



International Agreement Report

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

Prepared by

J.K. Suh, Y.S. Bang, H.J. Kim

Korea Institute of Nuclear Safety
19 Kusung-Dong, Yusong-Gu
Taejeon, KOREA, 305-338

Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

January 2001

Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Code Application and Maintenance Program (CAMP)

Published by
U.S. Nuclear Regulatory Commission

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at NRC's Public Electronic Reading Room at www.nrc.gov/NRC/ADAMS/index.html.

Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

1. The Superintendent of Documents
U.S. Government Printing Office
P. O. Box 37082
Washington, DC 20402-9328
www.access.gpo.gov/su_docs
202-512-1800
2. The National Technical Information Service
Springfield, VA 22161-0002
www.ntis.gov
1-800-533-6847 or, locally, 703-805-6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: Office of the Chief Information Officer,
Reproduction and Distribution
Services Section
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: DISTRIBUTION@nrc.gov
Facsimile: 301-415-2289

Some publications in the NUREG series that are posted at NRC's Web site address www.nrc.gov/NRC/NUREGS/indexnum.html are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute
11 West 42nd Street
New York, NY 10036-8002
www.ansi.org
212-642-4900

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG-XXXX) or agency contractors (NUREG/CR-XXXX), (2) proceedings of conferences (NUREG/CP-XXXX), (3) reports resulting from international agreements (NUREG/IA-XXXX), (4) brochures (NUREG/BR-XXXX), and (5) compilations of legal decisions and orders of the Commission and Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of NRC's regulations (NUREG-0750).

DISCLAIMER: This report was prepared under an international cooperative agreement for the exchange of technical information. Neither the U.S. Government nor any agency thereof, nor any employee, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for any third party's use, or the results of such use, of any information, apparatus, product or process disclosed in this publication, or represents that its use by such third party would not infringe privately owned rights.



International Agreement Report

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

Prepared by

J.K. Suh, Y.S. Bang, H.J. Kim

Korea Institute of Nuclear Safety
19 Kusung-Dong, Yusong-Gu
Taejeon, KOREA, 305-338

**Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001**

January 2001

Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Code Application and Maintenance Program (CAMP)

**Published by
U.S. Nuclear Regulatory Commission**

Assessment of RELAP5/MOD3.2.2gamma with the LOFT L9-3 Experiment Simulating an Anticipated Transient Without Scram

Abstract

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

Contents

Abstract	iii
Contents	v
List of Tables	vi
List of Figures	vii
Executive Summary	ix
1. Introduction	1
2. Facility and Test Description	3
2.1 Facility Description	3
2.2 Test Description	3
3. Code and Modeling	5
3.1 Code Description	5
3.2 Input Modeling	5
4. Review of Sensitivity Parameters	7
5. Result and Discussions	9
5.1 Base Case	9
5.2 Parametric Study	11
5.3 Run statistics	13
6. Summary and Conclusions	14
References	15
Tables	16
Figures	19
Appendix A: Input Deck for Steady State Calculation of Base Case	A-1
Appendix B: Input Deck for Transient Calculation of Base Case	B-1

List of Tables

Table 1	Initial Condition for Experiment L9-3	16
Table 2	Sequence of Events for Experiment L9-3	17
Table 3	Summary of Parametric Study and Discharged Energy	18

List of Figures

Fig. 1	LOFT System Configuration	19
Fig. 2	RELAP5 Nodalization Diagram for Calculation of LOFT L9-3 Test	20
Fig. 3	Moderator Density Coefficient	21
Fig. 4	Energy Flows through Relief Valves	21
Fig. 5	Comparison of RCS Pressure	22
Fig. 6	Comparison of Coolant Temperatures at Hot and Cold Legs	22
Fig. 7	Comparison of Discharged Flow through PORV and SRV	23
Fig. 8	Comparison of Reactor Power	23
Fig. 9	Comparison of SG Secondary Side Pressure	24
Fig. 10	Comparison of SG Liquid Level	24
Fig. 11	Parametric Effect on RCS Pressure	25
Fig. 12	Parametric Effect on Coolant Temperatures at Hot and Cold Legs	25
Fig. 13	Parametric Effect on Reactor Power	26
Fig. 14	The Required CPU Time in the Base Case Calculation	27
Fig. 15	The Time Step Size of Base Case Calculation	27
Fig. 16	The Mass Error of Base Case Calculation	28

Executive Summary

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

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

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

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

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

transfer to the SG secondary side.

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

1. Introduction

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

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

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

Thermal-hydraulic response during the ATWS event was generally known to be related to the dryout phenomena in steam generator (SG) secondary side, the single- and two-phase coolant discharge phenomena through the relief valves on the pressurizer in RCS, and the reactivity feedback process to power through the MTC [4]. Therefore, thermal-hydraulic analysis computer code should have a capability to predict those phenomena and should be verified by the applicable experimental data

simulating those phenomena. The experiment L9-3 [5] which was a unique nuclear experiment simulating an ATWS event induced by loss of feedwater accident, conducted at the Loss-of-Fluid-Test (LOFT) facility has been a appropriate one to benchmark computer codes. The analysis of the LOFT L9-3 experiment was conducted by several researchers using the RELAP5 code [5]. It was reported that the code could reasonably predict the RCS thermal-hydraulic response, the reactor power response and the secondary system response following the experiment. In those analyses, the safety relief valve (SRV) opened more than two times by the over-prediction of the RCS pressure whereas it opened only one time in the experiment. And, the further sensitivity studies were needed on the effect of steam generator modeling, the SRV discharge modeling, and the MDC feedback on the system response.

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

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

2. Facility and Test Description

2.1 Facility Description

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

2.2 Test Description

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

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

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

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

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

3. Code and Modeling

3.1 Code Description

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

3.2 Input Modeling

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

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

The reactor vessel was modeled by a downcomer annulus, a lower plenum, an active core, a core-bypass flow path, an upper plenum, an upper head and a filler gap flow path. The filler gap flow path was especially modeled for simulating an upward flow during a natural circulation phase. The active core, the downcomer and the filler gap were modeled by 3, 6, 7 volumes stacked vertically, respectively. Totally 26 volumes and 50 heat structures were used. The rod bundle interface friction model option was selected for the active core volumes. The fuel rods were modeled

by 3 heat structures representing the central fuel assembly and 3 heat structures representing the peripheral fuel assemblies of LOFT core. The reactor kinetics model was used for simulating the moderator density and doppler temperature feedback and a scram curve was provided. The ANS-79 model was used for a decay heat simulation.

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

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

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

4. Review of Sensitivity Parameters

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

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

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

To assess the comparative effect of those parameters, the total discharged energy through relief valves was calculated. It is the important factor in mitigating the RCS pressure and was calculated by integrating the instantaneous energy flow curve presented in Fig. 4 with time as the Equation (1). It was calculated from the time of the PORV open to 200 seconds. Because the most important thermal-hydraulic

phenomenon, i.e., SG secondary side dryout, single- and two-phase coolant discharge and moderator temperature feedback to reactor power were observed before 200 seconds. The differences between calculation and experiment determined by the Equation (2) in each case were compared to identify the most dominant parameter to concern in the analysis of the ATWS at real plant.

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

$$\delta E = E_{Cal} - E_{Exp} \quad (2)$$

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

5. Result and Discussions

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

5.1 Base Case

RCS Response

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

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

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

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

Reactor Power Response

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

Secondary System Response

Figure 9 shows a comparison of SG secondary side pressure between the experiment and the RELAP5 calculation. The SG pressure increased due to the

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

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

5.2 Parametric Study

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

Subcooled Discharge Coefficient of PORV (Case A)

In Case A, the subcooled discharge coefficient of PORV was set to 1.1. There were no outstanding effects in the RCS temperatures and the reactor power compared with the base case. However, the behavior of the RCS pressure is significantly influenced by the subcooled discharge coefficient. As the coefficient increased, the discharged flow also increased, which resulted in the mitigation of the RCS pressure increasing. Figure 11 shows that the PORV opened three times before opening the SRV in the calculation whereas it opened only one time in the

experiment. And, it can be identified that the PORV open/close frequency decreased because the pressure drops sharply after the PORV open and reaches the closing set point fast. The total discharged energy through the relief valves was 318.14 MJ which is larger by 27.9 % than that of the experiment.

Loss Coefficient of Spray Valve (Case B)

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

Steam Generator Node Number (Case C)

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

Moderator Density Coefficient (Case D)

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

5.3 Run Statistics

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

Computer time, CPU = 157.08 – 1.31 = 155.77 (sec)

Number of time step, DT = 4421

Number of volume, C = 128

Grind time = $\text{CPU} \times 1000 / (C \times \text{DT}) = 0.27527 \text{ CPU m sec/vol/step}$

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

6. Summary and Conclusions

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

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

References

- [1] USNRC, Code of Federal Register, 10 Part 50, Sec. 50.62, *Requirements for reduction of risk from anticipated transients without scram (ATWS) events for light-water-cooled nuclear power plants*, April 1989
- [2] KEPCO, *Final Level 1 Probabilistic Safety Assessment for YGN Nuclear Units 3 and 4*, July 1993
- [3] USNRC, *Final Safety Evaluation Report Related to the Certification of the System 80+ Design*, NUREG-1462, August 1994
- [4] Charles L. Nalezny, *Summary of the Nuclear Regulatory Commission's LOFT Program Research Findings*, NUREG/CR-3005, April 1985
- [5] P. D. Bayless et. Al., *Experiment Data Report for LOFT Anticipated Transient Without Scram Experiment L9-3*, NUREG/CR-2717, May 1982
- [6] The Thermal Hydraulics Group, *RELAP5/MOD3 Code Manual*, Formerly NUREG/CR-5535, March 1998
- [7] USNRC, *Proposed Rulemaking to Amend 10 CFR 50 Concerning Anticipated Transient Without Scram (ATWS) Event*, SECY-80-409, Sept. 1980
- [8] W. Tauche, *Loss-of-feedwater Induced Loss of Coolant Accident Analysis*, WCAP-9744, May 1980
- [9] Young. S. Bang, et. al., *Assessment of RELAP5/MOD3 With the LOFT L9-1/L3-3 Experiment Simulating an Anticipated Transient With Multiple Failures*, NUREG/IA-0114, Feb. 1994
- [10] D. Reeder, *LOFT System and Test Description*, NUREG/CR-0247, July 1978
- [11] J. P. Adams, *Experiment Analysis and Summary Report for LOFT ATWS Experiment L9-3 and L9-4*, NUREG/CR-3417 September 1983
- [12] A. Taylor, et al., *Best Estimate Prediction for LOFT Nuclear Experiment L9-1/L3-3*, EGG-LOFT-5413, April 1981

Table 1 Initial Condition for Experiment L9-3

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

Table 2 Sequence of Events for Experiment L9-3

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

Table 3 Summary of Parametric Study and Discharged Energy

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

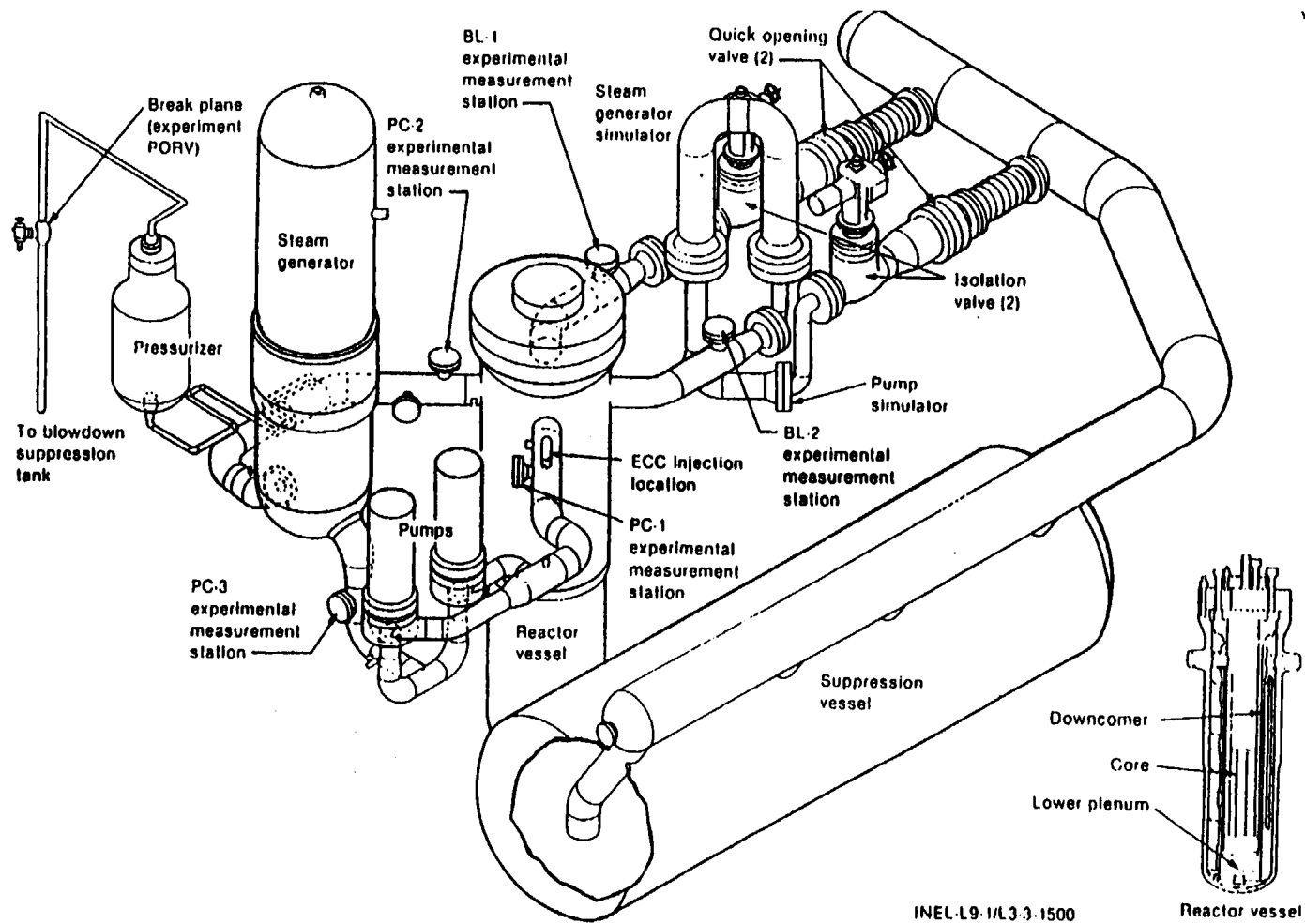


Fig. 1 LOFT System Configuration

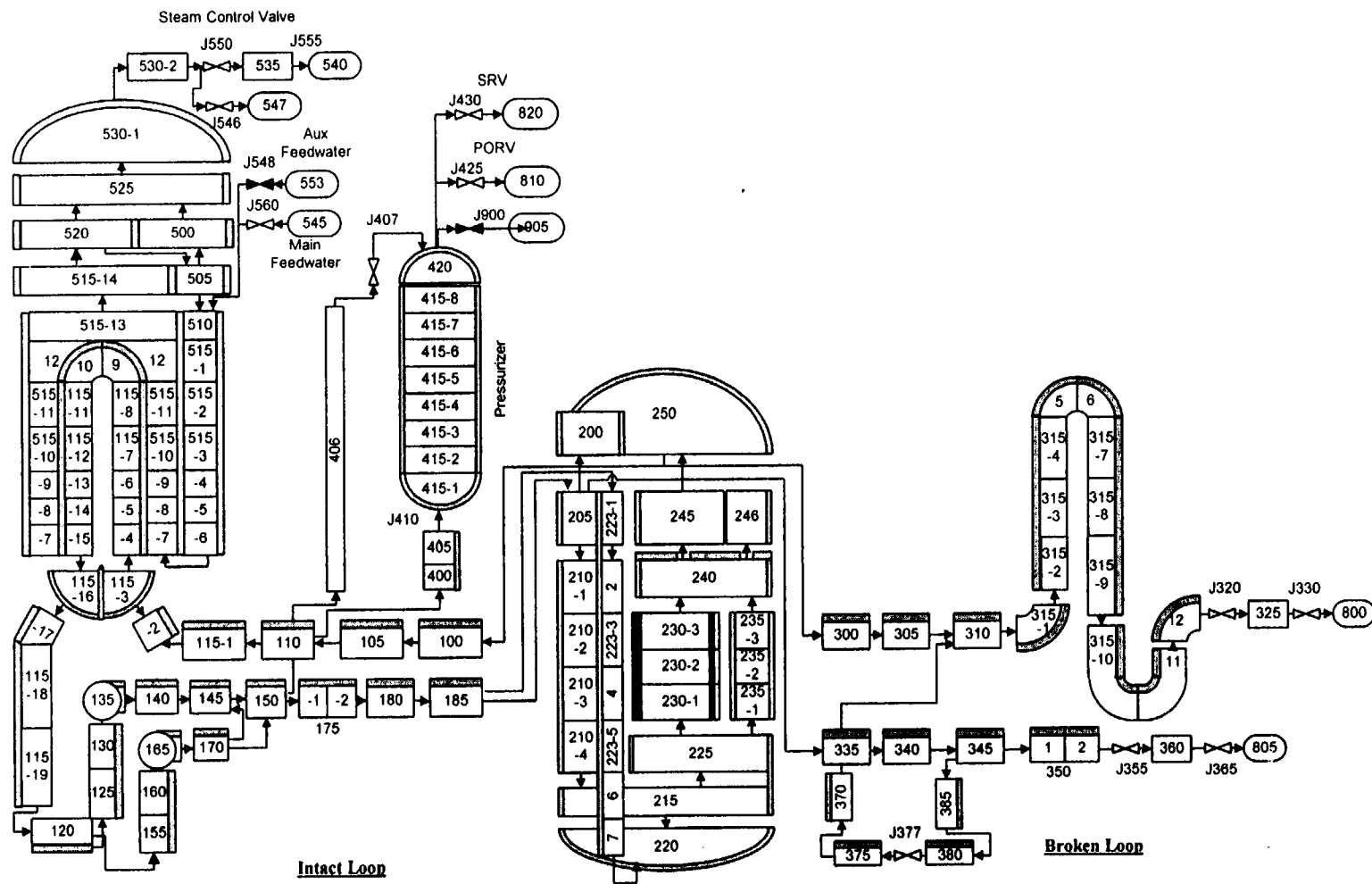


Fig. 2 RELAP5 Nodalization Diagram for Calculation of LOFT L9-3 Test

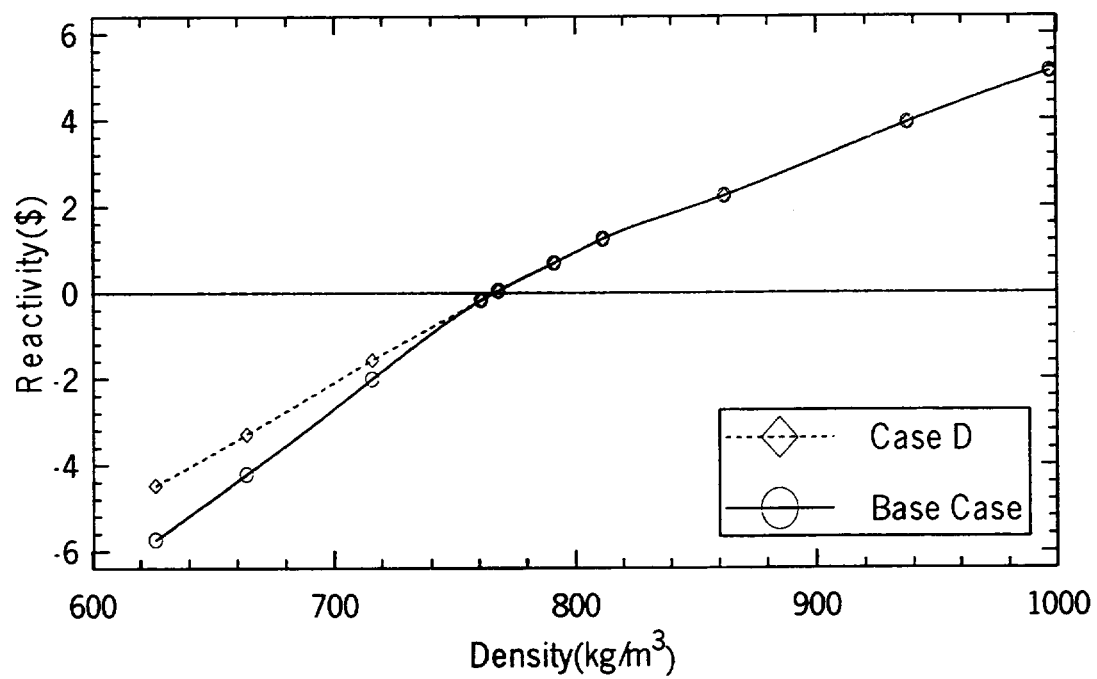


Fig. 3 Moderator Density Coefficient

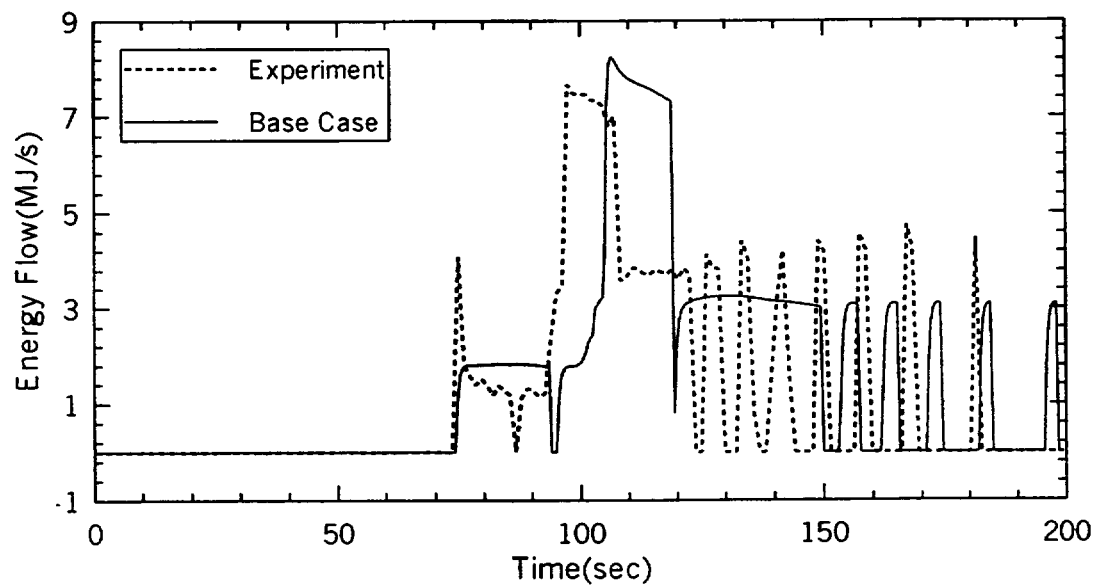


Fig. 4 Energy Flows through Relief Valves

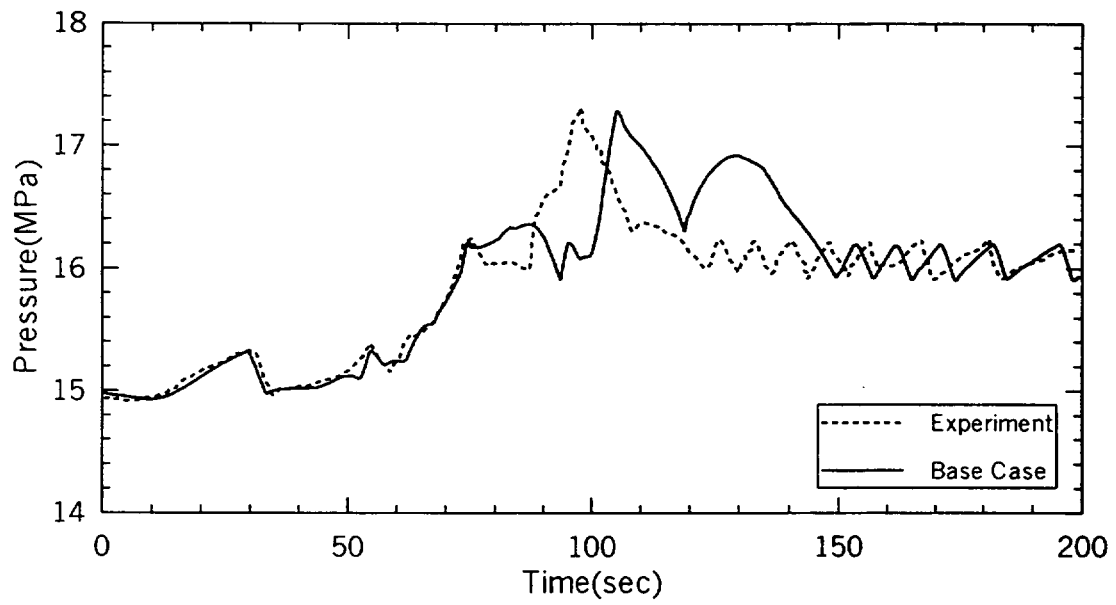


Fig. 5 Comparison of RCS Pressure

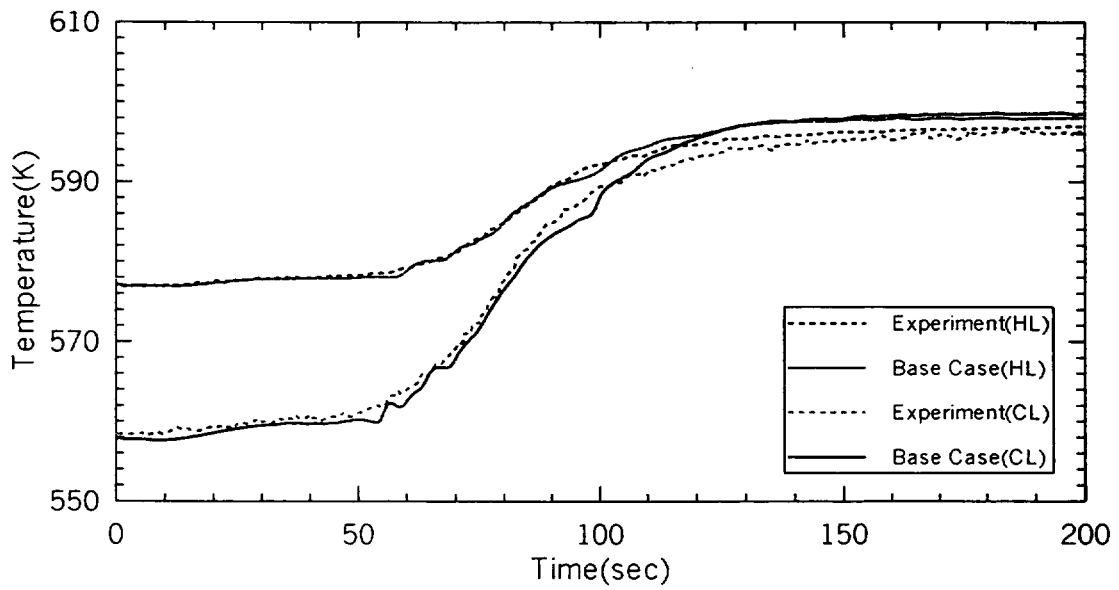


Fig. 6 Comparison of Coolant Temperatures at Hot and Cold Legs

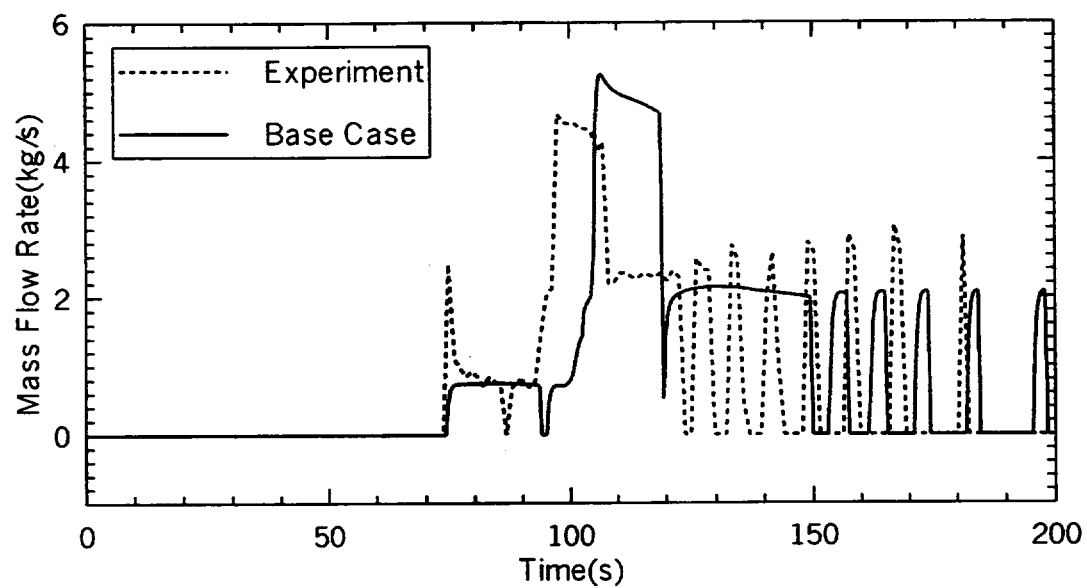


Fig. 7 Comparison of Discharged Flow through PORV and SRV

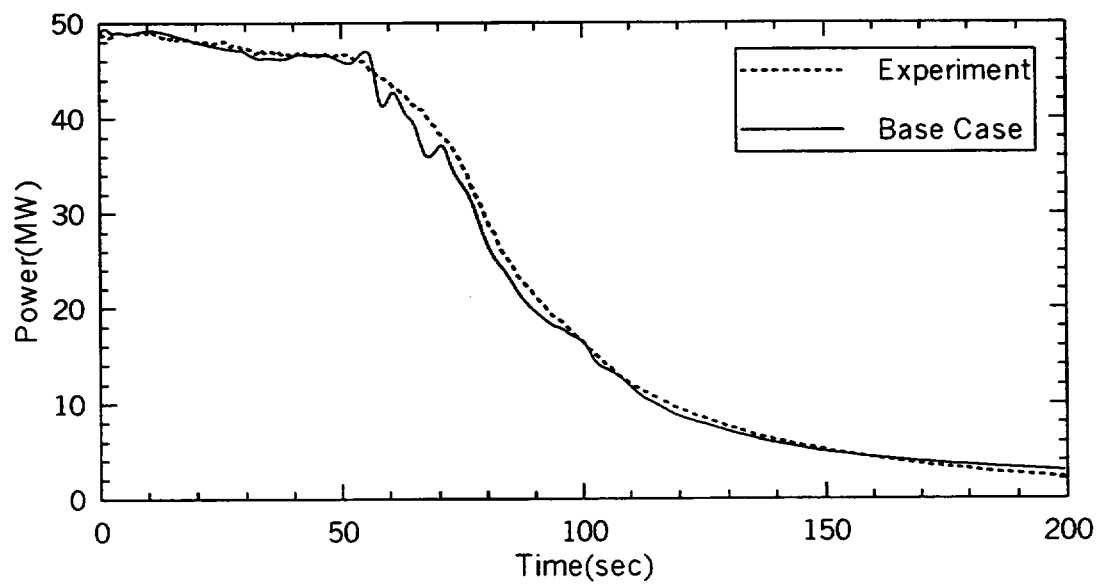


Fig. 8 Comparison of Reactor Power

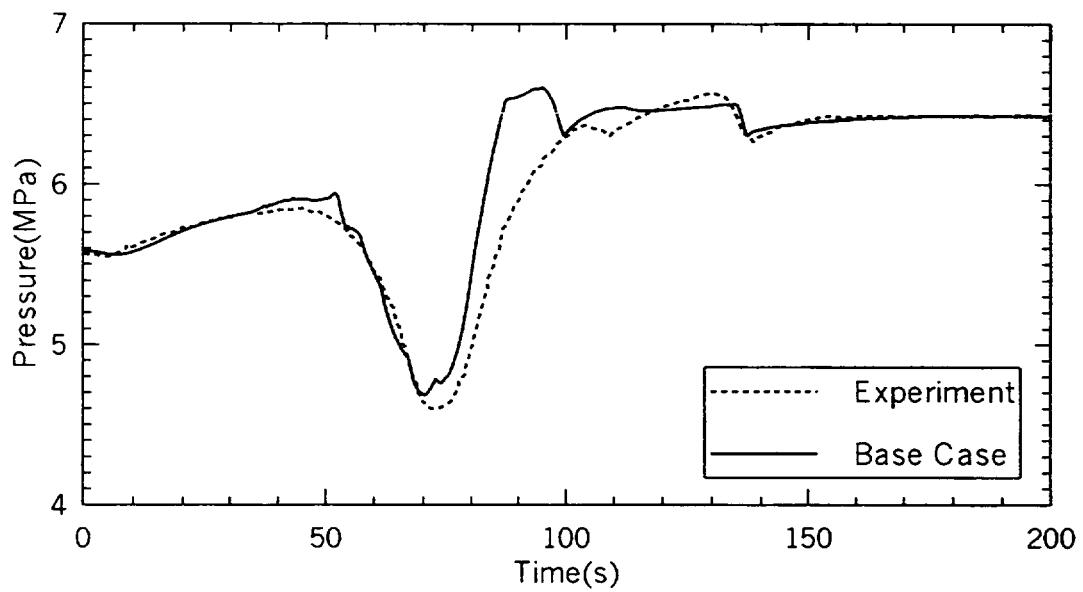


Fig. 9 Comparison of SG Secondary Side Pressure

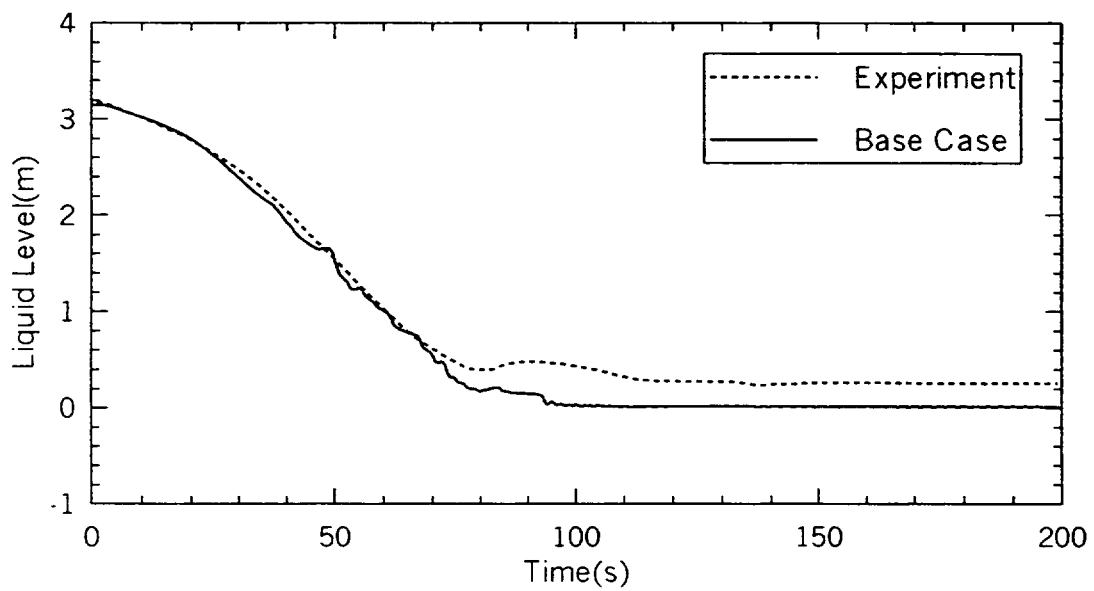


Fig. 10 Comparison of SG Liquid Level

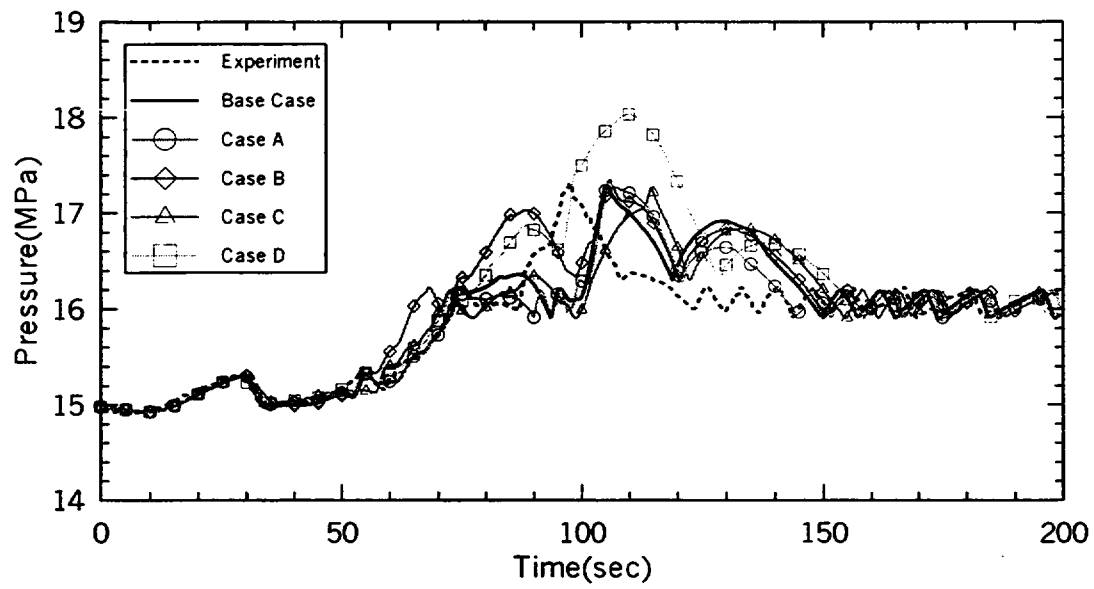


Fig. 11 Parametric Effect on RCS Pressure

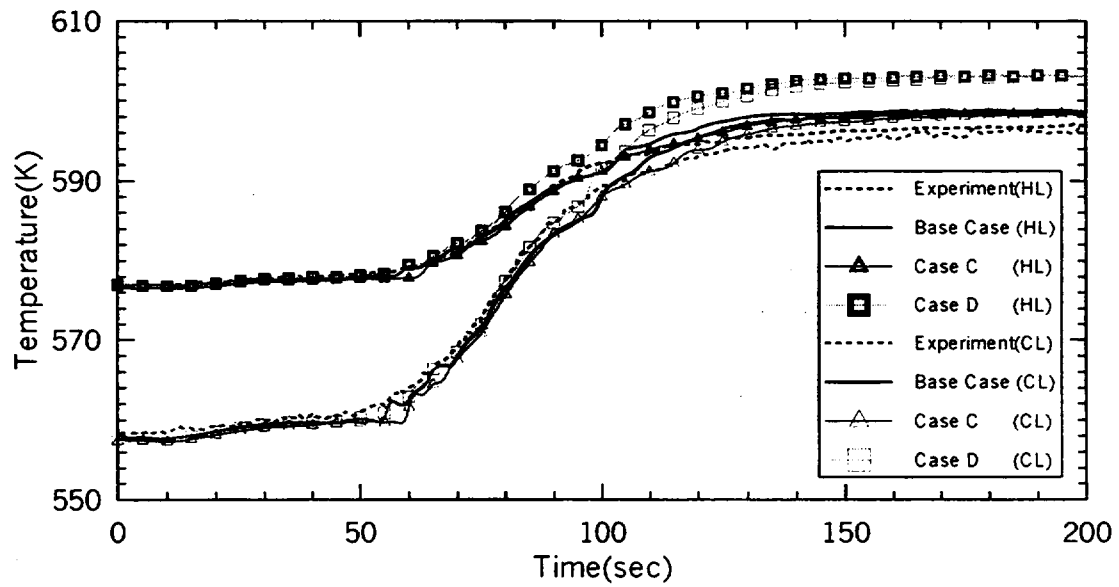


Fig. 12 Parametric Effect on Coolant Temperatures at Hot and Cold Legs

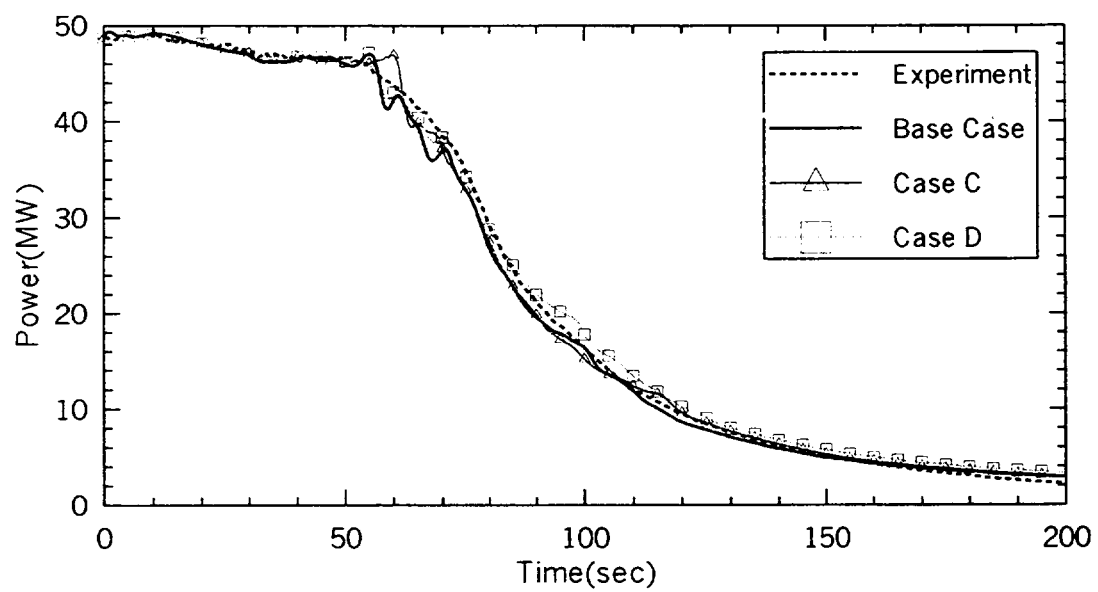


Fig. 13 Parametric Effect on Reactor Power

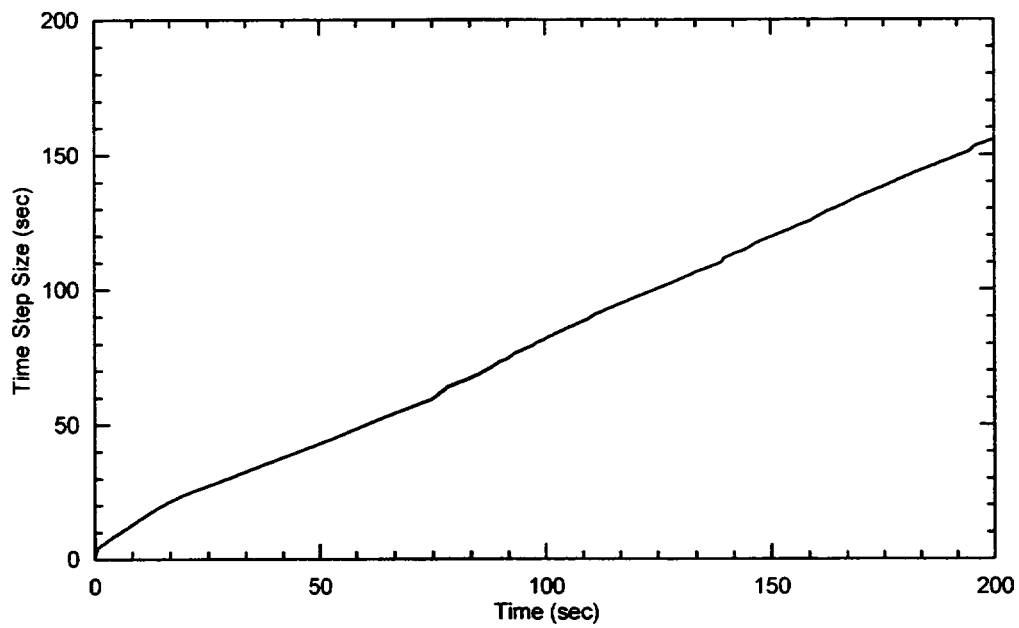


Fig. 14 The Required CPU Time in the Base Case Calculation

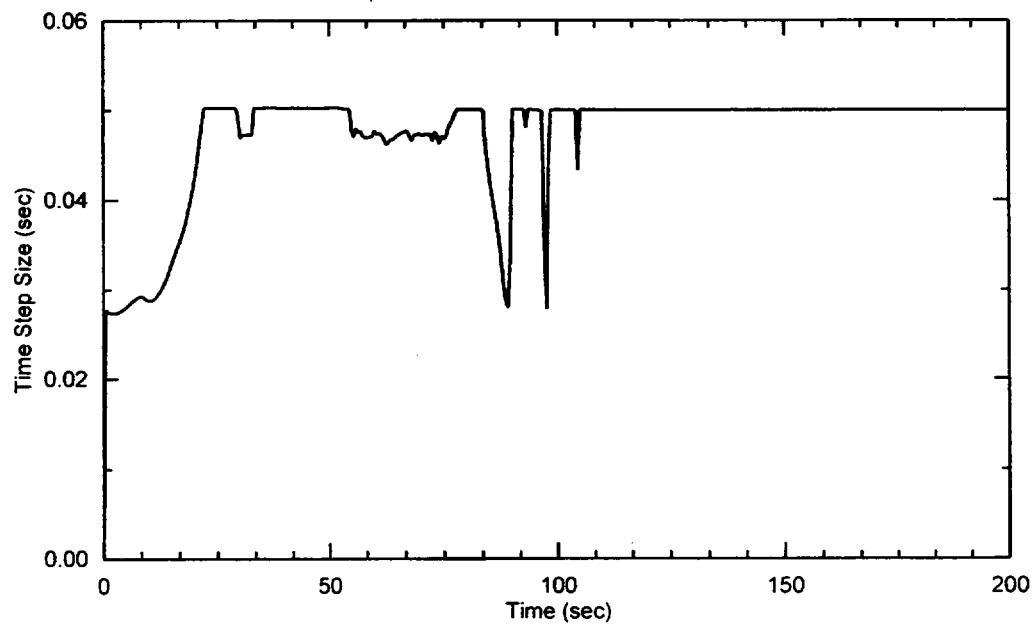


Fig. 15 The Time Step Size of Base Case Calculation

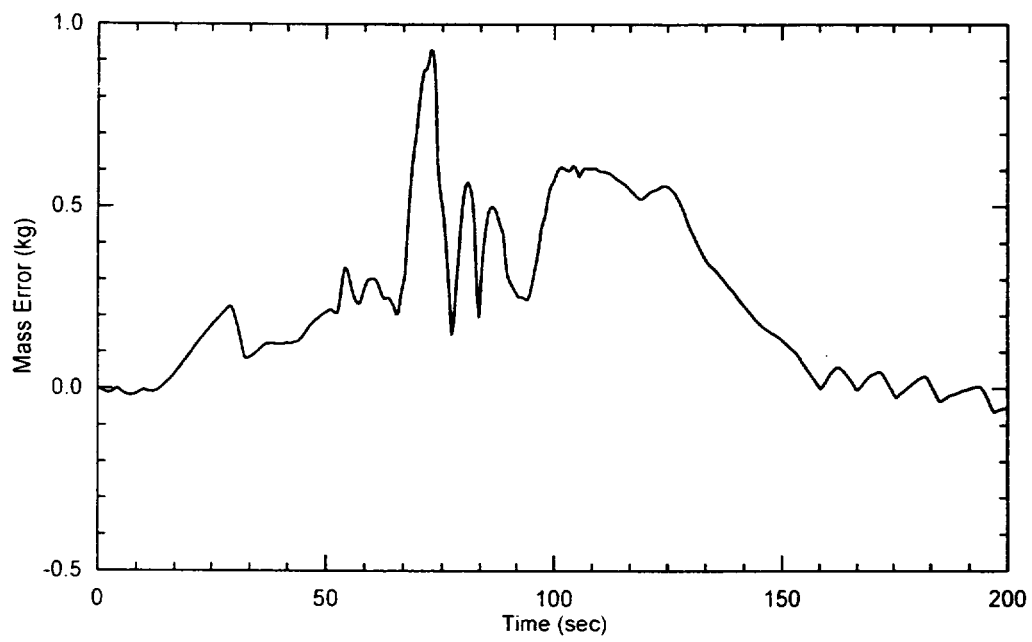


Fig. 16 The Mass Error of Base Case Calculation

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

```

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

```

```

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

```

```

1151213 0 1.47119e+07 0.12410e+07 0.24661e+07 0.0 0.0 0.0 19
1151300 0
1151301 10.447 10.447 0.0 01
1151302 8.1183 8.1183 0.0 02
1151303 4.3289 4.3290 0.0 03
1151304 4.2693 4.2693 0.0 06
1151305 4.2239 4.2240 0.0 08
1151306 4.1858 4.1858 0.0 09
1151307 4.1546 4.1546 0.0 10
1151308 4.1293 4.1293 0.0 12
1151309 4.1070 4.1070 0.0 15
1151310 7.7626 7.7626 0.0 16
1151311 9.2494 9.2495 0.0 17
1151312 9.7826 9.7826 0.0 18
*
* pump data
*
* pump suction tee
*
1200000 pmpscct branch
1200001 3 0
1200101 0.0634 0.76 0.0 0.0 0.0 0.0
1200102 4.0e-5 0.0 00000
1200200 0 1.47085e+07 0.12410e+07 0.24662e+07 0.0
1201101 115010000 120000000 0.0 0.1 0.1 000000
1202101 120010000 125000000 0.0317 0.2 0.2 000100
1203101 120010000 155000000 0.0317 0.2 0.2 000100
1201201 9.7826 9.7827 0.0
1202201 5.0746 5.0746 0.0
1203201 5.0735 5.0735 0.0
*
* pump1 suction tee outlet
*
1250000 pmp1scct branch
1250001 2 0
1250101 0.0 1.003 0.0613 0.0 90.0 0.521
1250102 4.0e-5 0.0 00000
1250200 0 1.46957e+07 0.12410e+07 0.24664e+07 0.0
1251101 125010000 130000000 0.0 0.1 0.1 000100
1252101 125000000 155000000 0.0 0.0 0.0 000100
1251201 7.8657 7.8657 0.0
1252201 -0.24790 -0.24790 0.0
*
* pump 1 inlet
*
1300000 pmp1inlet snglvol
1300101 0.0 0.457 0.0189 0.0 90.0 0.457
1300102 4.0e-5 0.0 00000
1300200 0 1.46736e+07 0.12410e+07 0.24669e+07 0.0
*
* primary coolant pump 1
*
1350000 pcpump1 pump
1350101 0.0366 0.0 0.099 0.0 90.0 0.319
1350102 00000
1350108 130010000 0.0 0.0 0.0 000100
1350109 140000000 0.0 0.05 0.05 000100
1350200 0 1.48967e+07 0.12412e+07 0.24622e+07 0.0
1350201 0 8.8881 8.8882 0.0
1350202 0 8.8868 8.8868 0.0
1350301 0 0 0 -1 -1 519 0
1350302 369.0 0.88469 3155000 96 000000 500.60000 1.431
1350303 613.6 0.0 207.0000 0.0040000 19.598000 0.0
1350310 0.0 0.0 0.0
*
* single phase head curves
*
* head curve no. 1
* ---1---1---1---1---1---1---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-----
* head curve no. 2
*-----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-----
* head curve no. 3
*-----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-----
* head curve no. 4
*-----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-----
* head curve no. 5
*-----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-----
* head curve no. 6
*-----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-----
* head curve no. 7
*-----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-----
* head curve no. 8
*-----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
*-----1-----1-----1-----1-----1-----
* single phase torque data
*-----1-----1-----1-----1-----1-----
* torque curve no. 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-----
* torque curve no. 2
*-----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-----
* torque curve no. 3
*-----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-----
* torque curve no. 4
*-----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-----
* torque curve no. 5
*-----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-----
* torque curve no. 6
*-----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

* torque curve no. 7

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

* torque curve no. 8

1352600 2 8
 1352601 -1.000000e+00 -1.000000e+00
 1352602 -2.500000e-01 -9.000000e-01
 1352603 -8.000000e-02 -8.000000e-01
 1352604 0.000000e+00 -6.700000e-01

* two - phase multiplier data from 19-1 test data

* head curve

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

* torque curve

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

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

* head curve no. 2

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

* head curve no. 3

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

* head curve no. 4

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

* head curve no. 5

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

* head curve no. 6

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

* head curve no. 7

1354700 1 7
 1354701 -1.000000e+00 0.000000e+00
 1354702 0.000000e+00 0.000000e+00

* head curve no. 8

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 7.438600e-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
*-----1-----1-----1-----1-----1-----1-----
* pump 1 outlet pump side
*-----1-----1-----1-----1-----1-----1-----
1400000 pmp1outp snglvol
1400101 0.0366 0.502 0.0 0.0 0.0 0.0
1400102 4.0e-5 0.0 00000
1400200 0 1.51268e+07 0.12412e+07 0.24568e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* pump1 outlet pipe tee side
*-----1-----1-----1-----1-----1-----1-----
1450000 pmp1outt branch
1450001 2 0
1450101 0.0 1.4084 0.0633 0.0 0.0 0.0
1450102 4.0e-5 0.0 00000
1450200 0 1.51312e+07 0.12412e+07 0.24567e+07 0.0
1451101 140010000 145000000 0.0 0.1 0.1 000100
1452101 145010000 150000000 0.0 0.0 0.0 000100
1451201 8.8843 8.8843 0.0
1452201 10.426 10.426 0.0
*-----1-----1-----1-----1-----1-----1-----
* pump outlet tee
*-----1-----1-----1-----1-----1-----1-----
1500000 pmpoutt branch
1500001 3 0
1500101 0.0634 0.4966 0.0 0.0 0.0 0.0
1500102 4.0e-5 0.0 00000
1500200 0 1.51126e+07 0.12412e+07 0.24572e+07 0.0
1501101 170010000 150000000 0.0183 0.2 0.2 000100
1502101 150010000 175000000 0.0 0.1 0.1 000100
1503101 150010000 406000000 0.0 0.0 0.0 000100
1501201 4.1361 4.1361 0.0
1502201 9.7788 9.7788 0.0
1503201 2.66479e-07 2.66479e-07 0.0
*-----1-----1-----1-----1-----1-----1-----
* pump 2 suction tee outlet
*-----1-----1-----1-----1-----1-----1-----
1550000 pmp2sctt branch
1550001 1 0
1550101 0.0 1.003 0.0613 0.0 90.0 0.521
1550102 4.0e-5 0.0 00000
1550200 0 1.46976e+07 0.12410e+07 0.24664e+07 0.0
1551101 155010000 160000000 0.0 0.1 0.1 000100
1551201 7.1313 7.1313 0.0
*-----1-----1-----1-----1-----1-----1-----
* pump 2 inlet pipe
*-----1-----1-----1-----1-----1-----1-----
1600000 pmp2inet snglvol
1600101 0.0 0.457 0.0189 0.0 90.0 0.457
1600102 4.0e-5 0.0 00000
1600200 0 1.46788e+07 0.12410e+07 0.24668e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* primary coolant pump 2
*-----1-----1-----1-----1-----1-----1-----
1650000 pcpump2 pump
1650101 0.0366 0.0 0.099 0.0 90.0 0.319
1650102 00000
1650108 160010000 0.0 0.0 0.0 000100
1650109 170000000 0.0 0.1 0.1 000100
1650200 0 1.49127e+07 0.12412e+07 0.24618e+07 0.0
1650201 0 8.0583 8.0583 0.0
1650202 0 8.0569 8.0569 0.0
1650301 135 135 135 -1 -1 519 0
1650302 369 00000 0.8599 .31550000 96.000000 500.60000 1.431

```

```

1650303 613.6 0.0 207.433 0.004 19.5980 0.0
1650310 0.0 0.0 0.0
*****
* pump 2 outlet
*****
1700000 pmp2outt branch
1700001 1 0
1700101 0.0366 0.514 0.0 0.0 0.0 0.0
1700102 4.0e-5 0.0 00000
1700200 0 1.5151e+07 0.12412e+07 0.24562e+07 0.0
1701101 145010000 170010000 0.0183 0.2 0.2 000100
1701201 -3.9184 -3.9184 0.0
*-----1-----1-----1-----1-----1-----1-----
* cold leg pipe to ecc connection tee
*****
1750000 ilcpipe pipe
1750001 2
1750101 0.0634 2
1750201 0.0 1
1750301 0.559 1
1750302 0.613 2
1750401 0.0 2
1750501 0.0 2
1750601 0.0 2
1750701 0.0 2
1750801 4.0e-5 0.0 2
1750901 0.15 0.15 1
1751001 00000 2
1751101 000100 1
1751201 0 1.51081e+07 0.12412e+07 0.24573e+07 0.0 0.0 0.1
1751202 0 1.51017e+07 0.12412e+07 0.24574e+07 0.0 0.0 0.2
1751300 0
1751301 9.7789 9.7789 0.0 0.1
*****
* ecc connection tee pump side
*****
1800000 ecct branch
1800001 1 0
1800101 0.06343 1.152 0.0 0.0 0.0 0.0
1800102 4.0e-5 0.0 00000
1800200 0 1.50985e+07 0.12412e+07 0.24575e+07 0.0
1801101 175010000 180000000 0.0 0.05 0.05 000100
1801201 9.7789 9.7789 0.0
*****
* cold leg pipe from ecc connection to reactor vessel
*****
1850000 rvnlic branch
1850001 3 0
1850101 0.06379 1.01 0.0 0.0 0.0 0.0
1850102 4.0e-5 0.0 00000
1850200 0 1.50967e+07 0.12412e+07 0.24576e+07 0.0
1851101 185010000 205000000 0.0634 1.0 1.0 000100
1852101 180010000 185000000 0.0 0.0 0.0 000100
1853101 185010000 223000000 0.0 45.0 45.0 000100
1851201 9.0375 9.0375 0.0
1852201 9.7790 9.7790 0.0
1853201 1.6149 1.6149 0.0
*****
* reactor vessel
*
*-----1-----1-----1-----1-----1-----1-----
* inlet annulus top volume
*-----1-----1-----1-----1-----1-----1-----
2000000 inantop branch
2000001 2 0
2000101 0.0 0.33 0.0855 0.0 90.0 0.33
2000102 4.0e-5 0.178 00000
2000200 0 1.50826e+07 0.12412e+07 0.24579e+07 0.0
2001101 200000000 205000000 0.0 0.0 0.0 000100
2002101 200000000 245010000 0.001 1800 1800 000100
2001201 -2.99198e-02 -2.99198e-02 0

```

```

2002201 6.79995e-02 6.79995e-02 0.0
*-----1-----1-----1-----1-----1-----1-----
* inlet annulus bottom volume
*-----1-----1-----1-----1-----1-----1-----
2050000 inanbot branch
2050001 1 0
2050101 0.0 0.424 0.11 0.0 -90.0 -0.424
2050102 4.0e-5 0.172 00000
2050200 0 1.50837e+07 0.12412e+07 0.24579e+07 0.0
2051101 205010000 210000000 0.0 0.0 0.0 000100
2051201 3.9237 3.9237 0.0
*-----1-----1-----1-----1-----1-----1-----
* downcomer
*-----1-----1-----1-----1-----1-----1-----
2100000 downcomr annulus
2100001 4
2100101 0.142 4
2100201 0.0 3
2100301 0.958 4
2100401 0.0 4
2100501 0.0 4
2100601 -90.0 4
2100801 4.0e-5 0.102 4
2100901 0.0 0.0 3
2101001 00000 4
2101101 000000 3
2101201 0 1.50830e+07 0.12412e+07 0.24579e+07 0.0 0.0 0.1
2101202 0 1.50892e+07 0.12412e+07 0.24577e+07 0.0 0.0 0.2
2101203 0 1.50954e+07 0.12412e+07 0.24576e+07 0.0 0.0 0.3
2101204 0 1.51016e+07 0.12412e+07 0.24574e+07 0.0 0.0 0.4
2101300 0
2101301 3.9237 3.9237 0.0 0.1
2101302 3.9237 3.9237 0.0 0.2
2101303 3.9237 3.9237 0.0 0.3
*-----1-----1-----1-----1-----1-----1-----
* lower plenum top volume
*-----1-----1-----1-----1-----1-----1-----
2150000 lwrplot branch
2150001 3 0
2150101 0.74 0.360 0.0 0.0 -90.0 -0.36
2150102 4.0e-5 0.0 00000
2150200 0 1.51098e+07 0.12410e+07 0.24572e+07 0.0
2151101 210010000 215000000 0.0 0.0 0.0 000100
2152101 215010000 220000000 0.0 0.0 0.0 000100
2153101 215000000 225000000 0.15 0.0 0.0 000100
2151201 3.9236 3.9237 0.0
2152201 -6.34506e-02 -6.34506e-02 0.0
2153201 2.4164 2.4164 0.0
*-----1-----1-----1-----1-----1-----1-----
* lower plenum bottom volume
*-----1-----1-----1-----1-----1-----1-----
2200000 lwrplot singlvol
2200101 0.79 0.37 0.0 0.0 -90.0 -0.37
2200102 4.0e-5 0.0 00000
2200200 0 1.51125e+07 0.12387e+07 0.24572e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* core filler bypass
*-----1-----1-----1-----1-----1-----1-----
2230000 fillegap annulus
2230001 7
2230101 2.9110-2 7
2230201 0.0 6
2230301 0.424 1
2230302 0.958 5
2230303 0.36 6
2230304 0.37 7
2230401 0.0 7
2230501 0.0 7
2230601 -90.0 7
2230801 4.0e-5 0.0 7
2230901 0.0 0.0 6
2231001 00000 7

```

```

2231101 000000 6
2231201 0 1.50887e+07 0.12410e+07 0.24578e+07 0.0 0.0 01
2231202 0 1.50937e+07 0.12405e+07 0.24576e+07 0.0 0.0 02
2231203 0 1.51007e+07 0.12401e+07 0.24575e+07 0.0 0.0 03
2231204 0 1.51078e+07 0.12396e+07 0.24573e+07 0.0 0.0 04
2231205 0 1.51148e+07 0.12392e+07 0.24571e+07 0.0 0.0 05
2231206 0 1.51196e+07 0.12390e+07 0.24570e+07 0.0 0.0 06
2231207 0 1.51223e+07 0.12388e+07 0.24569e+07 0.0 0.0 07
2231300 0
2231301 1.6148 1.6148 0.0 01
2231302 1.6144 1.6144 0.0 02
2231303 1.6141 1.6141 0.0 03
2231304 1.6137 1.6137 0.0 04
2231305 1.6133 1.6133 0.0 05
2231306 1.6132 1.6132 0.0 06
*-----1-----1-----1-----1-----1-----1-----
* junction from filler gap to lower plenum
*-----1-----1-----1-----1-----1-----1-----
2240000 flrgapp sngljun
2240101 223010000 220010000 0.0 10. 10. 000100
2240201 0 1.6131 1.6131 0.0
*-----1-----1-----1-----1-----1-----1-----
* lower core support structure
*-----1-----1-----1-----1-----1-----1-----
2250000 lcoreup branch
2250001 2 0
2250101 0.25 0.52 0.0 0.0 90.0 0.52
2250102 4.0e-5 0.095 00000
2250200 0 1.50986e+07 0.12410e+07 0.24575e+07 0
2251101 225010000 230000000 0.0975 0.3 0.3 000000
2252101 225010000 235000000 0.0 0.0 0.0 000000
2251201 3.3511 3.3511 0.0
2252201 2.1831 2.1831 0.0
*-----1-----1-----1-----1-----1-----1-----
* active core
*-----1-----1-----1-----1-----1-----1-----
2300000 core pipe
2300001 3
2300101 0.1705 3
2300201 0.1440 2
2300301 0.559 2
2300302 0.657 3
2300401 0.0 3
2300501 0.0 3
2300601 90.0 3
2300801 4.0e-5 0.012 3
2300901 0.66 0.66 2
2301001 00100 3
2301101 000100 2
2301201 0 1.50762e+07 0.12871e+07 0.24581e+07 0.0 0.0 01
2301202 0 1.50637e+07 0.13370e+07 0.24584e+07 0.0 0.0 02
2301203 0 1.50502e+07 0.13529e+07 0.24587e+07 0.0 0.0 03
2301300 0
2301301 3.4276 3.4276 0.0 01
2301302 3.5187 3.5187 0.0 02
*-----1-----1-----1-----1-----1-----1-----
* core bypass volume
*-----1-----1-----1-----1-----1-----1-----
2350000 corebyps pipe
2350001 3
2350101 0.015 3
2350201 0.0 2
2350301 0.559 2
2350302 0.657 3
2350401 0.0 3
2350501 0.0 3
2350601 90.0 3
2350801 4.0e-5 0.003 3
2350901 0.0 0.0 2
2351001 00000 3
2351101 000000 2
2351201 0 1.50877e+07 0.12410e+07 0.24578e+07 0.0 0.0 01

```

```

2351202 0 1.50693e+07 0.12410e+07 0.24582e+07 0.0 0.0 02
2351203 0 1.50492e+07 0.12411e+07 0.24587e+07 0.0 0.0 03
2351300 0
2351301 2.1831 2.1831 0.0 01
2351302 2.1832 2.1832 0.0 02
*-----1-----1-----1-----1-----1-----1-----
* upper core support structure
*-----1-----1-----1-----1-----1-----1-----
2400000 ucosst branch
2400001 2 0
2400101 0.297 1.118 0.0 0.0 90.0 1.118
2400102 4.0e-5 0.145 00000
2400200 0 1.50346e+07 0.13468e+07 0.24591e+07 0.0
2401101 230010000 240000000 0.12 0.3 0.3 000000
2402101 235010000 240000000 0.0 0.0 0.0 000000
2401201 3.5504 3.5504 0.0
2402201 2.1833 2.1833 0.0
*-----1-----1-----1-----1-----1-----1-----
* upper flow skirt region
*-----1-----1-----1-----1-----1-----1-----
2450000 ufosre branch
2450001 1 0
2450101 0.114 0.843 0.0 0.0 90.0 0.843
2450102 4.0e-5 0.131 00000
2450200 0 1.50141e+07 0.13455e+07 0.24596e+07 0.0
2451101 240010000 245000000 0.0 0.0 0.0 000100
2451201 5.5952 5.5952 0.0
*-----1-----1-----1-----1-----1-----1-----
* dead end of fuel modules
*-----1-----1-----1-----1-----1-----1-----
2460000 fumodu branch
2460001 1 0
2460101 0.183 0.7 0.0 0.0 90.0 0.7
2460102 4.0e-5 0.214 00000
2460200 0 1.50299e+07 0.13438e+07 0.24592e+07 0.0
2461101 240010000 246000000 0.0 0.0 0.0 000100
2461201 -8.22277e-07 -8.22277e-07 0.0
*-----1-----1-----1-----1-----1-----1-----
* upper plenum lower volume
*-----1-----1-----1-----1-----1-----1-----
2500000 uplvol branch
2500001 1 0
2500101 0.268 1.566 0.0 0.0 90.0 1.566
2500102 4.0e-5 0.0 00000
2500200 0 1.50159e+07 0.13440e+07 0.24595e+07 0.0
2501101 245010000 250000000 0.0 0.0 0.0 000100
2501201 5.6629 5.6629 0.0
*****
*
* broken loop
*
*****
* reactor vessel nozzle - broken loop hot leg
*-----1-----1-----1-----1-----1-----1-----
3000000 rvtbhl branch
3000001 2 0
3000101 0.0634 0.876 0.0 0.0 0.0 0.0
3000102 4.0e-5 0.0 00000
3000200 0 1.50214e+07 0.12349e+07 0.24594e+07 0.0
3001101 250000000 300000000 0.0634 0.0 0.0 000100
3002101 300010000 305000000 0.0 0.1 0.1 000000
3001201 -0.12677 -0.12677 0.0
3002201 -0.12680 -0.12680 0.0
*-----1-----1-----1-----1-----1-----1-----
* hot leg pipe to reflood assist bypass tee
*-----1-----1-----1-----1-----1-----1-----
3050000 hlpras branch
3050001 1 0
3050101 0.0634 0.698 0.0 0.0 0.0 0.0
3050102 4.0e-5 0.0 00000
3050200 0 1.50214e+07 0.12354e+07 0.24594e+07 0.0
3051101 305010000 310000000 0.0 0.1 0.1 000100

```

```

3051201 -0.17141 -0.17141 0.0
*-----1-----1-----1-----1-----1-----1-----
* broken loop hot leg contraction
*-----1-----1-----1-----1-----1-----1-----
3100000 sgsl branch
3100001 2 0
3100101 0.0 1.5001 0.06785 0.0 0.0 0.0
3100102 4.0e-5 0.0 00000
3100200 0 1.50214e+07 0.12358e+07 0.24594e+07 0.0
3101101 370010000 310000000 0.0 0.0 0.0 000100
3102101 310010000 315000000 0.0 0.0 0.0 000100
3101201 0.20738 0.20738 0.0
3102201 3.10704e-04 3.10704e-04 0.0
*-----1-----1-----1-----1-----1-----1-----
* steam generator and pump simulator
*-----1-----1-----1-----1-----1-----1-----
3150000 sgpsi pipe
3150001 12
3150101 0.00836 2
3150102 0.108 8
3150103 0.0 10
3150104 0.00836 11
3150105 0.0525 12
3150201 0.0 2
3150202 0.0326 4
3150203 0.108 5
3150204 0.0326 7
3150205 0.0 8
3150206 0.0 9
3150207 0.0081 10
3150208 0.0 11
3150301 0.4054 1
3150302 0.5265 2
3150303 0.362 3
3150304 1.692 4
3150305 0.8495 6
3150306 1.692 7
3150307 0.362 8
3150308 1.346 9
3150309 1.325 10
3150310 1.842 11
3150311 0.667 12
3150401 0.0 8
3150402 0.0162 9
3150403 0.0648 10
3150404 0.0 12
3150601 90.0 5
3150602 -90.0 10
3150603 90.0 11
3150604 0.0 12
3150701 0.127 1
3150702 0.488 2
3150703 0.362 3
3150704 1.692 4
3150705 0.457 5
3150706 -0.457 6
3150707 -1.692 7
3150708 -0.362 8
3150709 -1.143 9
3150710 -0.686 10
3150711 1.214 11
3150712 0.0 12
3150801 4.0e-5 0.0 3
3150802 4.0e-5 0.124 4
3150803 4.0e-5 0.0 6
3150804 4.0e-5 0.124 7
3150805 4.0e-5 0.0 12
3150901 0.2 0.2 1
3150902 0.0 0.0 2
3150903 93.9 93.9 4
3150904 0.4 0.4 5
3150905 93.9 93.9 7

```

```

3150906 0.0 0.0 8
3150907 0.2 0.2 9
3150908 4.1 4.1 10
3150909 0.4 0.4 11
3151001 00000 12
3151101 000000 1
3151102 000100 4
3151103 000000 5
3151104 000100 11
3151201 0 1.50209e+07 0.11839e+07 0.24594e+07 0.0 0.0 0.0 01
3151202 0 1.50186e+07 0.11694e+07 0.24595e+07 0.0 0.0 0.0 02
3151203 0 1.50153e+07 0.12058e+07 0.24595e+07 0.0 0.0 0.0 03
3151204 0 1.50077e+07 0.12176e+07 0.24597e+07 0.0 0.0 0.0 04
3151205 0 1.49996e+07 0.12206e+07 0.24599e+07 0.0 0.0 0.0 05
3151206 0 1.49996e+07 0.12220e+07 0.24599e+07 0.0 0.0 0.0 06
3151207 0 1.50076e+07 0.12245e+07 0.24597e+07 0.0 0.0 0.0 07
3151208 0 1.50153e+07 0.12198e+07 0.24596e+07 0.0 0.0 0.0 08
3151209 0 1.50209e+07 0.12237e+07 0.24594e+07 0.0 0.0 0.0 09
3151210 0 1.50277e+07 0.12236e+07 0.24592e+07 0.0 0.0 0.0 10
3151211 0 1.50258e+07 0.12244e+07 0.24593e+07 0.0 0.0 0.0 11
3151212 0 1.50212e+07 0.12233e+07 0.24594e+07 0.0 0.0 0.0 12
3151300 0
3151301 0 0.0 0.0 01
3151302 0 0.0 0.0 02
3151303 0 0.0 0.0 03
3151304 0 0.0 0.0 04
3151305 0 0.0 0.0 05
3151306 0 0.0 0.0 06
3151307 0 0.0 0.0 07
3151308 0 0.0 0.0 08
3151309 0 0.0 0.0 09
3151310 0 0.0 0.0 10
3151311 0 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 trpviv
3200301 504
*-----1-----1-----1-----1-----1-----1-----
* pipe section between isolat
*-----1-----1-----1-----1-----1-----1-----
3250000 vvohl singvol
3250101 0.0525 0.823 0.0 0.0 0.0 0.0
3250102 4.0e-5 0.0 00000
3250200 0 1.47400e+07 0.12385e+07 0.24655e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* quick opening blowdown valve hot leg
*-----1-----1-----1-----1-----1-----1-----
3300000 qobvhl valve
3300101 325010000 800000000 0.0466 0.0 0.0 000100
3300201 1 0.0 0.0 0.0
3300300 trpviv
3300301 504
*-----1-----1-----1-----1-----1-----1-----
* reactor vessel nozzle - broken loop cold leg
*-----1-----1-----1-----1-----1-----1-----
3350000 rvnbl branch
3350001 2 0
3350101 0.0634 0.7495 0.0 0.0 0.0 0.0
3350102 4.0e-5 0.0 00000
3350200 0 1.50838e+07 0.12408e+07 0.24579e+07 0.0
3351101 205000000 335000000 0.0634 1.0 1.0 000100
3352101 335010000 340000000 0.0 0.1 0.1 000000
3351201 0.12722 0.12722 0.0
3352201 0.12719 0.12719 0.0
*-----1-----1-----1-----1-----1-----1-----
* cold leg pipe to reflood assist bypass tee
*-----1-----1-----1-----1-----1-----1-----
3400000 ctbarv branch

```

```

3400001 1 0
3400101 0.0634 0.698 0.0 0.0 0.0 0.0
3400102 4.0e-5 0.0 00000
3400200 0 1.50838e+07 0.12404e+07 0.24579e+07 0.0
3401101 340010000 345000000 0.0 0.1 0.1 000000
3401201 0.12717 0.12717 0.0
*-----1-----1-----1-----1-----1-----1-----
* broken loop cold leg contraction to break plane
*-----1-----1-----1-----1-----1-----1-----
3450000 baocl branch
3450001 2 0
3450101 0.0634 0.974 0.0 0.0 0.0 0.0
3450102 4.0e-5 0.0 00000
3450200 0 1.50838e+07 0.12398e+07 0.24579e+07 0.0
3451101 345000000 385000000 0.0 0.0 0.0 000100
3452101 345010000 350000000 0.0 0.0 0.0 000100
3451201 0.20769 0.20769 0.0
3452201 2.02355e-04 2.02355e-04 0.0
*-----1-----1-----1-----1-----1-----1-----
* ecc tee isolation valve cold leg
*-----1-----1-----1-----1-----1-----1-----
3500000 etivcl pipe
3500001 2
3500101 0.0 2
3500201 0.0 1 * break plane
3500301 0.488 1
3500302 1.6085 2
3500401 0.00541 1
3500402 0.07770 2
3500801 0.0 2
3500801 4.0e-5 0.0 1
3500802 4.0e-5 0.0 2
3500901 0.0 0.0 1
3501001 00000 2
3501101 000100 1
3501201 0 1.50838e+07 0.10201e+07 0.24579e+07 0.0 0.0 0.1
3501202 0 1.50838e+07 0.11596e+07 0.24579e+07 0.0 0.0 0.2
3501300 0
3501301 0 .0 0.0 0.1
*-----1-----1-----1-----1-----1-----1-----
* isolation valve cold leg
*-----1-----1-----1-----1-----1-----1-----
3550000 isvcl valve
3550101 350010000 360000000 0.0 0.0 0.0 000100
3550201 1 0.0 0.0 0.0
3550300 trpvlv
3550301 504
*-----1-----1-----1-----1-----1-----1-----
* pipe section between isolation valve and qobv cold leg
*-----1-----1-----1-----1-----1-----1-----
3600000 vvoicl snglvol
3600101 0.0525 0.813 0.0 0.0 0.0 0.0
3600102 4.0e-5 0.0 00000
3600200 0 1.47400e+07 0.12385e+07 0.24655e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* quick opening blowdown cold leg
*-----1-----1-----1-----1-----1-----1-----
3650000 qobvcl valve
3650101 360010000 805000000 0.0466 0.0 0.0 000100
3650201 1 0.0 0.0 0.0
3650300 trpvlv
3650301 504
*-----1-----1-----1-----1-----1-----1-----
* reflood assist bypass piping - cold leg side
*-----1-----1-----1-----1-----1-----1-----
3700000 rabsphl branch
3700001 1 0
3700101 0.0388 2.203 0.0 0.0 90.0 0.653
3700102 4.0e-5 0.0 00000
3700200 0 1.50238e+07 0.12366e+07 0.24593e+07 0.0
3701101 375010000 370000000 0.0 0.0 0.0 000100
3701201 0.20747 0.20747 0.0

```

```

*-----1-----1-----1-----1-----1-----1-----
* reflood assist bypass parrel pipes hot leg side
*-----1-----1-----1-----1-----1-----1-----
3750000 rabphl snglvol
3750101 0.0776 0.0 0.0858 0.0 0.0 0.0
3750102 4.0e-5 0.0 00000
3750200 0 1.50262e+07 0.12375e+07 0.24593e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* reflood assist bypass valves
*-----1-----1-----1-----1-----1-----1-----
3770000 rabsvvl sngljun
3770101 380010000 375000000 0.0 1.4e+4 1.4e+4 000000
3770201 0 0.10375 0.10375 0.0
*-----1-----1-----1-----1-----1-----1-----
* reflood assist bypass parrel pipes cold leg side
*-----1-----1-----1-----1-----1-----1-----
3800000 rabppcl snglvol
3800101 0.0776 0.0 0.0855 0.0 0.0 0.0
3800102 4.0e-5 0.0 00000
3800200 0 1.50886e+07 0.12380e+07 0.24578e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
* reflood assist bypass single pipe cold leg side
*-----1-----1-----1-----1-----1-----1-----
3850000 rabspl branch
3850001 1 0
3850101 0.0388 0.0 0.11802 0.0 -90.0 -0.653
3850102 4.0e-5 0.0 00000
3850200 0 1.50862e+07 0.12384e+07 0.24578e+07 0.0
3851101 385010000 380000000 0.0 0.0 0.0 000100
3851201 0.20755 0.20755 0.0
*****
*
* pressurizer
*
*****
* surge line pcs side
*-----1-----1-----1-----1-----1-----1-----
4000000 slpcs branch
4000001 2 0
4000101 0.00145 3.45 0.0 0.0 90.0 0.54
4000102 4.0e-5 0.0 00000
4000200 0 1.49932e+07 0.13445e+07 0.24601e+07 0.0
4001101 110000000 400000000 0.0 0.93 0.93 000100
4002101 400010000 405000000 0.0 0.93 0.93 000000
4001201 -1.76611e-03 -1.76611e-03 0.0
4002201 -1.76637e-03 -1.76637e-03 0.0
*-----1-----1-----1-----1-----1-----1-----
* surge line pressurizer vessel
*-----1-----1-----1-----1-----1-----1-----
4050000 slprv snglvol
4050101 0.00145 3.45 0.0 0.0 90.0 0.60
4050102 4.0e-5 0.0 00000
4050200 0 1.49892e+07 0.13500e+07 0.24602e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
*
* spray line
*-----1-----1-----1-----1-----1-----1-----
4060000 spray snglvol
4060101 0.000336 6.322 0.0 0.0 90.0
4060102 3.161 4.0e-5 0.0 00000
4060200 0 1.51369e+07 0.12441e+07 0.24566e+07 0.0
*-----1-----1-----1-----1-----1-----1-----
*
* spray valve
*-----1-----1-----1-----1-----1-----1-----
4070000 sprvlv valve
4070101 406010000 420010000 3.3451e-4 0.0 0.0 000100
0.93
4070201 0 .000000 0.00000 0.0
4070300 trpvlv
4070301 690
*

```

```

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

```

```

*-----1-----1-----1-----1-----1-----1-----
* containment power operated relief valve
*-----1-----1-----1-----1-----1-----1-----
8100000 cporv  tmdpvol
8100101 0.0 1.0 0.1 0.0 0.0 0.0
8100102 0.0 0.0 00000
8100200 2
8100201 0.0 0.107e+6 1.0
*
*-----1-----1-----1-----1-----1-----1-----
* containment power operated relief valve
*-----1-----1-----1-----1-----1-----1-----
8200000 cporv  tmdpvol
8200101 0.0 1.0 0.1 0.0 0.0 0.0
8200102 0.0 0.0 00000
8200200 2
8200201 0.0 0.107e+6 1.0
*
*-----1-----1-----1-----1-----1-----1-----
* steam generator secondary side
*-----1-----1-----1-----1-----1-----1-----
* primary separator
*-----1-----1-----1-----1-----1-----1-----
5000000 sepaout branch
5000001 2 0
5000101 1.273 0.718 0.0 0.0 +90.0 +0.718
5000102 4.e-5 0.7874 01000
5000200 0 5.61017e+06 0.11842e+07 0.25930e+07 0.98167
5001101 500010000 525000000 0.0 5.0 5.0 000000
5002101 500000000 505000000 0.0 0.0 0.0 000000
5001201 -2.7011 0.70073 0.0
5002201 0.58921 -8.34267e-05 0.0
*-----1-----1-----1-----1-----1-----1-----
* separator outlet region
*-----1-----1-----1-----1-----1-----1-----
5050000 hwrsep  branch
5050001 1
5050101 1.273 0.718 0.0 0.0 -90.0 -0.718
5050102 4.e-5 0.7874 01000
5050200 0 5.61221e+06 0.11842e+07 0.25930e+07 0.30082
5051101 505010000 510000000 0.0 0.0 0.0 000000
5051201 0.17414 -9.48643e-02 0.0
*-----1-----1-----1-----1-----1-----1-----
* feed inlet volume
*-----1-----1-----1-----1-----1-----1-----
5100000 feedinl branch
5100001 1 0
5100101 0.7525 0.518 0.0 0.0 -90.0 -0.518
5100102 4.e-5 0.10796 01000
5100200 0 5.61615e+06 0.11030e+07 0.25930e+07 0.0000
5101101 510010000 515000000 0.0 0.0 0.0 000100
5101201 0.51954 0.51954 0.0
*-----1-----1-----1-----1-----1-----1-----
* steam generator downcomer
*-----1-----1-----1-----1-----1-----1-----
5150000 dwncmr  annulus
5150001 14
5150101 0.23226 6
5150102 0.258 14
5150201 0.0 5
5150202 0.0 6
5150203 0.0 13
5150301 0.7102 1
5150302 0.3551 3
5150303 0.2367333 6
5150304 0.61691667 9
5150305 0.925375 11
5150306 1.85075 13
5150307 0.718 14

```


5150401 0.0 14
 5150601 -90.0 6
 5150602 21.0 12
 5150603 16.0 13
 5150604 90.0 14
 *
 5150701 -0.7102 1
 5150702 -0.3551 3
 5150703 -0.2367333 6
 5150704 0.2367333 9
 5150705 0.3551 11
 5150706 0.7102 12
 5150707 0.518 13
 5150708 0.718 14
 *
 5150801 4.e-5 0.10793 6
 5150802 4.e-5 0.0305 13
 5150803 4.e-5 0.0 14
 5150901 0.0 0.0 5
 5150902 17.5 17.5 6
 5150903 0.0 0.0 8
 5150904 2.1 2.1 9
 5150905 4.2 4.2 12
 5150906 4.4 4.4 13
 *
 5151001 0001000 6
 5151002 0001100 12
 5151003 0001000 14
 5151101 000000 5
 5151102 000000 6
 5151103 000000 13
 5151201 0 5.62080e+06 0.11038e+07 0.25929e+07 0.0000 0.0
 01
 5151202 0 5.62631e+06 0.11046e+07 0.25929e+07 0.0000 0.0
 03
 5151203 0 5.63182e+06 0.11053e+07 0.25929e+07 0.0000 0.0
 06
 5151204 0 5.63067e+06 0.11745e+07 0.25928e+07 0.32326 0.0 09
 5151205 0 5.62614e+06 0.11839e+07 0.25929e+07 0.49171 0.0 11
 5151206 0 5.62047e+06 0.11846e+07 0.25929e+07 0.60409 0.0 12
 5151207 0 5.61560e+06 0.11844e+07 0.25930e+07 0.59935 0.0 13
 5151208 0 5.61269e+06 0.11844e+07 0.25930e+07 0.51173 0.0 14
 5151300 0
 5151301 0.51971 0.51971 0.0 01
 5151302 0.51987 0.51987 0.0 03
 5151303 0.52002 0.83703 0.0 06
 5151304 0.61397 2.5665 0.0 09
 5151305 0.73514 4.0513 0.0 11
 5151306 0.83034 5.2889 0.0 12
 5151307 0.82057 5.3343 0.0 13
 * ---1---1---1---1---1---1---1---
 * top of the riser
 * ---1---1---1---1---1---1---1---
 5200000 separin separatr
 5200001 3 0
 5200101 0.27871 0.718 0.0 0.0 90.0 0.718
 5200102 4.e-5 0.0 01000
 5200200 0 5.61107e+06 0.11843e+07 0.25930e+07 0.81844
 5201101 520010000 525000000 0.0 3.7 3.7 000000
 5202101 520000000 505000000 0.0 0.0 0.0 000000
 5203101 515010000 520000000 0.0 4.4 4.4 000000
 5201201 0.67331 6.2512 0.0
 5202201 0.67331 6.2512 0.0
 5203201 0.67331 6.2512 0.0
 * ---1---1---1---1---1---1---1---
 * below mist extractor, above top of shroud in steam dome
 * ---1---1---1---1---1---1---1---
 5250000 botstm branch
 5250001 1 0
 5250101 1.5886 0.762 0.0 0.0 90.0 0.762
 5250102 4.e-5 0.0 00000
 5250200 0 5.60992e+06 0.11841e+07 0.25930e+07 1.0000

5251101 525010000 530000000 0.0 0.8 0.8 000100
 5251201 0.66195 0.71981 0.0
 * ---1---1---1---1---1---1---1---
 * mist extractor and steam generator outlet pipe to scv
 * ---1---1---1---1---1---1---1---
 5300000 stmpipe pipe
 5300001 2
 5300101 1.2728 1
 5300102 0.04635 2
 5300201 0.01365 1
 5300301 0.762 1
 5300302 25.074 2
 5300401 0.0 2
 5300601 90.0 1
 5300602 0.0 2
 5300801 4.e-5 0.0 2
 5300901 0.8 0.8 1
 5301001 00000 2
 5301101 000100 1
 5301201 3 5.61e+06 554.0 0.0 0.0 0.0 01
 5301202 3 5.49e+06 554.0 0.0 0.0 0.0 02
 5301300 0
 5301301 10.500 19.767 0.0 01
 * ---1---1---1---1---1---1---1---
 * pipe downstream of steam control valve
 * ---1---1---1---1---1---1---1---
 5350000 condint snglvol
 5350101 0.06557 54.44 0.0 0.0 0.0 0.0
 5350102 4.e-5 0.0 00000
 5350200 0 2.12350e+06 0.92017e+06 0.25983e+07 0.99600
 * ---1---1---1---1---1---1---1---
 * air cooled condenser
 * ---1---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---1---
 * feed storage tank
 * ---1---1---1---1---1---1---1---
 5450000 feedtnk tmdpvol
 5450101 29.81 3.048 0.0 0.0 0.0 0.0
 5450102 4.e-5 0.0 00000
 5450200 1
 5450201 -1.0 480.62 0.0
 5450202 0.0 480.62 0.0
 * ---1---1---1---1---1---1---1---
 * steam control valve bypass
 * ---1---1---1---1---1---1---1---
 5460000 scvbyp valve
 5460101 530010000 547000000 4.48e-4 0.0 0.0 000000
 5460201 0 000000 000000 0.0
 5460300 trpvtv
 5460301 504
 * ---1---1---1---1---1---1---1---
 * air cooled condenser
 * ---1---1---1---1---1---1---1---
 5470000 condnsr tmdpvol
 5470101 0.21677 17.67 0.0 0.0 0.0 0.0
 5470102 4.e-5 0.0 00000
 5470200 2
 5470207 0.0 2.069e+6 1.0
 * ---1---1---1---1---1---1---1---
 * steam flow control valve
 * ---1---1---1---1---1---1---1---
 5500000 cv-p4-1 sngljun
 5500101 530010000 535000000 0.00337 0.0 0.0 000100 0.93
 5500201 0 18.585 20.163 0.0
 * ---1---1---1---1---1---1---1---
 * flow path to the air cooled condenser
 * ---1---1---1---1---1---1---1---

```

5550000 coacco  sngljun
5550101 535010000 540000000 0.0 0.0 0.0 000100
5550201 0 8.1357 35.082 0.0
*-----1-----1-----1-----1-----1-----1-----
* main feed water valve
*-----1-----1-----1-----1-----1-----1-----
5600000 mnfeed  tmdpjun
5600101 545000000 510000000 0.05
5600200 1
5600201 0.0 25.7 0.0 0.0
*****
*
* containment
*
*-----1-----1-----1-----1-----1-----1-----
* containment broken loop hot leg
*-----1-----1-----1-----1-----1-----1-----
8000000 cblhl  tmdpvcl
8000101 0.0 1.0 0.1 0.0 0.0 0.0
8000102 0.0 0.0 00000
8000200 2
8000201 0.0 0.107e6 1.0
8000202 10000.0 0.107e6 1.0
*-----1-----1-----1-----1-----1-----1-----
* containment broken loop cold leg
*-----1-----1-----1-----1-----1-----1-----
8050000 c805  tmdpvcl
8050101 0.0 1.0 0.1 0.0 0.0 0.0
8050102 0.0 0.0 00000
8050200 2
8050201 0.0 1.0e+5 1.0
8050202 10000.0 1.0e+5 1.0
*
*-----1-----1-----1-----1-----1-----1-----
*
* heat structure input data
*
*****
* steam generator heat structures
*
*****
* steam generator tubing
*****
10060000 12 8 2 1 0.0051054
10060100 0 1
10060101 7 0.006348984
10060201 6 7
10060301 0.0 7
10060401 540.0 8
*
10060501 115040000 10000 1 1 562.493667 3
10060502 115070000 10000 1 1 843.7405 5
10060503 115090000 10000 1 1 1687.481 7
10060504 115110000 10000 1 1 843.7405 9
10060505 115130000 10000 1 1 562.493667 12
*
10060601 515070000 10000 1 1 562.493667 3
10060602 515100000 10000 1 1 843.7405 5
10060603 515120000 0 1 1 1687.481 7
10060604 515110000 -10000 1 1 843.7405 9
10060605 515090000 -10000 1 1 562.493667 12
*
10060701 0 0 0 0 12
10060801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 12 * mod 3
10060901 0.0 11.0 11.0 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 1.0 2 * mod 3
*****
* tube sheet periphery
*****
11152000 2 20 1 1 0.0
11152100 0 1
11152101 19 0.623795
11152201 5 19
11152301 0.0 19
11152401 577.0 20
11152501 115030000 0 1 1 0.1579621 1
11152502 115160000 0 1 1 0.1579621 2
11152601 515060000 0 1 1 0.1579621 2
11152701 0 0.0 0.0 0.0 2
11152801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 2 * mod 3
11152901 0.0 11.0 11.0 0.0 0.0 0.0 1.0 2 * mod 3
*****
* intact loop piping
*****
11001000 12 11 2 1 0.142
11001100 0 1
11001101 10 0.178
11001201 4 10
11001301 0.0 10
11001401 540.0 11
11001501 100010000 0 1 1 1.5373 1
11001502 105010000 0 1 1 1.634 2
11001503 110010000 0 1 1 0.623 3
11001504 115010000 0 1 1 1.4385 4
11001505 115180000 0 1 1 0.689 5
11001506 115190000 0 1 1 0.559 6
11001507 120010000 0 1 1 0.76 7
11001508 150010000 0 1 1 0.4966 8
11001509 175010000 0 1 1 0.559 9
11001510 175020000 0 1 1 0.613 10
11001511 180010000 0 1 1 0.701 11
11001512 185010000 0 1 1 1.461 12
11001601 -939 0 3949 1 1.5373 1
11001602 -939 0 3949 1 1.634 2
11001603 -939 0 3949 1 0.623 3
11001604 -939 0 3949 1 1.4385 4
11001605 -939 0 3949 1 0.689 5
11001606 -939 0 3949 1 0.559 6
11001607 -939 0 3949 1 0.76 7
11001608 -939 0 3949 1 0.4966 8
11001609 -939 0 3949 1 0.559 9
11001610 -939 0 3949 1 0.613 10
11001611 -939 0 3949 1 0.701 11
11001612 -939 0 3949 1 1.461 12
11001701 0 0 0 0 12
11001801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 1 * mod 3
11001802 0.0 11.0 11.0 0.0 0.0 0.0 1.0 2 * mod 3
11001803 0.0 11.0 11.0 0.0 0.0 0.0 1.0 3 * mod 3
11001804 0.0 11.0 11.0 0.0 0.0 0.0 1.0 4 * mod 3
11001805 0.0 11.0 11.0 0.0 0.0 0.0 1.0 5 * mod 3
11001806 0.0 11.0 11.0 0.0 0.0 0.0 1.0 6 * mod 3
11001807 0.0 11.0 11.0 0.0 0.0 0.0 1.0 7 * mod 3
11001808 0.0 11.0 11.0 0.0 0.0 0.0 1.0 8 * mod 3
11001809 0.0 11.0 11.0 0.0 0.0 0.0 1.0 9 * mod 3
11001810 0.0 11.0 11.0 0.0 0.0 0.0 1.0 10 * mod 3
11001811 0.0 11.0 11.0 0.0 0.0 0.0 1.0 11 * mod 3
11001812 0.0 11.0 11.0 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

```

* .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

```

* 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	11.000	0.0	0.0	0.0	1.04	* mod 3
12100802	0.0	11.0	11.000	0.0	0.0	0.0	1.05	* mod 3
12100803	0.0	11.0	11.000	0.0	0.0	0.0	1.06	* mod 3
12100901	0.0	11.0	11.000	0.0	0.0	0.0	1.04	* mod 3
12100902	0.0	11.0	11.000	0.0	0.0	0.0	1.05	* mod 3
12100903	0.0	11.0	11.000	0.0	0.0	0.0	1.06	* 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	11.000	0.0	0.0	0.0	1.01	* mod 3
12110802	0.0	11.0	11.000	0.0	0.0	0.0	1.02	* mod 3
12110803	0.0	11.0	11.000	0.0	0.0	0.0	1.03	* 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	11.000	0.0	0.0	0.0	1.01	* mod 3
12120802	0.0	11.0	11.000	0.0	0.0	0.0	1.03	* mod 3
12120803	0.0	11.0	11.000	0.0	0.0	0.0	1.04	* mod 3
12120804	0.0	11.0	11.000	0.0	0.0	0.0	1.05	* 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	11.000	0.0	0.0	0.0	1.01	* mod 3
12200901	0.0	11.0	11.000	0.0	0.0	0.0	1.01	* 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	11.000	0.0	0.0	0.0	1.01	* mod 3
12250802	0.0	11.0	11.000	0.0	0.0	0.0	1.03	* mod 3
12250803	0.0	11.0	11.000	0.0	0.0	0.0	1.04	* mod 3
12250804	0.0	11.0	11.000	0.0	0.0	0.0	1.05	* mod 3
12250805	0.0	11.0	11.000	0.0	0.0	0.0	1.06	* mod 3
12250806	0.0	11.0	11.000	0.0	0.0	0.0	1.07	* 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	11.000	0.0	0.0	0.0	1.01	* 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	11.000	0.0	0.0	0.0	1.03	* 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	11.000	0.0	0.0	0.0	1.01	* 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 1.0 1 * mod 3
12460901 0.0 11.0 11.0 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 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 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 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 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 1.0 1 * mod 3
13150802 0.0 11.0 11.0 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 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 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 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 1.0 1 * mod 3

```

```

13155000 1 11 2 1 0.1420
13155100 0 1
13155101 10 0.1780
13155201 4 10
13155301 0.0 10
13155401 540.0 11
13155501 315100000 0 1 1 0.0489057 1

```

13155601 -939 0 3979 1 0.0489057 1
 13155701 0 0 0 0 0 1
 13155801 0.0 11.0 11.0 0.0 0.0 0.0 0.0 1.0 1 * mod 3

* nozzle piping

13000000 3 11 2 1 0.1420
 13000100 0 1
 13000101 10 0.1780
 13000201 4 10
 13000301 0.0 10
 13000401 540.0 11
 13000501 300010000 0 1 1 0.876 1
 13000502 305010000 0 1 1 0.698 2
 13000503 310010000 0 1 1 1.424 3
 13000601 -939 0 3979 1 0.876 1
 13000602 -939 0 3979 1 0.698 2
 13000603 -939 0 3979 1 1.424 3
 13000701 0 0 0 0 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 [rbvsv]

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

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

* vessel sides - large diameter section

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

* vessel sides - small diameter section

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 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 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 1.0 1 *mod 3

```

* steam generator heat structures

* shroud secondary side steam generator -upper section

```

*-----1-----1-----1-----1-----1-----1-----
15000000 3 4 2 1 0.3048
15000100 0 1
15000101 3 0.3143
15000201 5 3
15000301 0.0 3
15000401 540.0 4
15000501 500010000 0 1 1 0.7725 1
15000502 505010000 0 1 1 0.7725 2
15000503 510010000 0 1 1 0.152 3
15000601 520010000 0 1 1 0.7725 1
15000602 515140000 0 1 1 0.7725 2
15000603 515130000 0 1 1 0.152 3
15000701 0 0.0 0.0 0.0 3
15000801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 3 *mod 3
15000901 0.0 11.0 11.0 0.0 0.0 0.0 1.0 3 *mod 3

```

* shroud - lower section

```

*-----1-----1-----1-----1-----1-----1-----
15150000 7 4 2 1 0.6445
15150100 0 1
15150101 3 0.6572
15150201 5 3
15150301 0.0 3
15150401 540.0 4
15150501 510010000 0 1 1 0.152 1
15150502 515010000 0 1 1 0.7113 2
15150503 515020000 10000 1 1 0.35565 4
15150504 515040000 10000 1 1 0.2371 7

```

```

15150601 515130000 0 1 1 0.152 1
15150602 515120000 0 1 1 0.7113 2
15150603 515110000 -10000 1 1 0.35565 4
15150604 515090000 -10000 1 1 0.2371 7
15150701 0 0 0 0 7
15150801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 7 *mod 3
15150901 0.0 11.0 11.0 0.0 0.0 0.0 1.0 7 *mod 3

```

* vessel wall

```

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

```

```

15300000 11 10 2 1 0.7112
15300100 0 1
15300101 9 0.765165
15300201 5 9
15300301 0.0 9
15300401 530.0 10
15300501 530010000 0 1 1 0.762 1
15300502 525010000 0 1 1 0.762 2
15300503 500010000 0 1 1 0.718 3
15300504 505010000 0 1 1 0.718 4
15300505 510010000 0 1 1 0.518 5
15300506 515010000 0 1 1 0.7102 6
15300507 515020000 10000 1 1 0.3551 8
15300508 515040000 10000 1 1 0.23673 11

```

```

15300601 -939 0 3959 1 0.762 1
15300602 -939 0 3959 1 0.762 2
15300603 -939 0 3959 1 0.718 4
15300604 -939 0 3959 1 0.518 5
15300605 -939 0 3959 1 0.7102 6
15300606 -939 0 3959 1 0.3551 8
15300607 -939 0 3959 1 0.23673 11

```

```

15300701 0 0.0 0.0 0.0 11
15300801 0.0 11.0 11.0 0.0 0.0 0.0 1.0 11 *mod 3

```

* heat structure thermal property data

```

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

```

```

20100100 tbl/fctn 1 1 *uo2
20100200 tbl/fctn 1 1 *gap
20100300 tbl/fctn 1 1 *zr
20100400 tbl/fctn 1 1 *s-steel
20100500 c-steel
20100600 tbl/fctn 1 1 *inconel 600
20100700 tbl/fctn 1 1 *mgo
20100800 tbl/fctn 1 1 *nicr

```

```

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

```

* uo2 - thermal conductivity

```

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

```

```

20100101 2.7315e2 8.44
20100102 4.1667e2 6.46
20100103 5.3315e2 5.782385
20100104 6.99817e2 4.633177
20100105 8.66483e2 3.880307
20100106 1.03315e3 3.357625
20100107 1.08871e3 3.155129
20100108 1.19982e3 2.983787
20100109 1.28315e3 2.836674
20100110 1.36648e3 2.713792
20100111 1.53315e3 2.521680
20100112 1.61648e3 2.448990
20100113 1.69982e3 2.391875
20100114 1.97759e3 2.289762
20100115 2.25537e3 2.307069
20100116 2.53315e3 2.433413
20100117 2.81093e3 2.661870
20100118 3.08871e3 2.994171

```

```

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

```

* gap - thermal conductivity
 *-----1-----1-----1-----1-----1-----1-----
 20100201 273.15 0.14
 20100202 590.0 0.24
 20100203 810.0 0.29
 20100204 1090.0 0.36
 20100205 1370.0 0.42
 20100206 3260.0 0.75
 *-----1-----1-----1-----1-----1-----1-----
 * zircaloy-4 - thermal conductivity from matpro
 *-----1-----1-----1-----1-----1-----1-----
 20100301 380.4 13.6
 20100302 469.3 14.6
 20100303 577.6 15.8
 20100304 685.9 17.3
 20100305 774.8 18.4
 20100306 872.0 19.8
 20100307 973.2 21.8
 20100308 1073.2 23.2
 20100309 1123.2 25.4
 20100310 1152.3 24.2
 20100311 1232.2 25.5
 20100312 1331.2 26.6
 20100313 1404.2 28.2
 20100314 1576.2 33.0
 20100315 1625.2 36.7
 20100316 1755.2 41.2
 20100317 2273.2 55.0
 *-----1-----1-----1-----1-----1-----1-----
 * s-steel - thermal conductivity
 *-----1-----1-----1-----1-----1-----1-----
 20100401 273.15 12.98
 20100402 1199.82 25.1
 *-----1-----1-----1-----1-----1-----1-----
 * inconel-600 - thermal conductivity
 *-----1-----1-----1-----1-----1-----1-----
 20100601 366.5 13.85
 20100602 477.6 15.92
 20100603 588.7 18.17
 20100604 700.0 20.42
 20100605 810.9 22.50
 20100606 922.0 24.92
 20100607 1033.2 26.83
 20100608 1144.3 29.42
 20100609 1477.6 36.06
 *-----1-----1-----1-----1-----1-----1-----
 * uo2 - volumetric heat capacity
 *-----1-----1-----1-----1-----1-----1-----
 20100151 2.73150e2 2.310427e6
 20100152 3.23150e2 2.571985e6
 20100153 3.73150e2 2.746357e6
 20100154 6.7315e2 3.138694e6
 20100155 1.37315e3 3.443844e6
 20100156 1.77315e3 3.531030e6
 20100157 1.97315e3 3.792588e6
 20100158 2.17315e3 4.228518e6
 20100159 2.37315e3 4.882412e6
 20100160 2.67315e3 6.015829e6
 20100161 2.77315e3 6.320980e6
 20100162 2.87315e3 6.582538e6
 20100163 2.97315e3 6.713317e6
 20100164 3.11315e3 6.800503e6
 20100165 4.69982e3 6.800503e6
 *-----1-----1-----1-----1-----1-----1-----
 * gap - volumetric heat capacity
 *-----1-----1-----1-----1-----1-----1-----
 20100251 273.15 5.4
 20100252 3260.0 5.4
 *-----1-----1-----1-----1-----1-----1-----
 * zircaloy-4 - volumetric heat capacity from matpro
 *-----1-----1-----1-----1-----1-----1-----
 20100351 255.4 1.904e6

20100352 1077.6 2.312e6
 20100353 1185.9 5.712e6
 20100354 1248.4 2.311e6
 20100355 2199.8 2.312e6
 *-----1-----1-----1-----1-----1-----1-----
 * s-steel - volumetric heat capacity
 *-----1-----1-----1-----1-----1-----1-----
 20100451 273.15 3.83e6
 20100452 366.5 3.83e6
 20100453 1366.5 5.376e6
 *-----1-----1-----1-----1-----1-----1-----
 * inconel-600 - volumetric heat capacity
 *-----1-----1-----1-----1-----1-----1-----
 20100651 366.5 3.908+6
 20100652 477.6 4.084+6
 20100653 588.7 4.260+6
 20100654 700.0 4.436+6
 20100656 810.9 4.665+6
 20100657 922.0 4.929+6
 20100658 1033.2 5.105+6
 20100659 1477.6 5.727+6
 *-----1-----1-----1-----1-----1-----1-----
 * magnesium oxide - thermal conductivity
 *-----1-----1-----1-----1-----1-----1-----
 20100701 373.15 0.2451
 20100702 422.04 0.2405
 20100703 477.59 0.2352
 20100704 533.15 0.2300
 20100705 588.71 0.2249
 20100706 644.26 0.2196
 20100707 699.82 0.2143
 20100708 755.37 0.2091
 20100709 810.93 0.2039
 20100710 866.48 0.1987
 20100711 922.04 0.1934
 20100712 977.59 0.1882
 20100713 1033.15 0.1830
 20100714 1088.71 0.1777
 20100715 1144.26 0.1725
 20100716 1199.82 0.1673
 20100717 1255.37 0.1621
 20100718 1310.93 0.1568
 20100719 1366.48 0.1516
 20100720 1422.04 0.1464
 20100721 1477.59 0.1412
 20100722 1533.15 0.1359
 20100723 1588.71 0.1307
 20100724 1644.26 0.1255
 20100725 1699.82 0.1203
 20100726 1755.37 0.1150
 20100727 1810.93 0.1098
 20100728 1866.48 0.1046
 20100729 1922.04 0.0993
 20100730 5000.00 0.0993
 *-----1-----1-----1-----1-----1-----1-----
 * magnesium oxide - volumetric heat capacity
 *-----1-----1-----1-----1-----1-----1-----
 20100751 373.15 2033.52
 20100752 422.04 2004.59
 20100753 477.59 1917.74
 20100754 533.15 1938.87
 20100755 588.71 1906.01
 20100756 644.26 1873.15
 20100757 699.82 1840.29
 20100758 755.37 1807.43
 20100759 810.93 1774.56
 20100760 866.48 1741.70
 20100761 922.04 1708.84
 20100762 977.59 1675.96
 20100763 1033.15 1643.11
 20100764 1088.71 1610.25
 20100765 1144.26 1577.39


```

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

```

```

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

```

```

30000106 0.0321 3.914
.....
* power history
.....
30000401 4.87e+7 70. hr
*
.....
* reactivity curve numbers
.....
30000011 609
.....
* moderator density reactivity table
.....
30000501 0.62626e+3 -4.4769
30000502 0.66396e+3 -3.2923
30000503 0.71617e+3 -1.5692
30000504 0.76112e+3 -0.1692
30000505 0.76837e+3 0.04615
30000506 0.79157e+3 0.6923
30000507 0.81188e+3 1.2398
30000508 0.86263e+3 2.2415
30000509 0.93804e+3 3.9231
30000510 0.99749e+3 5.1077
*
.....
* doppler reactivity table
.....
30000601 293.16 1.375
30000602 338.72 1.125
30000603 422.05 0.682
30000604 477.60 0.419
30000605 505.38 0.274
30000606 570.72 0.000
30000607 588.72 -0.075
30000608 695.83 -0.526
30000609 922.05 -1.386
30000610 1310.94 -2.543
30000611 1810.94 -3.865
30000612 2088.72 -4.502
30000613 2499.83 -5.392
30000614 3027.60 -6.417
*
.....
* volume weighting factors
.....
* moderator temperature feedback
.....
*30000701 230010000 0 0.31493 0.0
*30000702 230020000 0 0.31493 0.0
*30000703 230030000 0 0.37014 0.0
.....
* doppler feedback
.....
*30000801 2300001 0 0.43153 0.0
*30000802 2300002 0 0.51686 0.0
*30000803 2300003 0 0.05161 0.0
*
*----- mtc curve monitor -----
*
20593300 mtcmon function 1.0 0 0
20593301 rho 230020000 933
*
20293300 reac-t
20293301 0.62626e+3 -9.2
20293302 0.66396e+3 -3.8
20293303 684.0 -1.5
20293304 692.0 -0.7
20293305 707.0 -0.2
20293306 0.71819e+3 0.0
20293307 737.0 0.5
20293308 744.0 0.6
20293309 0.76112e+3 0.7

```

```

20293310 0.76837e+3 0.8
20293311 0.79157e+3 1.05
*
*-----1-----1-----1-----1-----1-----1-----
* power from experimental data
*-----1-----1-----1-----1-----1-----1-----
20270000 power 530
20270001 1.08400000e+00 4.878200307e+07
20270002 3.48400000e+00 4.886505087e+07
20270003 4.68400000e+00 4.890413219e+07
20270004 7.08400000e+00 4.895786901e+07
20270005 9.48400000e+00 4.909465363e+07
20270006 1.18840000e+01 4.874292175e+07
20270007 1.42840000e+01 4.845469701e+07
20270008 1.66840000e+01 4.843515635e+07
20270009 1.90840000e+01 4.822020909e+07
20270010 2.14840000e+01 4.790755853e+07
20270011 2.38840000e+01 4.788313271e+07
20270012 2.62840000e+01 4.768772610e+07
20270013 2.86840000e+01 4.751186016e+07
20270014 3.10840000e+01 4.708685081e+07
20270015 3.34840000e+01 4.712104696e+07
20270016 3.58840000e+01 4.690609970e+07
20270017 3.82840000e+01 4.695006619e+07
20270018 4.06840000e+01 4.672534860e+07
20270019 4.30840000e+01 4.704288432e+07
20270020 4.54840000e+01 4.659344914e+07
20270021 4.78840000e+01 4.664230079e+07
20270022 5.02840000e+01 4.659344914e+07
20270023 5.26840000e+01 4.620263594e+07
20270024 5.50840000e+01 4.571900460e+07
20270025 5.74840000e+01 4.442932104e+07
20270026 5.98840000e+01 4.379913475e+07
20270027 6.22840000e+01 4.278790559e+07
20270028 6.46840000e+01 4.149822202e+07
20270029 6.70840000e+01 4.057004067e+07
20270030 6.94840000e+01 3.890908456e+07
20270031 7.18840000e+01 3.757054935e+07
20270032 7.42840000e+01 3.564090916e+07
20270033 7.66840000e+01 3.282216895e+07
20270034 7.90840000e+01 3.039424193e+07
20270035 8.14840000e+01 2.798097041e+07
20270036 8.38840000e+01 2.556281373e+07
20270037 8.62840000e+01 2.344265211e+07
20270038 8.86840000e+01 2.193313611e+07
20270039 9.10840000e+01 2.060437123e+07
20270040 9.34840000e+01 1.918278821e+07
20270041 9.58840000e+01 1.834742499e+07
20270042 9.82840000e+01 1.717498538e+07
20270043 1.00684000e+02 1.594880896e+07
20270044 1.03084000e+02 1.494735014e+07
20270045 1.05484000e+02 1.385795834e+07
20270046 1.07884000e+02 1.279299236e+07
20270047 1.10284000e+02 1.198694013e+07
20270048 1.12684000e+02 1.132255769e+07
20270049 1.15084000e+02 1.072168239e+07
20270050 1.17484000e+02 1.011103676e+07
20270051 1.19884000e+02 9.471080147e+06
20270052 1.22284000e+02 8.943482324e+06
20270053 1.24684000e+02 8.489161978e+06
20270054 1.27084000e+02 8.059267456e+06
20270055 1.29484000e+02 7.595176779e+06
20270056 1.31884000e+02 7.277641052e+06
20270057 1.34284000e+02 6.906368511e+06
20270058 1.36684000e+02 6.554636629e+06
20270059 1.39084000e+02 6.305493213e+06
20270060 1.41484000e+02 6.046579467e+06
20270061 1.43884000e+02 5.699732751e+06
20270062 1.46284000e+02 5.470129995e+06
20270063 1.48684000e+02 5.318689879e+06
20270064 1.51084000e+02 5.030465143e+06
20270065 1.53484000e+02 4.810632717e+06

```

```

20270066 1.55884000e+02 4.629881611e+06
20270067 1.58284000e+02 4.405164020e+06
20270068 1.60684000e+02 4.214642584e+06
20270069 1.63084000e+02 4.014350818e+06
20270070 1.65484000e+02 3.901992023e+06
20270071 1.67884000e+02 3.716355752e+06
20270072 1.70284000e+02 3.589341462e+06
20270073 1.73884000e+02 3.349968376e+06
20270074 1.75084000e+02 3.276690900e+06
20270075 1.77484000e+02 3.095939795e+06
20270076 1.79884000e+02 3.086169465e+06
20270077 1.81084000e+02 3.017777154e+06
20270078 1.83484000e+02 2.807715058e+06
20270079 1.85884000e+02 2.695356263e+06
20270080 1.87084000e+02 2.656274943e+06
20270081 1.89484000e+02 2.568341972e+06
20270082 1.91884000e+02 2.495064497e+06
20270083 1.94284000e+02 2.382705702e+06
20270084 1.95484000e+02 2.328968886e+06
20270085 1.96684000e+02 2.299657896e+06
20270086 1.97884000e+02 2.260576576e+06
20270087 1.99084000e+02 2.211724926e+06
20270088 2.00284000e+02 2.182413936e+06
*
* control variables
*
*-----1-----1-----1-----1-----1-----1-----
* steam generator downcomer collapsed liquid level
*-----1-----1-----1-----1-----1-----1-----
20500100 sglvl sum 1.0 0.0 1
20500101 0.0 0.718 voidf 500010000
20500102 0.718 voidf 505010000
20500103 0.518 voidf 510010000
20500104 0.7102 voidf 515010000
20500105 0.3551 voidf 515020000
20500106 0.3551 voidf 515030000
20500107 0.2367333 voidf 515040000
20500108 0.2367333 voidf 515050000
20500109 0.2367333 voidf 515060000
*-----1-----1-----1-----1-----1-----1-----
* pressurizer collapsed liquid level
*-----1-----1-----1-----1-----1-----1-----
20500200 pzrlvl sum 1.0 0.0 1.3 0.0 1.83
20500201 0.0 0.224 voidf 415010000
20500202 0.403 voidf 415020000
20500203 0.403 voidf 415030000
20500204 0.207 voidf 415040000
20500205 0.207 voidf 415050000
20500206 0.1705 voidf 415060000
20500207 0.1705 voidf 415070000
20500208 0.118 voidf 415080000
20500209 0.118 voidf 420010000
*-----1-----1-----1-----1-----1-----1-----
* core collapsed liquid level
*-----1-----1-----1-----1-----1-----1-----
20500300 rvlvl sum 1.0 0.0 1
20500301 0.0 0.712 voidf 250010000
20500302 0.854 voidf 250010000
20500303 0.843 voidf 245010000
20500304 1.118 voidf 240010000
20500305 0.657 voidf 230030000
20500306 0.559 voidf 230020000
20500307 0.559 voidf 230010000
20500308 0.520 voidf 225010000
20500309 0.360 voidf 215010000
20500310 0.370 voidf 220010000
*-----1-----1-----1-----1-----1-----1-----
* hot leg intact loop
*-----1-----1-----1-----1-----1-----1-----
20504100 pcsvol1 sum 1.0 0.0 1
20504101 0.0 .09746482 rho 100010000

```

```

20504102 0.1035956 rho 105010000
20504103 3.0300e-2 rho 110010000
20504104 9.0000e-2 rho 115010000
20504105 5.7000e-2 rho 115020000
*-----1-----1-----1-----1-----1-----1-----
* steam generator
*-----1-----1-----1-----1-----1-----1-----
20504200 pcsvol2 sum 1.0 0.0 1
20504201 0.0 0.3350000 rho 115030000
20504202 0.1611170 rho 115040000
20504203 0.1611170 rho 115050000
20504204 6.7950e-2 rho 115060000
20504205 6.7950e-2 rho 115070000
20504206 1.61117-1 rho 115080000
20504207 1.61117-1 rho 115090000
20504208 3.3500e-1 rho 115100000
*-----1-----1-----1-----1-----1-----1-----
* sg-pump piping
*-----1-----1-----1-----1-----1-----1-----
20504300 pcsvol3 sum 1.0 0.0 1
20504301 0.0 4.37000-2 rho 115170000
20504302 4.62000-2 rho 115180000
20504303 3.54406-2 rho 115190000
20504304 4.81840-2 rho 120010000
20504305 6.13000-2 rho 125010000
20504306 1.89000-2 rho 130010000
20504307 6.13000-2 rho 155010000
20504308 1.89000-2 rho 160010000
*-----1-----1-----1-----1-----1-----1-----
* cold leg intact loop
*-----1-----1-----1-----1-----1-----1-----
20500400 pcsvol4 sum 1.0 0.0 1
20500401 0.0 9.90000-2 rho 135010000
20500402 1.83732-2 rho 140010000
20500403 6.33000-2 rho 145010000
20500404 3.14844-2 rho 150010000
20500405 9.90000-2 rho 165010000
20500406 1.88124-2 rho 170010000
20500407 3.54406-2 rho 175010000
20500408 3.88642-2 rho 175020000
20500409 4.44434-2 rho 180010000
20500410 9.26274-2 rho 185010000
*-----1-----1-----1-----1-----1-----1-----
* reactor
*-----1-----1-----1-----1-----1-----1-----
20500500 pcsvol5 sum 1.0 0.0 1
20500501 0.0 2.66400-1 rho 215010000
20500502 2.92300-1 rho 220010000
20500503 1.30000-1 rho 225010000
20500504 9.53095-2 rho 230010000
20500505 9.53095-2 rho 230020000
20500506 0.1120185 rho 230030000
20500507 8.38500-3 rho 235010000
20500508 8.38500-3 rho 235020000
20500509 9.35500-3 rho 235030000
20500510 3.32046-1 rho 240010000
20500511 9.61020-2 rho 245010000
20500512 1.28100-1 rho 246010000
20500513 2.45952-1 rho 250010000
20500514 1.73728-1 rho 250010000
*-----1-----1-----1-----1-----1-----1-----
* hot leg broken loop
*-----1-----1-----1-----1-----1-----1-----
20500600 pcsvol6 sum 1.0 0.0 1
20500601 0.0 5.55384-2 rho 300010000
20500602 4.42532-2 rho 305010000
20500603 6.68000-2 rho 310010000
20500604 3.38914-3 rho 315010000
20500605 4.40154-3 rho 315020000
20500606 3.90960-2 rho 315030000
20500607 1.82736-1 rho 315040000
20500608 9.17460-2 rho 315050000

```

```

20500609 9.17460-2 rho 315060000
20500610 1.82736-1 rho 315070000
20500611 3.90960-2 rho 315080000
20500612 1.62000-2 rho 315090000
20500613 6.48000-2 rho 315100000
20500614 .01539912 rho 315110000
20500615 3.50175-2 rho 315120000
20500616 8.54764-2 rho 370010000
20500617 8.58000-2 rho 375010000
*-----1-----1-----1-----1-----1-----
* cold leg broken loop
*-----1-----1-----1-----1-----1-----
20500700 pcsvol7 sum 1.0 0.0 1
20500701 0.0 4.75183-2 rho 335010000
20500702 4.42532-2 rho 340010000
20500703 6.17516-2 rho 345010000
20500704 5.41000-3 rho 350010000
20500705 8.55000-2 rho 380010000
20500706 1.18030-1 rho 385010000
*-----1-----1-----1-----1-----1-----
* pressurizer
*-----1-----1-----1-----1-----1-----
20500800 pcsvol8 sum 1.0 0.0 1
20500801 0.0 5.00250-3 rho 400010000
20500802 5.00250-3 rho 405010000
20500803 8.10880-2 rho 415010000
20500804 2.27695-1 rho 415020000
20500805 2.27695-1 rho 415030000
20500806 1.16955-1 rho 415040000
20500807 1.16955-1 rho 415050000
20500808 7.94530-2 rho 415060000
20500809 7.94530-2 rho 415070000
20500810 1.53400-2 rho 415080000
*-----1-----1-----1-----1-----1-----
* reactor vessel downcomer mass
*-----1-----1-----1-----1-----1-----
20500900 dwnrcms sum 1.0 0.0 1
20500901 0.0 8.55000-2 rho 200010000
20500902 1.10000-1 rho 205010000
20500903 1.36036-1 rho 210010000
20500904 1.36036-1 rho 210020000
20500905 1.36036-1 rho 210030000
20500906 1.36036-1 rho 210040000
20500907 1.23426-2 rho 223010000
20500908 2.78874-2 rho 223020000
20500909 2.78874-2 rho 223030000
20500910 2.78874-2 rho 223040000
20500911 2.78874-2 rho 223050000
20500912 1.04796-2 rho 223060000
20500913 1.04796-2 rho 223070000
*-----1-----1-----1-----1-----1-----
* pcs mass
*-----1-----1-----1-----1-----1-----
20501000 pcsmass sum 1.0 0.0 1
20501001 0.0 1.0 cntrlvar 41
20501002 1.0 cntrlvar 42
20501003 1.0 cntrlvar 43
20501004 1.0 cntrlvar 4
20501005 1.0 cntrlvar 5
20501006 1.0 cntrlvar 6
20501007 1.0 cntrlvar 7
20501008 1.0 cntrlvar 8
20501009 1.0 cntrlvar 9
*-----1-----1-----1-----1-----1-----
* break energy computer
*-----1-----1-----1-----1-----1-----
20542500 pvfstm div 1.0 0.0 1
20542501 rhof 420010000 p 420010000
*
20542600 hfstm sum 1.0 0.0 1
20542601 0.0 1.0 uf 420010000
20542602 1.0 cntrlvar 425

```

```

*
20542700 pvgstm div 1.0 0.0 1
20542701 rhog 420010000 p 420010000
*
20542800 hgstm sum 1.0 0.0 1
20542801 0.0 1.0 ug 420010000
20542802 1.0 cntrlvar 427
*
20542900 xhgstm mult 1.0 0.0 1
20542901 quals 420010000 cntrlvar 428
*
20543000 xhfstm mult 1.0 0.0 1
20543001 quals 420010000 cntrlvar 426
*
20543100 yhfstm sum 1.0 0.0 1
20543101 0.0 1.0 cntrlvar 426
20543102 -1.0 cntrlvar 430
*
20543200 hsteam sum 1.0 0.0 1
20543201 0.0 1.0 cntrlvar 429
20543202 1.0 cntrlvar 431
*
20543300 brkpwr mult 1.0 0.0 1
20543301 mflowj 425000000 cntrlvar 432
*
20543400 brkflow integral 1.0 0.0 1
20543401 mflowj 425000000
*
*----- SRV -----
*
20552500 pvfstm div 1.0 0.0 1
20552501 rhof 420010000 p 420010000
*
20552600 hfstm sum 1.0 0.0 1
20552601 0.0 1.0 uf 420010000
20552602 1.0 cntrlvar 525
*
20552700 pvgstm div 1.0 0.0 1
20552701 rhog 420010000 p 420010000
*
20552800 hgstm sum 1.0 0.0 1
20552801 0.0 1.0 ug 420010000
20552802 1.0 cntrlvar 527
*
20552900 xhgstm mult 1.0 0.0 1
20552901 quals 420010000 cntrlvar 528
*
20553000 xhfstm mult 1.0 0.0 1
20553001 quals 420010000 cntrlvar 526
*
20553100 yhfstm sum 1.0 0.0 1
20553101 0.0 1.0 cntrlvar 526
20553102 -1.0 cntrlvar 530
*
20553200 hsteam sum 1.0 0.0 1
20553201 0.0 1.0 cntrlvar 529
20553202 1.0 cntrlvar 531
*
20553300 brkpwr mult 1.0 0.0 1
20553301 mflowj 430000000 cntrlvar 532
*
20553400 brkflow integral 1.0 0.0 1
20553401 mflowj 430000000
*
*-----1-----1-----1-----1-----1-----
* 011 - 031 heat transfer rate calculator
*-----1-----1-----1-----1-----1-----
* heat added to pcs from core
*-----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 htnr 230000301
*-----1-----1-----1-----1-----1-----
* heat removed from pcs at to s/g tubes
*-----1-----1-----1-----1-----1-----
20511200 sghttr sum 1.0 0.0 1
20511201 0.0 14.2746667 htnr 006000100
20511202 14.2746667 htnr 006000200
20511203 14.2746667 htnr 006000300
20511204 22.412 htnr 006000400
20511205 22.412 htnr 006000500
20511206 44.824 htnr 006000600
20511207 44.824 htnr 006000700
20511208 22.412 htnr 006000800
20511209 22.412 htnr 006000900
20511210 14.2746667 htnr 006001000
20511211 14.2746667 htnr 006001100
20511212 14.2746667 htnr 006001200
*-----1-----1-----1-----1-----1-----
* heat loss from reactor vessel
*-----1-----1-----1-----1-----1-----
20511300 rvheat sum 1.0 0.0 1
20511301 0.0 2.3244 htnr 211000101
20511302 5.25183 htnr 211000201
20511303 3.56335 htnr 211000301
20511304 1.59598 htnr 212000101
20511305 4.96411 htnr 212000201
20511306 4.96411 htnr 212000301
20511307 1.86543 htnr 212000401
20511308 1.91724 htnr 212000501
20511309 1.68000 htnr 220000101
20511310 0.71200 htnr 255000101
*-----1-----1-----1-----1-----1-----
* heat loss from pzz
*-----1-----1-----1-----1-----1-----
20511400 pzzheat sum 1.0 0.0 1
20511401 0.0 0.362 htnr 415100101
20511402 0.702464 htnr 415200101
20511403 1.26381 htnr 415200201
20511404 1.26381 htnr 415200301
20511405 0.649152 htnr 415200401
20511406 0.649152 htnr 415200501
20511407 0.534688 htnr 415200601
20511408 0.534688 htnr 415200701
20511409 0.273063 htnr 416200101
20511410 0.130000 htnr 420100101
20511411 0.273063 htnr 420200101
*-----1-----1-----1-----1-----1-----
* heat loss from s/g
*-----1-----1-----1-----1-----1-----
20511500 sgheat sum 1.0 0.0 1
20511501 0.0 3.5343 htnr 530000101
20511502 3.5343 htnr 530000201
20511503 3.33022 htnr 530000301
20511504 3.33022 htnr 530000401
20511505 2.40258 htnr 530000501
20511506 3.29404 htnr 530000601
20511507 3.29404 htnr 530000701
20511508 3.29404 htnr 530000801
*-----1-----1-----1-----1-----1-----
* total heat loss from major components
*-----1-----1-----1-----1-----1-----
20511600 toheat sum 1.0 0.0 1
20511601 0.0 1.0 cntrivar 113
20511602 1.0 cntrivar 114
20511603 1.0 cntrivar 115
*-----1-----1-----1-----1-----1-----
* heat loss from broken loop hot leg
*-----1-----1-----1-----1-----1-----
20511700 blhlheat sum 1.0 0.0 1
20511701 0.0 0.97972 htnr 300000101
20511702 0.78065 htnr 300000201
20511703 1.59260 htnr 300000301

```

```

*-----1-----1-----1-----1-----1-----
* heat loss from broken loop cold leg
*-----1-----1-----1-----1-----1-----
20511800 blclheat sum 1.0 0.0 1
20511801 0.0 0.83825 htnr 335000101
20511802 0.78065 htnr 335000201
20511803 1.0893 htnr 335000301
*-----1-----1-----1-----1-----1-----
* heat loss from rabs piping
*-----1-----1-----1-----1-----1-----
20511900 rabheat sum 1.0 0.0 1
20511901 0.0 1.7153 htnr 370000101
20511902 0.94828 htnr 370000201
20511903 0.94497 htnr 370000301
20511904 2.6090 htnr 370000401
*-----1-----1-----1-----1-----1-----
* heat loss from intact loop hot leg
*-----1-----1-----1-----1-----1-----
20512000 ilhlheat sum 1.0 0.0 1
20512001 0.0 1.7193 htnr 100100101
20512002 1.8275 htnr 100100201
20512003 0.69677 htnr 100100301
20512004 1.6088 htnr 100100401
20512005 0.90304 htnr 100200101
20512006 1.8855 htnr 100400101
*-----1-----1-----1-----1-----1-----
* heat loss from intact loop cold leg
*-----1-----1-----1-----1-----1-----
20512100 ilclheat sum 1.0 0.0 1
20512101 0.0 0.77058 htnr 100100501
20512102 0.62519 htnr 100100601
20512103 0.84999 htnr 100100701
20512104 0.55540 htnr 100100801
20512105 0.62519 htnr 100100901
20512106 0.68558 htnr 100101001
20512107 0.78400 htnr 100101101
20512108 1.6340 htnr 100101201
20512109 0.69769 htnr 100200201
20512110 0.85765 htnr 100300101
20512111 0.39195 htnr 100300201
20512112 0.43054 htnr 100300301
20512113 1.2079 htnr 100300401
20512114 0.86023 htnr 100300501
20512115 0.39195 htnr 100300601
20512116 0.44083 htnr 100300701
20512117 1.8855 htnr 100400201
*-----1-----1-----1-----1-----1-----
* total heat loss to environment
*-----1-----1-----1-----1-----1-----
20512200 sumhtls sum 1.0 0.0 1
20512201 0.0 1.0 cntrivar 116
20512202 1.0 cntrivar 117
20512203 1.0 cntrivar 118
20512204 1.0 cntrivar 119
20512205 1.0 cntrivar 120
20512206 1.0 cntrivar 121
*-----1-----1-----1-----1-----1-----
* metal heating in pzz
*-----1-----1-----1-----1-----1-----
20512300 pzzmht sum 1.0 0.0 1
20512301 0.0 0.3620 htnr 415100100
20512302 0.59522 htnr 415200100
20512303 1.07086 htnr 415200200
20512304 1.07086 htnr 415200300
20512305 0.550045 htnr 415200400
20512306 0.550045 htnr 415200500
20512307 0.453056 htnr 415200600
20512308 0.453056 htnr 415200700
20512309 0.150656 htnr 416200100
20512310 0.13000 htnr 420100100
20512311 0.150656 htnr 420200100
*-----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
```

* metal heating in broken loop (1st part)

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

```
20512600 bk1pmht 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 bk1pmt 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 ihlmht 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 iklmht 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 blhsim sum 1.0 0.0 1
20513001 0.0 0.1312 htmr 315000100
20513002 0.1703 htmr 315000200
20513003 0.0042 htmr 315100100
20513004 0.00347 htmr 315200100
20513005 0.12452 htmr 315300100
20513006 0.12452 htmr 315300200
20513007 0.12452 htmr 315300300
20513008 0.12452 htmr 315300400
20513009 0.12452 htmr 315300500
20513010 0.12452 htmr 315300600
20513011 0.04239 htmr 315400100
20513012 0.04363 htmr 315500100
```

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

* metal heating in steam generator

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

```
20555100 sgmth1 sum 1.0 0.0 1
20555101 0.0 1.47943 htmr 500000100
20555102 1.47943 htmr 500000200
20555103 0.291097 htmr 500000300
20555104 1.52566 htmr 500000101
20555105 1.52566 htmr 500000201
20555106 0.300194 htmr 500000301
20555107 0.615526 htmr 515000100
20555108 2.88042 htmr 515000200
20555109 1.44021 htmr 515000300
20555110 1.44021 htmr 515000400
20555111 0.96014 htmr 515000500
20555112 0.96014 htmr 515000600
20555113 0.96014 htmr 515000700
20555114 0.627655 htmr 515000101
20555115 2.93718 htmr 515000201
20555116 1.46859 htmr 515000301
20555117 1.46859 htmr 515000401
20555118 0.994572667 htmr 515000501
```

20555119 0.994572667 htmr 515000601
20555120 0.994572667 htmr 515000701

20555200 sgmth2 sum 1.0 0.0 1
20555201 0.0 3.40507 htmr 530000100
20555202 3.40507 htmr 530000200
20555203 3.20846 htmr 530000300
20555204 3.30846 htmr 530000400
20555205 2.31474 htmr 530000500
20555206 3.17360 htmr 530000600
20555207 3.17360 htmr 530000700
20555208 3.17360 htmr 530000800

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

* pcs-tubesheet heat transfer

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

20513200 pcstb 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---1---1---

* tubesheet-scs heat transfer

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

* metal hx in rabs

* ---1---1---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 qbhtotal sum 1.0 0.0 1
20517101 0.0 1.0 cntrivar 127
20517102 1.0 cntrivar 170
20517103 1.0 cntrivar 130 * only for simula

* pcs stored energy excluding pressurizer

20557000 pcsqre sum 1.0 0.0 1
20557001 0.0 1.0 cntrivar 253 * rv metal heat
20557002 1.0 cntrivar 113 * rv ambloss
20557003 1.0 cntrivar 171 * only for simula
20557004 1.0 cntrivar 117 * bihi ambloss
20557005 1.0 cntrivar 118 * bick ambloss
20557006 1.0 cntrivar 119 * rabv ambloss
20557007 1.0 cntrivar 128 * iihl heat
20557008 1.0 cntrivar 120 * iihl ambloss
20557009 1.0 cntrivar 129 * ikcl heat
20557010 1.0 cntrivar 121 * ikcl ambloss
20557011 1.0 cntrivar 132 * pcs-tubesheet
20557012 1.0 cntrivar 133 * tubesheet-scs

* scs stored energy

20557300 scsqse sum 1.0 0.0 1
20557301 0.0 1.0 cntrivar 552 * sg heat
20557302 1.0 cntrivar 115 * sg ambloss

* heat flow calculations

* ecc energy flow

20515300 pvecc div 1.0 0.0 1
20515301 rhoj 630000000 p 600010000
20515400 hecc sum 1.0 0.0 1

*20515401 0.0 1.0 ufj 630000000
*20515402 1.0 cntrivar 153

*20515500 mdothecc mult 1.0 0.0 1
*20515501 mflowj 630000000
*20515502 cntrivar 154

*20515600 qecc/v mult 0.126646 0.0 1
*20515601 cntrivar 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 cntrivar 112

* core hx per unit pcs volume

20516100 qcove/v mult 0.126646 0.0 1
20516101 cntrivar 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 cntrivar 162
20516602 1.0 cntrivar 163
20516603 1.0 cntrivar 164
20516604 1.0 cntrivar 165
20516700 qpmp/v mult 0.126646 0.0 1
20516701 cntrivar 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 cntrivar 253

* total vessel hx/v

20562100 rvhx/v mult 1.0 0.0 1
20562101 cntrivar 620


```

20533004 1.16955-1 voidf 415040000
20533005 1.16955-1 voidf 415050000
20533006 7.94530-2 voidf 415060000
20533007 7.94530-2 voidf 415070000
20533008 1.53400-2 voidf 415080000
20533009 0.01534 voidf 420010000

```

* Pressurizer Vapor Volume

```

20534000 pzriqv sum 1.0 0.0 1
20534001 0.0 8.10880-2 voidg 415010000
20534002 2.27695-1 voidg 415020000
20534003 2.27695-1 voidg 415030000
20534004 1.16955-1 voidg 415040000
20534005 1.16955-1 voidg 415050000
20534006 7.94530-2 voidg 415060000
20534007 7.94530-2 voidg 415070000
20534008 1.53400-2 voidg 415080000
20534009 0.01534 voidg 420010000

```

* Steady State Controllers

```

* primary coolant pump speed controllers
* calculate mass flow error
20590100 msserr sum 1.0 0.0 1
20590101 467.6 -1.0 mflowj 100010000
* pump 1 speed
20590200 pcp1spd integral 0.34482 333.7236 1
20590201 cntrlvar 901
* pcp1 pump velocity table
1356100 508 cntrlvar 902
1356101 0.0 0.0
1356102 369.0 369.0
* modify pcp1 pump data
1350301 0 0 0 -1 0 504 0
* pump 2 speed
20590300 pcp2spd integral 0.34482 331.9524 1
20590301 cntrlvar 901
* pcp2 pump velocity table
1656100 508 cntrlvar 903
1656101 0.0 0.0
1656102 369.0 369.0
* modify pcp2 pump data
1650301 135 135 135 -1 0 504 0
* pressurizer spray valve controller
* spray valve
4070000 sprlv valve
4070101 406010000 420010000 3.3451e-4 0.0 0.0 000100 0.93
4070201 0 .00000000 .00000000 0.0

```

4070300 srvlv

```

4070301 904 999
* spray valve position calculator
20590400 spray sum -0.0001 0.0 1 *contin
+ 3 0.0 1.0
20590401 14.98e+6 -1.0 p 420010000
* position vs area table
20299900 normarea
20299901 0.0 0.0
20299902 0.1 0.0
20299903 1.0 1.0
* pressurizer level control using charging and letdown components
* charging reservoir
98000000 chrg tmdpvol
9800101 1.0 1.0 0.0 0.0 0.0 0.0
9800102 4.0-5 0.0 00000
9800200 3
9800201 0.0 2.07+07 558.9
* charging valve
98500000 chrg valve
9850101 980000000 185000000 3.8e-05 0.0 0.0 000100
9850201 0 .00000000 .00000000 0.0
9850300 srvlv
9850301 905 999
* charging valve position calculator
20590500 charge sum 7.7 0.0 1 *contin
+ 3 0.0 1.0
20590501 1.0 -1.0 cntrlvar 2
* letdown sink
99000000 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
* letdown valve
99500000 ltdwn valve
9950101 185000000 990000000 2.5-5 0.0 0.0 000100
9950201 0 .00000000 .00000000 0.0
9950300 srvlv
9950301 906 999
* letdown valve position calculator
20590600 letdown sum -7.7 0.0 1 *contin
+ 3 0.0 1.0
20590601 1.03 -1.0 cntrlvar 2
* steam valve controller
* changes to steam valve
*5500201 0 18.585 20.163 0.0
*5500300 srvlv
*5500301 910 540

```

```

* srv 550 valve area table
*-----1-----1-----1-----1-----1-----1-----
20254000 normarea
20254001 0.0 0.0
20254002 0.0001 0.0
20254003 0.9 0.6 * modi at 8/26 in base
20254004 1.0 0.6
*-----1-----1-----1-----1-----1-----1-----
* GT 908
*-----1-----1-----1-----1-----1-----1-----
20290800 reac-t
20290801 -100. -100.
20290802 -0.25 -0.25
20290803 -0.25 0.0
20290804 0.25 0.0
20290805 0.25 0.25
20290806 100. 100.
*-----1-----1-----1-----1-----1-----1-----
* compute delta t error
*-----1-----1-----1-----1-----1-----1-----
20590700 delta sum 1.0 0.0 1
20590701 557.0 -1. tempf 185010000
*-----1-----1-----1-----1-----1-----1-----
* filter delta t thru deadband
*-----1-----1-----1-----1-----1-----1-----
20590800 deadband function 1.0 0.0 1
20590801 cntrivar 907 908
*-----1-----1-----1-----1-----1-----1-----
* integrate delta t error
*-----1-----1-----1-----1-----1-----1-----
20590900 int integral 1.0 0.0 1
20590901 cntrivar 908
*-----1-----1-----1-----1-----1-----1-----
* steam valve position calculator
*-----1-----1-----1-----1-----1-----1-----
20591000 tcontrol sum 1.0 0.645229 0 *conti
+ 3 0.6 0.90
20591001 0.645229 -0.07126 cntrivar 908
20591002 -0.01492 cntrivar 909
*-----1-----1-----1-----1-----1-----1-----
* simplified feed system controller
*-----1-----1-----1-----1-----1-----1-----
20591100 sgivterr sum 1.0 0.0 1
20591101 3.15 -1.0 cntrivar 001
*-----1-----1-----1-----1-----1-----1-----
20591200 feedflow sum 1.0 0.0 1
20591201 0.0 1.0 mflowj 550000000
20591202 48.4 cntrivar 911
*-----1-----1-----1-----1-----1-----1-----
* junction quantities
*-----1-----1-----1-----1-----1-----1-----
20800001 flenth 425000000
20800002 flenth 430000000
*-----1-----1-----1-----1-----1-----1-----
* replace feed junction table
*-----1-----1-----1-----1-----1-----1-----
5600200 1 0 cntrivar 912
5600201 -100.0 25.553 0.0 0.0
5600202 -1.0 0.0 0.0 0.0
5600203 0.0 0.0 0.0 0.0
5600204 50.0 50.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* boundary volume intact loop hot leg
*-----1-----1-----1-----1-----1-----1-----
5920000 bvolum tmdpvol
5920101 0.0 1.0 0.1 0.0 0.0 0.0
5920102 0.0 0.0 00000
5920200 2
5920201 0.0 5.47091e6 1 0
*-----1-----1-----1-----1-----1-----1-----
* boundary valve for steam generator
*-----1-----1-----1-----1-----1-----1-----

```

```

5930000 bvalv sngljun
5930101 530020002 592000000 0.001 0.0 0.0 000100
5930201 0 0.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* boundary valve intact loop hot leg
*-----1-----1-----1-----1-----1-----1-----
9000000 bvalv sngljun
9000101 420010000 905000000 0.00001 0.0 0.0 000100
9000201 0 0.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* boundary volume intact loop hot leg
*-----1-----1-----1-----1-----1-----1-----
9050000 bvolum tmdpvol
9050101 0.0 1.0 1.0 0.0 0.0 0.0
9050102 0.0 0.0 00000
9050200 2
9050201 0.0 14.98e6 1.0
*

```

Appendix B. Input Deck for Transient Calculation of Base Case

=loft L9-3 ATWS experiment assessment calculation deck

*-----1-----1-----1-----1-----1-----1-----
 * initial conditions

* core power = 48.7 MW
 * pcs flow = 467.6 kg/s
 * Pzr pressure = 14.98 MPa
 * thot = 576.4 k
 * tcold = 557.0 k

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

* use reactor kinetics feedback
 * change mscv area to 0.0052235 from 0.00337

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

0000100 restart transnt
 0000101 run
 0000102 si
 0000105 5. 10.
 0000103 2241 rst

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

* time step control cards

* end time min dt max dt optn mnr mjr rst
 0000201 600.0 1.e-4 0.1 2 5 1000 1000

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

* minor edit variables

* pressure

0000308 cntrlvar 51 * pe-pc-2
 0000309 cntrlvar 50 * porv inlet
 0000314 cntrlvar 53 * pt-p4-10a

* temperatures

0000322 tempf 100010000 * te-pc-2a,2b,2c
 0000323 tempf 185010000 * te-pc-1
 0000326 tempf 505010000 * sg liq. temp.
 0000330 tempf 415030000 * pzr liq. te,p
 0000331 tempf 300010000 * broken loop hot leg
 0000332 tempf 335010000 * broken loop cold leg

* mass flow rates

0000360 mflowj 100010000 * ihl nozzle
 0000363 mflowj 400010000 * pres. surge line flow
 0000364 mflowj 407000000 * pzr spray flow
 0000367 mflowj 550000000 * steam flow control valve
 0000369 mflowj 560000000 * main feed
 0000360 mflowj 546000000 * sg bypass flow

* water level

0000370 cntrlvar 1 * s/g level
 0000375 cntrlvar 2 * pzr level

* power

*0000376 cntrlvar 701 * moderator density
 *0000377 cntrlvar 702 * doppler temp.
 0000378 cntrlvar 54 * power
 0000379 rkreact 0 * reactivity

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

* delete steady state component

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

20590100 msserr delete
 20590200 pcp1spd delete
 20590300 pcp2spd delete
 20590400 spray delete
 98000000 chrg delete
 98500000 chrg delete
 20590500 charge delete
 99000000 ltdwn delete
 99500000 ltdwn delete
 20590600 letdown delete
 20590700 delta delete
 20590800 deadband delete
 20590900 int delete
 20591000 int delete
 20591100 sgvlerr delete
 20591200 feedflow delete
 58300000 bvalv delete
 59200000 bvolum delete
 90000000 bvalv delete
 90500000 bvolum delete

* trips

* variable trips

0000504 time 0 lt null 0 0.0 I
 0000508 time 0 ge null 0 0.0 I
 0000509 tempf 100010000 ge null 0 597.0 I

* logical trips

0000609 504 or 504 I

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

* Loss of Feedwater : 501

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

0000501 time 0 ge null 0 0.0 I

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

* experimental power curve turn on

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

0000530 time 0 ge null 0 0.0 I

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

* Reactor Trip : 529, 609

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

0000529 time 0 ge null 0 10000.0 I

0000609 529 or 529 I

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

* primary coolant pump running on : 519

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

0000519 time 0 lt null 0 0.0 I

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

* Pressurizer Spray Cycling : 690

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

0000551 time 0 ge timeof 626 0.0 I

0000574 p 420010000 gt null 0 1.532e7 n

0000575 p 420010000 lt null 0 1.498e7 n

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

* changed close setpoint from 15.16 MPa

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

0000688 690 or 574 n

0000689 -575 and -575 n

0000690 688 and 689 n

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

```

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

```

```

1350000 pcpump1 pump
1350101 0.0366 0.0 0.099 0.0 90.0 0.319
1350102 00000
1350108 130010000 0.0 0.0 0.0 000100
1350109 140000000 0.0 0.05 0.05 000100
1350200 0 1.48950e+07 0.12394e+07 0.24622e+07 0.0
1350201 0 8.6588 8.6589 0.0
1350202 0 8.6575 8.6575 0.0
1350301 0 0 0 -1 -1 519 0
1350302 369.00000 0.87485 31550000 96.0 500.60000 1.431
1350303 613.6 0.0 207.0000 0.0040000 19.598000 0.0
1350310 0.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* single phase head curves
*-----1-----1-----1-----1-----1-----1-----
* 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

* head curve no. 7

1351700 1 7
 1351701 -1.000000e+00 -1.000000e+00
 1351702 -8.000000e-01 -6.300000e-01
 1351703 -6.000000e-01 -3.000000e-01
 1351704 -4.000000e-01 -5.000000e-02
 1351705 -2.000000e-01 1.500000e-01
 1351706 0.000000e+00 2.500000e-01

* head curve no. 8

1351800 1 8
 1351801 -1.000000e+00 -1.000000e+00
 1351802 -8.000000e-01 -9.700000e-01
 1351803 -6.000000e-01 -9.500000e-01
 1351804 -4.000000e-01 -8.800000e-01
 1351805 -2.000000e-01 -8.000000e-01
 1351806 0.000000e+00 -6.700000e-01

* single phase torque data

* torque curve no. 1

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

* torque curve no. 2

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

* torque curve no. 3

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

* torque curve no. 4

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

* torque curve no. 5

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

* torque curve no. 6

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

* torque curve no. 7

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

* torque curve no. 8

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

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

* torque curve

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 5.952000e-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 7.372500e-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
*-----1-----1-----1-----1-----1-----1-----
* primary coolant pump 2
*-----1-----1-----1-----1-----1-----1-----
1650000 pcump2 pump
1650101 0.0366 0.0 0.099 0.0 90.0 0.319
1650102 00000
1650108 160010000 0.0 0.0 0.0 000100
1650109 170000000 0.0 0.1 0.1 000100
1650200 0 1.49088e+07 0.12394e+07 0.24619e+07 0.0
1650201 0 8.2731 8.2732 0.0
1650202 0 8.2717 8.2717 0.0
1650301 135 135 135 -1 -1 519 0
1650302 369.00000 0.87005 .31550000 96.000000 500.60000 1.431
1650303 613.6 0.0 207.433 0.004 19.5980 0.0
1650310 0.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* spray valve
*-----1-----1-----1-----1-----1-----1-----
4070000 sprlv valve
*4070101 406010000 420010000 3.3451e-4 15.432 15.432 000100
4070101 406010000 420010000 3.3451e-4 0.0 0.0 000100
4070201 0 .000000 .000000 0.0
4070300 trpvlv
4070301 690
*-----1-----1-----1-----1-----1-----1-----
* porv
*-----1-----1-----1-----1-----1-----1-----
4250000 porv valve
4250101 420010000 810000000 2.4784e-5 0.0 0.0 000100
4250201 0 .000000 .000000 0.0
4250300 trpvlv
4250301 626
*-----1-----1-----1-----1-----1-----1-----
* experimental SRV
*-----1-----1-----1-----1-----1-----1-----
4300000 porv valve
4300101 420010000 820000000 6.24e-5 0.0 0.0 000100
4300201 0 .000000 .000000 0.0
4300300 trpvlv
4300301 634
*-----1-----1-----1-----1-----1-----1-----

```

```

* steam control valve bypass
*-----1-----1-----1-----1-----1-----1-----
5460000 scvbyp valve
5460101 530010000 547000000 4.8e-4 0.0 0.0 000100
5460201 0 0.0 0.0 0.0
5460300 trpvlv
5460301 644
*-----1-----1-----1-----1-----1-----1-----
* steam flow control valve
*-----1-----1-----1-----1-----1-----1-----
5500000 cv-p4-1 valve
5500101 530010000 535000000 0.0052235 0.0 0.0 000100
5500201 0 18.039 19.452 0.0
5500300 mtrvlv
5500301 612 616 0.05 0.6 550
*-----1-----1-----1-----1-----1-----1-----
* main feed water valve
*-----1-----1-----1-----1-----1-----1-----
5600000 mnfeed tmdpjun
5600101 545000000 510000000 0.05
5600200 0 501
5600201 0.0 0.67642 0.67642 0.0
5600202 5.0 0.0 0.0 0.0
*-----1-----1-----1-----1-----1-----1-----
* reactor kinetics data
*-----1-----1-----1-----1-----1-----1-----
30000000 point
30000001 gamma-ac 48.7e+6 0.0 348.43 1.0 0.556
30000002 ans79-1
*-----should not be changed for transient-----
*-----1-----1-----1-----1-----1-----1-----
* delayed neutron constants
*-----1-----1-----1-----1-----1-----1-----
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
*-----1-----1-----1-----1-----1-----1-----
* power history
*-----1-----1-----1-----1-----1-----1-----
30000401 4.87e+7 70. hr
*-----1-----1-----1-----1-----1-----1-----
* reactivity curve numbers
*-----1-----1-----1-----1-----1-----1-----
30000011 609
*-----1-----1-----1-----1-----1-----1-----
* moderator density reactivity table (slope change)
*-----1-----1-----1-----1-----1-----1-----
*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
*-----1-----1-----1-----1-----1-----1-----
30000501 0.62626e+3 -5.7396
30000502 0.66396e+3 -4.2208
30000503 0.71617e+3 -2.0118
30000504 0.76112e+3 -0.1692
30000505 0.76837e+3 0.04615
30000506 0.79157e+3 0.6923

```


30000507 0.81188e+3 1.2398
 30000508 0.86263e+3 2.2415
 30000509 0.93804e+3 3.9231
 30000510 0.99749e+3 5.1077

* doppler reactivity table

30000601 293.16 1.375
 30000602 338.72 1.125
 30000603 422.05 0.682
 30000604 477.60 0.419
 30000605 505.38 0.274
 30000606 570.72 0.000
 30000607 588.72 -0.075
 30000608 695.83 -0.526
 30000609 922.05 -1.386
 30000610 1310.94 -2.543
 30000611 1810.94 -3.865
 30000612 2088.72 -4.502
 30000613 2499.83 -5.392
 30000614 3027.60 -6.417

* volume weighting factors

* moderator temperature feedback

30000701 230010000 0 0.31493 0.0
 30000702 230020000 0 0.31493 0.0
 30000703 230030000 0 0.37014 0.0

* doppler feedback

30000801 2300001 0 0.43153 0.0
 30000802 2300002 0 0.51686 0.0
 30000803 2300003 0 0.05161 0.0

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

* scram reactivity data

* ---1---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

* --- mtc curve monitor ---

20593100 mtcmon1 function 1.0 0. 0
 20593101 rho 230010000 933
 20593200 mtcmon2 function 1.0 0. 0
 20593201 rho 230020000 933
 20593300 mtcmon3 function 1.0 0. 0
 20593301 rho 230030000 933
 20593400 mtcmon sum 1.0 0. 0
 20593401 0.0 0.31493 cntrlvar 931
 20593402 0.31493 cntrlvar 932
 20593403 0.37014 cntrlvar 933

20293300 reac-t
 20293301 0.62626e+3 -5.7396
 20293302 0.66396e+3 -4.2208
 20293303 0.71617e+3 -2.0118
 20293304 0.76112e+3 -0.1692
 20293305 0.76837e+3 0.04615
 20293306 0.79157e+3 0.6923
 20293307 0.81188e+3 1.2398
 20293308 0.86263e+3 2.2415
 20293309 0.93804e+3 3.9231
 20293310 0.99749e+3 5.1077

* --- dtc curve monitor ---

20597100 dtcmon1 function 1.0 0. 0
 20597101 htvat 2300001 973
 20597200 dtcmon2 function 1.0 0. 0
 20597201 htvat 2300002 973
 20597300 dtcmon3 function 1.0 0. 0
 20597301 htvat 2300003 973

20597400 dtcmon sum 1.0 0. 0
 20597401 0.0 0.43153 cntrlvar 971
 20597402 0.51686 cntrlvar 972
 20597403 0.05161 cntrlvar 973

20297300 reac-t
 20297301 293.16 1.375
 20297302 338.72 1.125
 20297303 422.05 0.682
 20297304 477.60 0.419
 20297305 505.38 0.274
 20297306 570.72 0.000
 20297307 588.72 -0.075
 20297308 695.83 -0.526
 20297309 922.05 -1.386
 20297310 1310.94 -2.543
 20297311 1810.94 -3.865
 20297312 2088.72 -4.502
 20297313 2499.83 -5.392
 20297314 3027.60 -6.417

* power from experimental data

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

20270000 power 530
 20270001 1.08400000e+00 4.878200307e+07
 20270002 3.48400000e+00 4.886505087e+07
 20270003 4.68400000e+00 4.890413219e+07
 20270004 7.08400000e+00 4.895786901e+07
 20270005 9.48400000e+00 4.909465363e+07
 20270006 1.18840000e+01 4.874292175e+07
 20270007 1.42840000e+01 4.845469701e+07
 20270008 1.66840000e+01 4.843515635e+07
 20270009 1.90840000e+01 4.822020909e+07
 20270010 2.14840000e+01 4.790755853e+07
 20270011 2.38840000e+01 4.788313271e+07
 20270012 2.62840000e+01 4.768772610e+07
 20270013 2.86840000e+01 4.751186016e+07
 20270014 3.10840000e+01 4.708685081e+07
 20270015 3.34840000e+01 4.712104696e+07
 20270016 3.58840000e+01 4.690609970e+07
 20270017 3.82840000e+01 4.695006619e+07
 20270018 4.06840000e+01 4.672534860e+07
 20270019 4.30840000e+01 4.704288432e+07
 20270020 4.54840000e+01 4.659344914e+07
 20270021 4.78840000e+01 4.664230079e+07
 20270022 5.02840000e+01 4.659344914e+07
 20270023 5.26840000e+01 4.620263594e+07
 20270024 5.50840000e+01 4.571900460e+07

20270025 5.74840000e+01 4.442932104e+07
 20270026 5.98840000e+01 4.379913475e+07
 20270027 6.22840000e+01 4.278790559e+07
 20270028 6.46840000e+01 4.149822202e+07
 20270029 6.70840000e+01 4.057004067e+07
 20270030 6.94840000e+01 3.890908456e+07
 20270031 7.18840000e+01 3.757054935e+07
 20270032 7.42840000e+01 3.564090916e+07
 20270033 7.66840000e+01 3.282216895e+07
 20270034 7.90840000e+01 3.039424193e+07
 20270035 8.14840000e+01 2.798097041e+07
 20270036 8.38840000e+01 2.556281373e+07
 20270037 8.62840000e+01 2.344265211e+07
 20270038 8.86840000e+01 2.193313611e+07
 20270039 9.10840000e+01 2.060437123e+07
 20270040 9.34840000e+01 1.918278821e+07
 20270041 9.58840000e+01 1.834742499e+07
 20270042 9.82840000e+01 1.717498538e+07
 20270043 1.00684000e+02 1.594880896e+07
 20270044 1.03084000e+02 1.494735014e+07
 20270045 1.05484000e+02 1.385795834e+07
 20270046 1.07884000e+02 1.279299236e+07
 20270047 1.10284000e+02 1.198694013e+07
 20270048 1.12684000e+02 1.132255769e+07
 20270049 1.15084000e+02 1.072168239e+07
 20270050 1.17484000e+02 1.011103676e+07
 20270051 1.19884000e+02 9.471080147e+06
 20270052 1.22284000e+02 8.943482324e+06
 20270053 1.24684000e+02 8.489161978e+06
 20270054 1.27084000e+02 8.059267456e+06
 20270055 1.29484000e+02 7.595176779e+06
 20270056 1.31884000e+02 7.277641052e+06
 20270057 1.34284000e+02 6.906368511e+06
 20270058 1.36684000e+02 6.554636629e+06
 20270059 1.39084000e+02 6.305493213e+06
 20270060 1.41484000e+02 6.046579467e+06
 20270061 1.43884000e+02 5.699732751e+06
 20270062 1.46284000e+02 5.470129995e+06
 20270063 1.48684000e+02 5.318689879e+06
 20270064 1.51084000e+02 5.030465143e+06
 20270065 1.53484000e+02 4.810632717e+06
 20270066 1.55884000e+02 4.629881611e+06
 20270067 1.58284000e+02 4.405164020e+06
 20270068 1.60684000e+02 4.214642584e+06
 20270069 1.63084000e+02 4.014350818e+06
 20270070 1.65484000e+02 3.901992023e+06
 20270071 1.67884000e+02 3.716355752e+06
 20270072 1.70284000e+02 3.589341462e+06
 20270073 1.73884000e+02 3.349968376e+06
 20270074 1.75084000e+02 3.276690900e+06
 20270075 1.77484000e+02 3.095939795e+06
 20270076 1.79884000e+02 3.086169465e+06
 20270077 1.81084000e+02 3.017777154e+06
 20270078 1.83484000e+02 2.807715058e+06
 20270079 1.85884000e+02 2.695356263e+06
 20270080 1.87084000e+02 2.656274943e+06
 20270081 1.89484000e+02 2.568341972e+06
 20270082 1.91884000e+02 2.495064497e+06
 20270083 1.94284000e+02 2.382705702e+06
 20270084 1.95484000e+02 2.328968886e+06
 20270085 1.96684000e+02 2.299657896e+06
 20270086 1.97884000e+02 2.260576576e+06
 20270087 1.99084000e+02 2.211724926e+06
 20270088 2.00284000e+02 2.182413936e+06

* reactor power in MWt

20505400 reacpor sum 1.0e-06 0.0 1

20505401 0.0 1.0 rktpow 0

* end of input

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev.,
and Addendum Numbers, if any.)

NUREG/IA-0192

2. TITLE AND SUBTITLE

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

3. DATE REPORT PUBLISHED

MONTH	YEAR
January	2001

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

J.K. Suh, Y.S. Bang, H.J. Kim

6. TYPE OF REPORT

Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Korea Institute of Nuclear Safety
19 Kusung-Dong, Yusong-Gu
Taejeon, KOREA, 305-338

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)

Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

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

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

RELAP5/MOD3.2.2 Gamma
ATWS
LOFT

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)

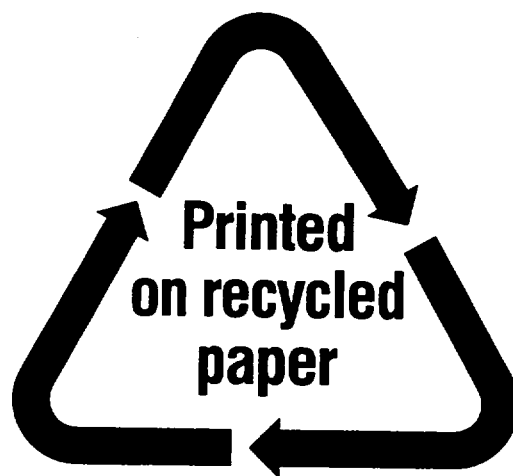
unclassified

(This Report)

unclassified

15. NUMBER OF PAGES

16. PRICE



Federal Recycling Program

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300