.61117-1 rho       115080000
20504207            6.7950e-2 rho       115090000
20504208            6.7950e-2 rho       115100000
20504209            1.61117-1 rho       115110000
20504210            0.0402793 rho       115120000
20504211            0.0402793 rho       115130000
20504212            0.0402793 rho       115140000
20504213            0.0402793 rho       115150000
20504214            3.3500e-1 rho       115160000
*---- ----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            0.07770   rho         350020000
20500706            8.55000-2 rho         380010000
20500707            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
*-----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      20.117   htrnr    006000100
20511202          20.117   htrnr    006000200
20511203          20.117   htrnr    006000300
20511204          20.117   htrnr    006000400
20511205          80.468   htrnr    006000500
20511206          33.937   htrnr    006000600
20511207          33.937   htrnr    006000700
20511208          80.468   htrnr    006000800
20511209          20.117   htrnr    006000900
20511210          20.117   htrnr    006001000
20511211          20.117   htrnr    006001100
20511212          20.117   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   htmr     370000101
20511902            0.94828  htmr     370000201
20511903            0.94497  htmr     370000301
20511904            2.6090   htmr     370000401
*-----1-----1-----1-----1-----1-----1---
*   heat loss from intact loop hot leg
*-----1-----1-----1-----1-----1-----1---
20512000  ilclheat  sum      1.0      0.0      1
20512001  0.0       1.7193   htmr     100100101
20512002            1.8275   htmr     100100201
20512003            0.69677  htmr     100100301
20512004            1.6088   htmr     100100401
20512005            0.90304  htmr     100200101
20512006            1.8855   htmr     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  htmr     100100501
20512102            0.62519  htmr     100100601
20512103            0.84999  htmr     100100701
20512104            0.55540  htmr     100100801
20512105            0.62519  htmr     100100901
20512106            0.68558  htmr     100101001
20512107            0.78400  htmr     100101101
20512108            1.6340   htmr     100101201
20512109            0.69769  htmr     100200201
20512110            0.85765  htmr     100300101
20512111            0.39195  htmr     100300201
20512112            0.43054  htmr     100300301
20512113            1.2079   htmr     100300401
20512114            0.86023  htmr     100300501
20512115            0.39195  htmr     100300601
20512116            0.44083  htmr     100300701
20512117            1.8855   htmr     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   htmr     415100100
20512302            0.59522  htmr     415200100
20512303            1.07086  htmr     415200200
20512304            1.07086  htmr     415200300
20512305            0.550045 htmr     415200400
20512306            0.550045 htmr     415200500
20512307            0.453056 htmr     415200600
20512308            0.453056 htmr     415200700
20512309            0.150656 htmr     416200100
20512310            0.13000  htmr     420100100
20512311            0.150656 htmr     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            2.88042   htmr      515000300
20555110            2.88042   htmr      515000400
20555111            0.627655  htmr      515000101
20555112            2.93718   htmr      515000201
20555113            2.93718   htmr      515000301
20555114            2.93718   htmr      515000401
*
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
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
20562700  dtqf/v mult      0.126646   0.0       1
20562701           cntrlvar  626
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* primary coolant pump speed controllers
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* calculate mass flow error
*---- ----1---- ----1---- ----1----
20590100  msserr    sum       1.0        0.0       1
20590101  479.30    -1.0      mflowj    100010000
*---- ----1---- ----1---- ----1----
* pump 1 speed
*---- ----1---- ----1---- ----1----
20590200  pcp1spd   integral  0.34482   333.7236  1
20590201  cntrlvar  901
*---- ----1---- ----1---- ----1----
* pcp1 pump velocity table
*---- ----1---- ----1---- ----1----
1356100   508       cntrlvar  902
1356101   0.0       0.0
1356102   369.0     369.0
*---- ----1---- ----1---- ----1----
* modify pcp1 pump data
*---- ----1---- ----1---- ----1----
1350301   0    0    0        -1        0         504       0
*---- ----1---- ----1---- ----1----
* pump 2 speed
*---- ----1---- ----1---- ----1----
20590300  pcp2spd   integral  0.34482   331.9524  1
20590301  cntrlvar  901
*---- ----1---- ----1---- ----1----
* pcp2 pump velocity table
*---- ----1---- ----1---- ----1----
1656100   508       cntrlvar  903
1656101   0.0       0.0
1656102   369.0     369.0
*---- ----1---- ----1---- ----1----
* modify pcp2 pump data
*---- ----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----
4070000   sprvlv         valve
4070101   406010000 420010000 3.3451e-4  1.2       1.2       000100
4070201   0         .00000000 .00000000 0.0
4070300   srvvlv
4070301   904       999
*---- ----1---- ----1---- ----1----
* spray valve position calculator
*---- ----1---- ----1---- ----1----
20590400  spray     sum       -1.0      0.0       1         * contin
+         3         0.0       1.0
20590401  14.93+6   -1.0      p         420010000
*---- ----1---- ----1---- ----1----
* position vs area table
*---- ----1---- ----1---- ----1----
20299900  normarea
20299901  0.0       0.0
20299902  0.0001    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----
*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----
* charging valve
*---- ----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----
* charging valve position calculator
*---- ----1---- ----1---- ----1----
*20590500 charge    sum       7.7       0.0       1
*contin
*+        3         0.0       1.0
*20590501 0.92      -1.0      cntrlvar  2
*---- ----1---- ----1---- ----1----
* letdown sink
*---- ----1---- ----1---- ----1----
*9900000  ltdwn         tmdpvol
*9900101  1.0       1.0       0.0       0.0       0.0       0.0
*9900102  4.0-5     0.0       00000
*9900200  3
*9900201  0.0       1.4+7     558.9
*---- ----1---- ----1---- ----1----
* letdown valve
*---- ----1---- ----1---- ----1----
*9950000  ltdwn         valve
*9950101  185000000 990000000  2.5-5    0.0       0.0       000100
*9950201  0         .00000000 .00000000 0.0
*9950300  srvvlv
*9950301  906       999
*---- ----1---- ----1---- ----1----
* letdown valve position calculator
*---- ----1---- ----1---- ----1----
*20590600 letdown   sum       -7.7      0.0       1
*contin
*+        3         0.0       1.0
```

```
*20590601  1.10      -1.0       cntrlvar  2
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* steam valve controller
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* changes to steam valve
*---- ----1---- ----1---- ----1----
*5500201   0         19.758     22.082     0.0
*5500300   srvvlv
*5500301   910       540
*20254000  normarea
*20254001  0.0       0.0
*20254002  0.0001    0.0
*20254003  1.0       1.0
*---- ----1---- ----1---- ----1----
* compute delta t error
*---- ----1---- ----1---- ----1----
*20590700  delta sum        1.0       0.0       1
*20590701  559.0   -1.      tempf     185010000
*---- ----1---- ----1---- ----1----
* filter delta t thru deadband
*---- ----1---- ----1---- ----1----
*20590800  deadband  function  1.0       0.0       1
*20590801  cntrlvar  907       908
*20290800  reac-t
*20290801  -100.     -100.
*20290802  -0.25     -0.25
*20290803  -0.25     0.0
*20290804  0.25      0.0
*20290805  0.25      0.25
*20290806  100.      100.
*---- ----1---- ----1---- ----1----
* integrate delta t error
*---- ----1---- ----1---- ----1----
*20590900  int integral  1.0       0.0       1
*20590901  cntrlvar  908
*---- ----1---- ----1---- ----1----
* steam valve position calculator
*---- ----1---- ----1---- ----1----
*20591000  tcontrol  sum       1.0       0.645229  0          *conti
*+         3         0.6       0.90
*20591001  0.645229  -0.07126  cntrlvar  908
*20591002            -0.01492  cntrlvar  909
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* simplified feed system controller
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
20591100  sglvlerr  sum       1.0       0.0       1
20591101  3.09      -1.0      cntrlvar  001
20591200  feedflow  sum       1.0       0.0       1
20591201  0.0       1.0       mflowj    550000000
20591202            48.4      cntrlvar  911
*---- ----1---- ----1---- ----1----
* replace feed junction table
*---- ----1---- ----1---- ----1----
5600200   1         0         cntrlvar  912
5600201   -100.0    25.553    0.0       0.0
5600202   -1.0      0.0       0.0       0.0
5600203   0.0       0.0       0.0       0.0
5600204   50.0      50.0      0.0       0.0
.
```

Appendix B

Transient Input Deck for Base Case

```
=loft l9-1 post test analysis deck
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
*            initial conditions
*
*            pcp pressure = 14.901 mpa
*            core power = 50. mw
*            pcs flow = 479.3 kg/s
*            thot = 578. k
*            tcold = 559.0 k
*
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
0000100   restart   transnt
0000101   run
0000102   si
0000103      15808
0000105   5.     10.
0000201   200.00    1.e-6    1.0    3   1    30   100
0000202   1000.0    1.e-6    1.0    3   5   300   500
0000203   2000.0    1.e-6    0.1    3   50  3000  5000
0000204   4000.0    1.e-6    0.5    3   10  1000  2000
0000205   8000.0    1.e-6    0.1    3   50  4000  5000
0000206   10000.    1.e-6    0.5    3   10  2000  2000
*************************************************************
*             minor edit variables
*
************************************************************* pressure
*************************************************************0000301   p     345010000     * pe-bl-1
0000301   p      310010000     .* pe-bl-2
*0000303   p      315110000     * pe-bl-3
*0000304   p      350010000     * pe-bl-4
*0000305   p      315090000     * pe-bl-6
*0000306   p      350020000     * pe-bl-8
0000302   p      185010000     * pe-pc-1
0000303   p      100010000     * pe-pc-2
0000304   p      420010000     * porv inlet
*0000310   p      110010000     * pt-139-2,3,4
0000305   p      245010000     * pe-1up-1a,1b
0000306   p      215010000     * pe-1st-1a,b/pe-2st-1a,b
*0000313   p      200010000     * pe-1st-3a,3b
0000307   p      530010000     * pe-sgs-01
0000308   p      535010000     * pt-p4-85
************************************************************* temperatures
*************************************************************0000309   tempf   406010000     * spray tempf
0000310   tempf   310010000     * te-bl-2a,2b,2c
0000311   tempf   100010000     * te-pc-2a,2b,2c
0000312   tempf   185010000     * te-pc-1
0000313   tempf   115030000     * te-sg-1
0000314   tempf   115100000     * te-sg-2
0000315   tempf   515070000     * te-sg-4
*0000328   tempf   415050000     * pzr volume 5
0000316   tempf   415040000     * te-139-19
*0000330   tempf   415030000     * te-139-20
*0000331   tempf   315120000     * te-p138-171
*0000332   tempf   350020000     * te-p138-170
*0000333   tempf   205010000     * te-1st-1/te-2st-1
0000317   tempf   210010000     * te-1st-2/te-2st-2
*0000335   tempf   345010000     * te-bl-1
*0000336   tempf   210030000     * te-1st-14/te-2st-14
*0000337   tempf   210040000     * te-3up-2
*0000338   tempf   245010000     * te-1up-6
*0000339   tempf   246010000     * te-2up-4
*0000340   tempf   250010000     * te-1up-3
************************************************************* densities
```

```
*************************************************************0000341   rho      345010000     * de-bl-1
0000318  rho      310010000      * de-bl-2
0000319  rho      185010000      * de-pc-1
0000320  rho      100010000      * de-pc-2
*0000345  rho     115120000      * de-pc-3
0000321  voidgj   400010000      * surge line density
*0000347  rho     115040000      * s/g tubes
*0000348  rho     115050000      * s/g tubes
*0000349  rho     115060000      * s/g tubes
*0000350  rho     115070000      * s/g tubes
************************************************************* velocities
*************************************************************0000351   voidf    100010000     * ilhl nozzle
*0000352  velf    100010000      * ilhl nozzle
*0000353  velf    115030000      * s/g inlet
*0000354  velf    400010000      * surge line
*0000355  velfj   425000000      * porv liq vel
*0000356  velg    100010000      * ilhl nozzle
*0000357  velg    115030000      * s/g inlet
*0000358  velg    400010000      * surge line
*0000359  velgj   425000000      * porv vap vel
************************************************************* mass flow rates
*************************************************************0000322   mflowj   100010000     * ilhl nozzle
*0000361  mflowj  150010000      * pump outlet
*0000362  mflowj  185020000      * dtt-rake ilcl
0000323  mflowj   400010000      * pres. surge line flow
0000324  mflowj   407000000      * pzr spray flow
0000325  mflowj   425000000      * pres. relief valve flow
0000326  mflowj   550000000      * steam flow control valve
0000327  mflowj   548000000      * aux feed
*0000369  mflowj  560000000      * main feed
************************************************************* cladding temperatures center module
*************************************************************0000371   httemp   230000110     * te-5h5-015
*0000372  httemp  230000210      * te-5h5-034
*0000373  httemp  230000310      * te-5h5-049
************************************************************* peak centerline temperatures     *
*************************************************************0000374   httemp   230000101     * core lower region
*0000375  httemp  230000201      * core middle region
*0000376  httemp  230000301      * core upper region
************************************************************* reactor kinetic parameters
*************************************************************
0000328  rktpow    0             * total reactor power
*0000378  rkfipow  0             * fission decay power
*0000379  rkgapow  0             * gamma decay power
*0000380  rkreac   0             * reactivity
*0000381  pmphead  135           * pcp1 head
*0000382  pmphead  165           * pcp2 head
0000329  mflowj   185010000
0000330  mflowj   185030000
*0000388  mflowj  200020000
0000331  pmpvel   135
*************************************************************     control variable requests
*************************************************************0000332     cntrlvar    001
0000333       cntrlvar     002
0000334       cntrlvar     003
0000335       cntrlvar     041
0000336       cntrlvar     042
0000337       cntrlvar     043
0000338       cntrlvar     004
0000339       cntrlvar     005
0000340       cntrlvar     006
0000341       cntrlvar     007
0000342       cntrlvar     008
0000343       cntrlvar     009
```

```
0000344    cntrlvar    010
0000345    cntrlvar    433
0000346    cntrlvar    434
0000347    cntrlvar    111
0000348    cntrlvar    112
0000349    cntrlvar    113
0000350    cntrlvar    114
0000351    cntrlvar    115
0000352    cntrlvar    116
0000353    cntrlvar    117
0000354    cntrlvar    118
0000355    cntrlvar    119
0000356    cntrlvar    120
0000357    cntrlvar    121
0000358    cntrlvar    122
0000359    cntrlvar    123
0000360    cntrlvar    251
0000361    cntrlvar    252
0000362    cntrlvar    253
0000363    cntrlvar    126
0000364    cntrlvar    127
0000365    cntrlvar    128
0000366    cntrlvar    129
0000367    cntrlvar    130
0000368    cntrlvar    551
0000369    cntrlvar    552
0000370    cntrlvar    132
0000371    cntrlvar    133
0000372    cntrlvar    170
0000373    cntrlvar    171
0000374    cntrlvar    570
0000375    cntrlvar    573
0000376    cntrlvar    153
0000377    cntrlvar    154
0000378    cntrlvar    155
0000379    cntrlvar    156
0000380    cntrlvar    157
0000381    cntrlvar    160
0000382    cntrlvar    161
0000383    cntrlvar    166
0000384    cntrlvar    167
0000385    cntrlvar    620
0000386    cntrlvar    621
0000387    cntrlvar    622
0000388    cntrlvar    623
0000389    cntrlvar    624
0000390    cntrlvar    625
0000391    cntrlvar    626
0000392    cntrlvar    627
0000393    tempg       515070000
0000394    rho         420010000
0000395    cputime     0
20800095   dt          0
20800096   dtcrnt      0
*************************************************************
*    trips
*
*************************************************************    variable trips
*************************************************************0000501   p   100010000  le  null   0   14.193103e6  l
*    ecc check valve
0000502   p   600010000   ge   p   185010000 20.e6   n
*    accumulator check valve
0000503   p   615010000   ge   p   185010000 20.e6   n
```

```
*        isolation valve hot leg
0000504  time    0          lt  null   0        0.0        l
*        isolation valve cold leg
0000505  time    0          lt  null   0        0.0        l
*        qobv hot leg
0000506  time    0          lt  null   0        0.0        l
*        qobv cold leg
0000507  time    0          lt  null   0        0.0        l
*        check valve surge line pressurizer
0000508  time    0          ge  null   0        0.0        l
*        pressurizer relief valve
0000509  tempf   100010000  ge  null   0        597.0      l
*        steam control valve
0000510  time    0          lt  null   0        0.0        l
*        boundary system valve
0000511  time    0          lt  null   0        0.0        l
*        lpis trip
0000512  time    0          ge  null   0        10000.0    l
*        hpis trip
0000513  time    0          ge  null   0        10000.0    l
*
0000520  p       530020000  gt  null   0        7.103448e6    n
0000521  p       530020000  lt  null   0        7.0344827e6   n
0000522  p       530020000  gt  null   0        6.3448275e6   n
0000523  p       530020000  lt  null   0        6.4137931e6   n
0000530  time    0          ge  null   0        3600.0        n
0000531  p       530020000  gt  p      547010000 0.0          n
0000536  time    0          ge  null   0        10000.0       n
0000540  tempf   100010000  gt  null   0        583.16        l
0000541  p       100010000  gt  null   0        1.574553e7    l
0000550  time    0          ge  null   0        10000.0       l
0000551  time    0          ge  timeof 625      0.0           l
0000552  time    0          ge  timeof 509      1580.         l
0000560  p       100010000  le  null   0        13.15862e6    n
0000561  time    0          ge  timeof 552      265.0         l
0000562  time    0          gt  null   0        5400.0        n
0000563  cntrlvar 1         lt  null   0        2.1844        n
0000564  cntrlvar 1         gt  null   0        2.9464        n
0000565  time    0          ge  timeof 669      966.          l
0000570  p       420010000  gt  null   0        1.620058e7    n
0000571  p       420010000  lt  null   0        1.606269e7    n
0000572  p       420010000  lt  null   0        1.486300e7    n
0000573  p       420010000  gt  null   0        1.506980e7    n
0000574  p       420010000  gt  null   0        1.533874e7    n
0000575  p       420010000  lt  null   0        1.505000e7    n
0000576  p       420010000  lt  null   0        1.482853e7    n
0000577  p       420010000  gt  null   0        1.495950e7    n
************************************************************ logical trips
************************************************************0000600   536
0000601  563     and     561     n
0000602  -563    and     -564    n
0000603  655     and     602     n
0000604  609     or      609     l
0000605  572     and     -509    n
0000606  -572    and     -573    n
0000607  608     and     606     n
0000608  605     or      607     n
0000609  540     or      541     l
0000610  612     or      520     n
0000611  -521    and     -616    n
0000612  611     and     610     n
0000613  616     or      523     n
0000614  -522    and     613     n
```

```
0000615  -612   and    609    n
0000616   615   and    614    n
0000617   612   or     616    n
0000618   605   or     607    n
0000621   623   or     570    n
0000622  -571   and   -571    n
0000623   621   and    622    n
0000624   509   and   -552    n
0000625   623   or     624    n
0000626   576   and   -509    n
0000627  -576   and   -577    n
0000628   629   and    627    n
0000629   626   or     628    n
0000635   504   and    504    n
0000636   509   and   -536    n
0000650  -652   and    550    n
0000651   650   or     652    n
0000652  -509   and    651    n
0000655   601   or     603    n
0000656   508   or     609    n
0000659   561   or     562    n
0000660   504   or     504    n
0000669   561   and    564    l
0000670   565   and   -655    n
0000680   530   or     530    n
0000688   690   or     574    n
0000689  -575   and   -551    n
0000690   688   and    689    n
* pzr heater delete
14201000  delete
14202000  delete
*---- ----1---- ----1---- ----1
*  control variable 114 re-define
*---- ----1---- ----1---- ----1
20511400   pzrheat   sum    1.0   0.0   1
20511401     0.0    0.362     htmr   415100101
20511402            0.702464  htmr   415200101
20511403            1.26381   htmr   415200201
20511404            1.26381   htmr   415200301
20511405            0.649152  htmr   415200401
20511406            0.649152  htmr   415200501
20511407            0.534688  htmr   415200601
20511408            0.534688  htmr   415200701
20511409            0.273063  htmr   416200101
*---- ----1---- ----1---- ----1
*  control variable 123 redefine
*---- ----1---- ----1---- ----1
20512300   pzr   sum   1.0   0.   1
20512301   0.0   0.362     htmr   415100100
20512302         0.59522   htmr   415200100
20512303         1.07086   htmr   415200200
20512304         1.07086   htmr   415200300
20512305         0.550045  htmr   415200400
20512306         0.550045  htmr   415200500
20512307         0.453056  htmr   415200600
20512308         0.453056  htmr   415200700
20512309         0.150656  htmr   416200100
************************************************************** 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       14818100. 1242890.  2463900.0  0.0
1350201  0       8.8943000 9.2942000 0.0
1350202  0       8.8928000 8.1177000 0.0
1350301  0   0   0      -1      0       509     0
1350302  369.000 .90178860 .315500 96.0000 500.600  1.4310000
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
************************************************************ pcp1 pump velocity table
************************************************************1356100   536
1356101   0.0         0.0
1356102   1.0         220.
```

```
************************************************************ 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         14832700. 1242890.  2463590.0   0.0
1650201   0         8.4974000 8.8872000 0.0
1650202   0         8.4959000 6.6507000 0.0
1650301   135  135  135       -1        135      509      0
1650302   369.00000 .89699187 .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   1.0   1.0      000100
4070201   0         .000000   .000000   0.0
4070300   trpvlv
4070301   690
*---- ----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   1         680
5470201   0.0       559.15    0.999
5470202   18000.    334.15    0.999
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* aux feed water
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5480000   auxfeed             tmdpjun
5480101   553000000 510000000 0.10
5480200   1         655
5480201   -1.0      0.0       0.0       0.0
5480202    0.0      0.0       0.0       0.0
5480203   0.0       2.5207    0.0       0.0
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* main feed water valve
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
5600000   mnfeed              tmdpjun
5600101   545000000 510000000 0.05
5600200   1         656
5600201   0.0       26.533    26.533    0.0
5600202   0.0       0.0       0.0       0.0
************************************************************
* core collapsed liquid level
************************************************************20255000  normarea   0  1.0  1.0
*20255001  0.0       9.25e-3
*20255002  9.25e-3   9.25e-3
*20255003  1.0       1.0
************************************************************
*          reactor kinetics data
*
************************************************************30000000   point   separabl
30000001   gamma-ac   49.6e+6   0.0      348.43     1.0      0.556
30000002   ans79-1
************************************************************ 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   4.89e+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
*---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1---- ----1----
* scram reactivity data
*---- ----1---- ----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
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10. SUPPLEMENTARY NOTES
A. Calvo, NRC Project Manager

11. ABSTRACT *(200 words or less)*

The purpose of this report is to assess the capability of the RELAP5/MOD3.3Beta computer code to simulate thermal-hydraulic behavior associated with the LOFT Experiment L9-1/L3-3. The Experiment L9-1/L3-3 was a simulation of the total loss-of-feedwater accident and its recovery modes. Experiment L9-1 simulated a loss-of-feedwater accident with delayed reactor scram and no auxiliary feedwater injection. The loss-of-feedwater accident led to a loss-of-coolant accident through the PORV cycling operation.

Generally, the RELAP5/MOD3.3Beta calculation results were in good agreement with the L9-1 experimental data. The discrepancies between the calculation and the experiment were also identified in the temperature behaviors of the SG secondary side after dryout of the SG. However, these discrepancies were not considered to be significant, since the SG was in a de-coupled state from the PCS after the dryout of the SG secondary side.

Experiment L3-3 simulated two recovery modes from the loss-of-feedwater accident L9-1 without the aid of the emergency core coolant system. The first recovery mode consisted of turning off the primary coolant pumps and latching open the PORV to depressurize the primary system. The second mode consisted of refilling the SG to restore the secondary heat sink and removing decay heat through the feed-and-bleed operation using the secondary side of the SG.

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