NUREG/IA-0030

International Agreement Report

Assessment of RELAP5/MOD2 Code Using Loss of Offsite Power Transient Data of KNU #1 Plant

Prepared by
Bud-Dong Chung, Hho-Jung Kim
Nuclear Safety Center
Korea Advanced Energy Research Institute

Young-Jin Lee
Department of Nuclear Engineering
Seoul National University

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

April 1990

Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Thermal-Hydraulic Code Assessment
and Application Program (ICAP)

Published by
U.S. Nuclear Regulatory Commission

Available from

Superintendent of Documents
U.S. Government Printing Office
P.O. Box 37082
Washington, D.C. 20013-7082

and

National Technical Information Service
Springfield, VA 22161

NUREG/IA-0030

International Agreement Report

Assessment of RELAP5/MOD2 Code Using Loss of Offsite Power Transient Data of KNU #1 Plant

Prepared by
Bud-Dong Chung, Hho-Jung Kim
Nuclear Safety Center
Korea Advanced Energy Research Institute

Young-Jin Lee
Department of Nuclear Engineering
Seoul National University

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

April 1990

Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Thermal-Hydraulic Code Assessment
and Application Program (ICAP)

Published by
U.S. Nuclear Regulatory Commission

NOTICE

Acknowledgement

We would like to express our appreciations for the help of KNU #1 utility company (KEPCO) staffs in preparing the plant input deck. We especially appriciate to Dr Sang Hoon Lee, president of the Nuclear Safety Center, in organizing the project. This assessment work was sponsered by the Ministry of Science and Technology in Korea.

Abstract

This report presents a code assessment study based on a real plant transient that occurred on June 9, 1981 at the KNU #1 (Korea Nuclear Unit Number 1). KNU #1 is a two-loop Westinghouse PWR plant of 587 Mwe. The loss of offsite power transient occurred at the 77.5 % reactor power with 0.5 %/hr power ramp. The real plant data were collected from available on-line plant records and computer diagnostics.

The transient was simulated by RELAP5/MOD2/36.05 and the results were compared with the plant data to assess the code weaknesses and strengths. Some nodalization studies were performed to contribute to developing a guideline for PWR nodalization for the transient analysis.

Executive Summary

This report presents a code assessment study based on a real plant transient that has occurred on June 9, 1981 at the KNU #1 (Korea Nuclear Unit Number 1). KNU #1 is a two-loop Westinghouse PWR plant of 587 Mwe. The loss of offsite power transient occurred at the 77.5 % reactor power with 0.5 %/hr power ramp. The real plant data were collected from available on-line plant recording and computer diagnostics.

The transient was simulated by RELAP5/MOD2/36.05 and compared with the plant data to assess the code weakness and strengths. Some nodalization studies were performed to develop the guideline of PWR nodalization for the transient analysis.

It was found that the code gives stable steady-state results and accurate predictions of the plant behavior for the transient, indicating the excellent capability of the code for this type of transients. In particular, the calculated primary thermal behavior closely follows the plant data and this validates that the relevant thermal-hydraulic and decay power model using previous power history data in the RELAP5/MOD2 are correctly describing the actual phenomena.

In the nodalization sensitivity study it was found that S/G noding with junctions between bypass plenum and steam dome is preferred to simulate the S/G water level decreasing and avoid the spurious level peak at turbine trip.

The pressurizer pressure increase is sensitive to the insurge flow. It is believed that the interfacial heat transfer in a horizontal stratified flow regime may be estimated low and the compression effect due to insurge flow may be high.

Contents

List of Tables

List of Figures

1. Introduction

The plant transient following a loss of offsite power have a relatively high probability of occurrence and many studies were performed about the accident sequence initiated by loss of offsite power. We have experience of this event in 1981 at KNU # 1 PWR plant. The event was initiated by loss of feedwater in one of two steam generators. During the transient, the major plant data was recorded by on-line computer data logging system and by strip charts. Although the collected data is very limited according to the frequency of data processing during the accident, the plant data is very useful for code assessments because the scaling problem would be eliminated.

The loss of offsite power transient was simulated by RELAP5/MOD2/36.05. The main objectives of simulation are to check the code capability for such event and to give the guideline of PWR nodalization for transient analysis.

The plant characteristics and the event of transient are described in Section 2 and 3. The plant simulation model and nodalization are included in section 4. The base case results are discussed in section 5 and the nodalization studies are discussed in section 6. A run statics are included in section 7.

2. Plant Description

This section provides a description of the plant and principal system relevant to understanding KNU # 1 loss of offsite power transient. Kori Unit 1 is a Westinghouse 2-loop PWR rated at 587 Mwe and commissioned in 1978, for which BECTHEL was the architect/engineer [1].

2.1 Reactor Coolant System

A flow schematic of the reactor coolant system (RCS) is presented in Fig. 1. As shown in Figure 1 the RCS is equipped with 2 reactor coolant loops (A and B) composing each steam generator (PCSG1,PCSG2) and main coolant pump (2P1A,2P1B). A 144 inches active core consists of 121 fuel assembly with 179 fuel rods per assembly. The nominal core power is 1723.5 Mwt.

The reactor vessel has two inlet and outlet nozzles located in a horizontal plane just below the reactor flange but above the top of the core. Coolant enters the vessel through the inlet nozzles and flows down the core barrel-vessel wall annulus, turns at bottom and flows through the core to the outlet nozzles.

Two steam generators are vertical Westinghouse U-type Model 51. The reactor coolant flows through the inverted U-tubes, entering and leaving through the nozzle located in the hemispheric bottom head of the steam generators. Steam is generated on the shell side and flows upward through the moisture separators to the outlet nozzle at the top of the vessel.

The reactor coolant pumps are identical single-speed centrifugal units driven by air-cooled, three phase induction motors. The type of pump is the Westinghouse Model W93-A. A flywheel the inertia of which is 82,000 lb-ft^2 provides additional inertia to extend pump coast down. The reactor coolant loop piping is specified in sizes consistent with system requirements. The hot leg inside diameter is 29 inches and the the inside diameter of the cold leg return line to the reactor vessel is 27.5 inches. The piping between the steam generator and the pump suction is increased to 31 inches inside diameter to reduce the pressure drop and improve flow conditions to the pump suction.

The pressurizer is a vertical, cylindrical vessel with hemispheric top and bottom heads and it's total free volume is about 1000 ft^3. Electrical heaters the maximum capacity of which capacity is 1,000 Kw,was installed through the bottom head of the vessel while the spray nozzle, relief and safety valve connections are located in the top of the vessel.

2.2 Configuration of Secondary System

The auxiliary feedwater system consists of two separate sections to ensure delivery of auxiliary feedwater. One section has two electric motor-driven pumps and the other section a single steam turbine-driven pump. The motor-driven pumps start automatically upon receipt of two-out-of-three low-low water level signal in both steam generators. The design flow of one pump is 215 gpm. The turbine-driven pump will be operated upon the same logic of motor-driven pump, but only if one of the motor-driven pumps does not operate. The design flow is about 410 gpm.

The steam supply line to the auxiliary feedwater pump turbine are connected to the upstream of the main steam stop valves to provide a dependable steam supply.

The steam dump system enables the nuclear supply system to follow load changes which exceed 10 percent step or 5 percent per minute. The steam dump system is designed to have a flow capacity of 40 percent of the full load steam flow at full load steam pressure.

2.3. Plant Diagnostics and Uncertainty Bands

There are three type of digital recordings from plant computer; the computer daily logging sheet [2],pre-post trip review record [3] and sequence record of event [4]. Besides of these digital recording, there are analog strip chart recordings the speed of which is 2 cm/hr. The processing interval of daily logging system is 1 hour. The trip review record system keeps the data started from 2 minute before the reactor trip to 3 minute after reactor trip. The processing frequency of the

trip review record is 10 seconds during the above period.

It is believed that the short time behavior is more useful for the loss of offsite power transient. Therefore the available data for code assessment are pre-post trip review record and sequence of event record. Trip review record contains important thermal-hydraulics parameters measured in primary and secondary systems. The recorded parameter of primary system are the reactor neutronic power, loop averaged temperature, loop temperature difference, hot leg temperature, cold leg temperature, pressurizer pressure,pressurizer level, loop flowrate, and system pressure. The recorded secondary system parameters are steam flowrates, feedwater flowrates, steam pressure, narrow and wide range water level of steam generators, and feedwater temperatures.

The evaluation of measurement uncertainty is quite difficult because it contains the calibration error caused by the human error. But in the rough precision of engineering sense, the uncertainty band of temperature sensors is estimated as 2.22 deg-K and that of pressure sensors is estimated as 2.1 bars.

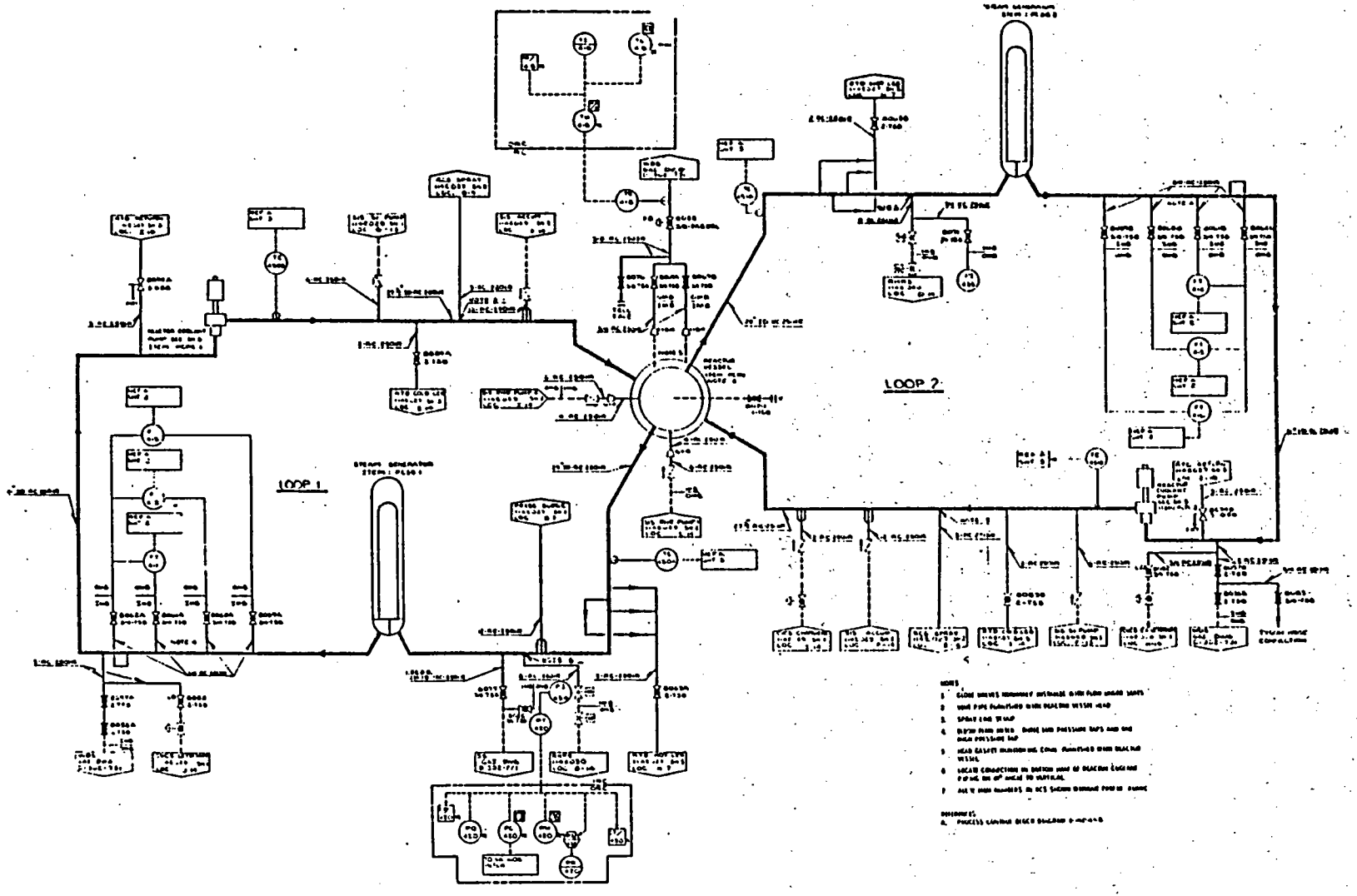


Fig.1 Schematic Diagram of Reactor Coolant System for KNU #1

3. Plant Transient Description

Plant transient sequence is based upon the sequence of events record from digital plant computer records. At around 11:00 AM on June 9, 1981, while operating at 77.5% reactor power and 447 MWe generator power, the I/I converter (LM-461A) of the S/G-A level control system mal-functioned generating a spurious signal that indicated high S/G-A water level. This signal activated the closure of the S/G-A main feedwater control valve(IFV-466) which subsequently caused the steam/water flow mismatch signal to be generated. The resulting S/G low level signal brought about the reactor/turbine trip at 11:05.20 AM. The turbine-generator continued to operate for 30 seconds, as designed, and then tripped at 11:05.50 AM. At the moment the generator trips, automatic transfer to the offsite power supply (154KV) should have occurred. However, both the automatic and the manual transfer of Bus-A failed, whereas Bus-B succeeded in automatic transfer to the offsite power initially but also failed after 31 seconds. Both buses were open at 11:06.21 AM.

Failure of Bus-A caused the RCP-A to trip at 11:05.55 AM immediately followed by the actuation of the diesel generator-A (D/G-A) which provides emergency power to safeguard Bus-A.The failure of Bus-B after the initial successful transfer caused a loss of offsite power transient for about 6 minutes from 11:06.21 AM. The failure of Bus-B caused the RCP-B to trip at 11:06.23 AM and the D/G-B to begin supplying power to safeguard Bus-B. After 6 minutes into the loss of offsite power transient, at 11:11.52 AM, Bus-B recovered the offsite power and subsequently the D/G-B was manually tripped. Despite the recovery of offsite power in Bus-B, the RCP-B continued to remain tripped until it was manually activated at 11:32 AM. Recovery of offsite power to Bus-A was achieved much later and the RCP-A was re-activated at 19:16.

In summary, from 11:06.23 to 11:32, both RCPs were not in operation causing a complete loss of reactor coolant flow accident for 26 minutes, and from 11:05.51 to 11:06.21 and also from 11:32 to 19:16, only one RCP was operating causing a partial loss of reactor coolant flow accident. Major sequence of events of the transient is summarized in Table 1.

Table 1. Sequence of Events for Plant Transient Simulation

Real Time (Hr.Min.Sec.)	Elapsed Time (sec)	Recorded Events	Remarks
-	0.0	-77.5% Power Operation (0.5% /hr increase)	Steady State Calculation
-	50.0	-Mal-function of I/I converter -S/G-A MFWCV start to close	Accident Starts
11.05.20.	100.0	-S/G-A Low Level & Flow mismatch cause Reactor/Tubine Trip	Simulation as input time
11.05.51.	131.0	-Unit on line Breaker 52/MT-345 Open	Loss of Onsite Power (345KV)
11.05.52.	132.0	-Safegard Bus-B operation	Transfer to Offsite Power (154KV)
11.05.55	135.0	-RCP #1 Trip Due to Tansfer Fail in Bus-A	Simulation as input time
11.05.57	137.0	-Safegard Bus-A Operation	Start of Station Blackout Sequence Loading
11.06.23	163.0	-RCP #2 Trip Due to Transfer Fail in Bus-B	Simulation as input time
-	300.0		Calculation Stop
11.11.52	392.0	-Restore the failure of Offsite Power Transfer	

4. Code and Input Model Description for Plant Simulation

The Code used was RELAP5/MOD2/CY36.05 and was processed on a CDC machine CYBER 170-875. The input deck was prepared by KAERI in cooperation with a utility company of KNU #1. The nodalization philosophy is based on the guideline of RELAP5 code manual [5] and the detailed data for specific volumes and junctions are based on the design or drawing values for KNU # 1.

The resulted nodalization is shown in Fig. 2. The nodalization divides the whole system into 114 volumes including 11 boundary volumes, 124 junctions and 79 heat slabs. Each steam generator is modeled with 8 heat slabs for U-tubes and 13 volumes including a steam separator. The outlets of both S/Gs are connected to form a single volume, 'steam head', which is then connected to two time-dependent volumes that act as the pressure boundary conditions for the steam generators.

The steady-state calculations were carried out to provide the initial conditions for the transient analyses. The transient was occurred at 77.5 % power condition. However plant conditions needed for starting a calculation are not known. Meanwhile the design values based on the full load condition are available. Thus it is necessary to calculate the steady state for the full power condition first, and next for the 77.5 % power condition by reducing the power from full load condition.

The simulated initial conditions along with the desired plant steady-state data for both power cases are summarized in Table 2 and Table 3. Generally the simulated values are in excellent agreement with the desired values. In the process of obtaining the desired value, it was necessary to adjust the total heat transfer area of steam generators.

During the transient the most thermal hydraulic parameters were determined by calculation but some parameters were taken from boundary conditions.

One of these is the feedwater. In the initial stages of the plant transient, the main feedwater flow rate was automatically controlled by the MFWCV(Main Feed Water Control Valve) following the mal-function of the S/G level indicator. Since the actual automatic operation of the MFWCV is difficult to identify, the feedwater flowrate shown in Fig. 3

is assumed based on the plant data so as to correctly simulate the plant thermal hydraulic behavior.

The decay power strongly depends on the history of power operation. The transient occurred during the escalation of power after the performance test. Thus the 4-day power history prior to reactor trip was used as input values, shown in Fig. 4. The resulted decay power is estimated as 94 % of decay power for infinite operation.

Table. 2 Simulated Initial Conditions for Full Load Condition

Parameters		Simulated	Desired
Core Thermal Power	(MW)	1,723.0	1,723.5
PZR Pressure	(MPa)	15.51	15.50
PZR Level	(%)	47.60	47.60
Hot Leg Temperature	(K)	589.45	589.36
Cold Leg Temperature	(K)	556.06	555.89
Loop Coolant Flowrate	(kg/sec)	4,686.50	4,687.50
Main Feedwater Flowrate	(kg/sec)	473.00	473.00
Feedwater Temperature	(K)	496.30	496.30
Steam Flowrate	(kg/sec)	472.64	473.10
S/G Pressure	(MPa)	5.52	5.55
S/G Narrow Range Level	(%)	44.01	44.00
S/G Mass Inventory	(kg)	44,612.3	44,776.7
U-tube Heat Transfer Area	(m^2)	5,214.4	4,784.5
U-tube Heat Transfer Rate	(Mw)	1,728.8	1,728.5
Recirculation Ratio		2.50	2.50

Table. 3 Simulated Initial Conditions for 77.5 % Power Condition

Parameters		Simulated	Desired
Core Thermal Power	(MW)	1,334.8	1,334.8
PZR Pressure	(MPa)	15.51	15.41
PZR Level	(%)	41.61	41.60
Hot Leg Temperature	(K)	583.06	583.10
Cold Leg Temperature	(K)	556.88	556.80
Loop Coolant Flowrate	(kg/sec)	4,688.28	4,686.50
Main Feedwater Flowrate	(kg/sec)	356.75	356.70
Feedwater Temperature	(K)	484.80	484.80
Steam Flowrate	(kg/sec)	357.00	356.70
S/G Pressure	(MPa)	5.896	-
S/G Narrow Range Level	(%)	44.02	44.00
S/G Mass Inventory	(kg)	49,783.4	-
U-tube Heat Transfer Area	(m^2)	5,214.4	4,784.5
U-Tube Heat Transfer Rate	(MW)	1,340.9	1,339.8
Recirculation Ratio		3.36	-

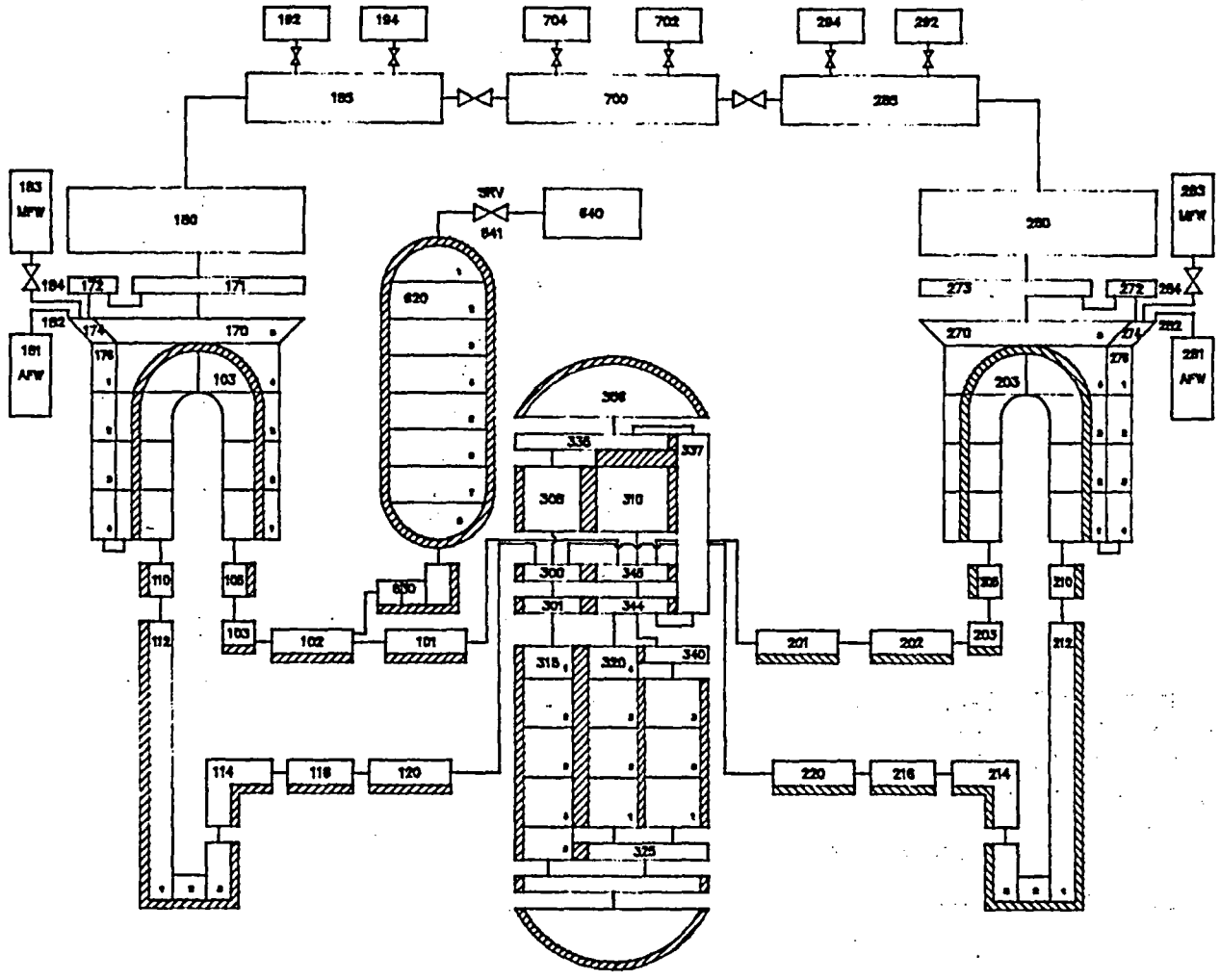


Fig.2 Nodalization of KNU #1 Power Plant

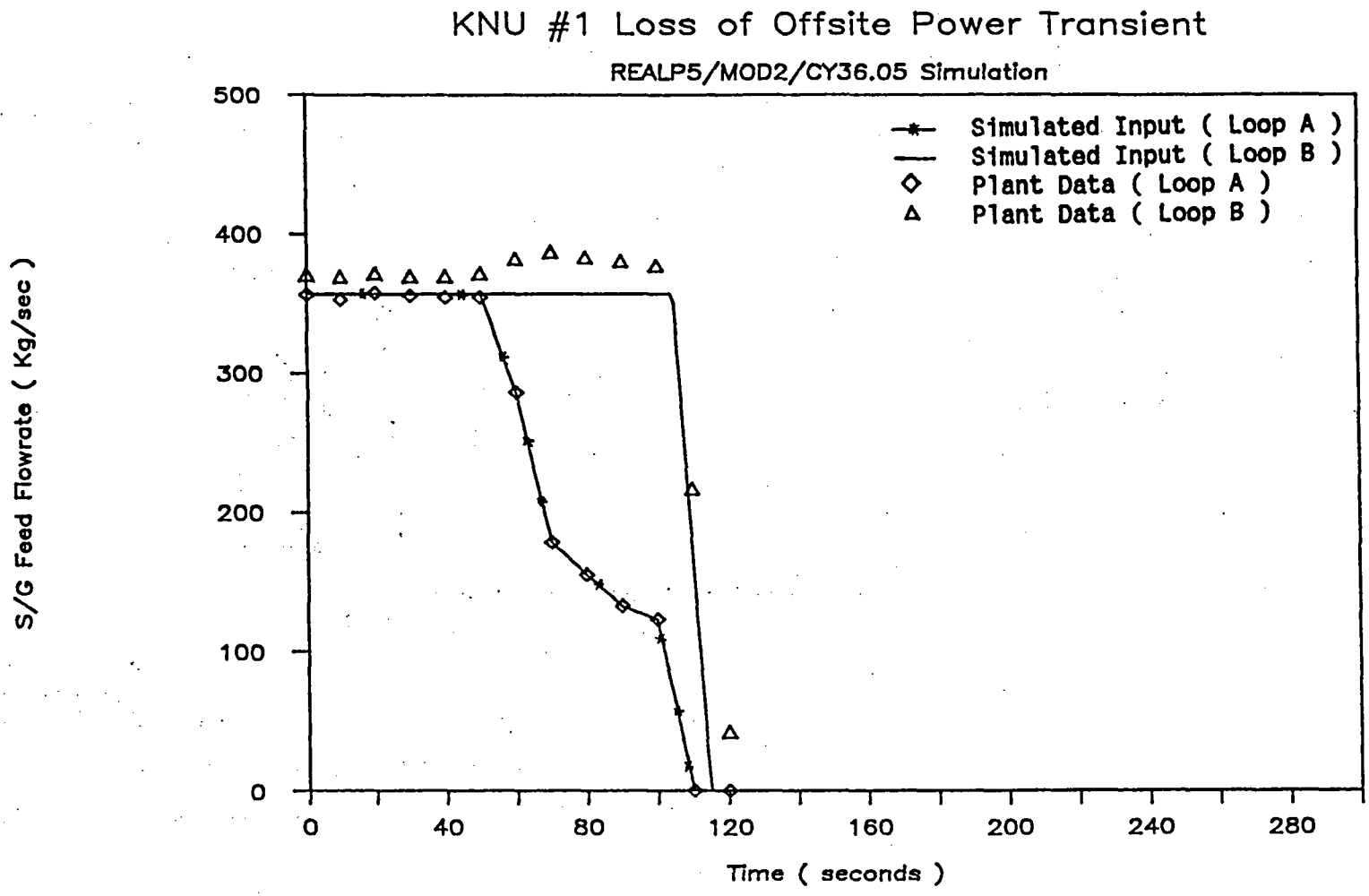


Fig.3 S/G Main Feedwater Flowrate and Simulated Boundary Condition

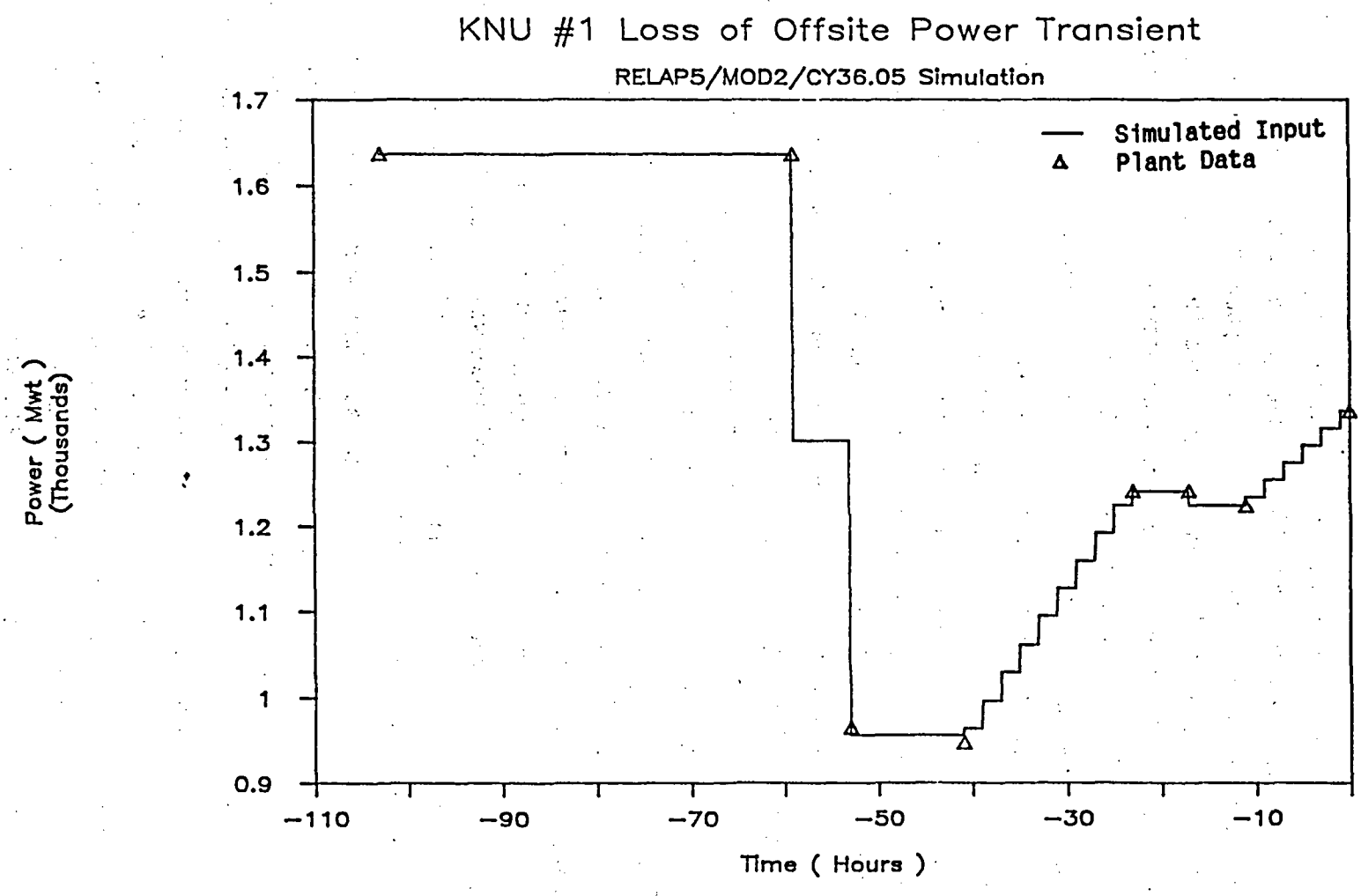


Fig.4 Power History prior to Reactor Trip and Simulated Input

5. Base Case Results and Discussions

Analyses were performed following the sequence described in Table 1. During the simulation time (300 seconds), the major events of sequence were the reactor trip and reactor coolant pump trip, which are not related to thermal hydraulic phenomena. Therefore the time of major events were treated as input values. The simulated thermal-hydraulic parameters are compared with the plant transient data, which are deduced from the computer trip review sheet. The plant transient occurred during power escalation, and hence most parameters were not in stabilized condition which led to difficulties in deciding the appropriate initial value. Hence, the unreasonable plant data were ignored and the initial values were chosen either by an averaging process, or in some cases, from the design values specified in the FSAR of KNU #1.

As can be seen in Fig. 3, the feedwater flow was decreased by malfunction of the level detector, and it result in the water level decreasing. The S/G water level was obtained not by the pressure difference method, as used in the actual plant measurement, but by calculating the collapsed water volume deduced from the void fraction. This is because the pressure difference method, when used in the simulation, often gave rise to a doubtful level oscillation. The calculated S/G water levels do not agree with the plant data as shown in Fig. 5. Moreover the spurious level peak was calculated at the turbine trip. This was caused by the nodalization of steam generator, and the details are discussed in section 6.

Since the two loops of the S/G secondary side are connected via a single common head and because the main steam isolation valve (MSIV) does not operate in these analyses, the pressure variations in S/G-A and B are identical as shown in Fig. 6. Following the reactor/turbine trip, the S/G pressure rapidly increases as the turbine stop valve closes. Normally, the turbine trip causes the steam dump valve to open, but in this transient, due to the loss of offsite power it remains closed. In the plant transient analysis, the S/G pressure starts to decrease as the supply of the auxiliary feedwater, actuated by the S/G low-low level signal, reaches its maximum capacity (155.94 sec) so that the secondary

heat removal capability begins to overcome the reactor decay power. The calculated S/G pressure variation up to the peak pressure agrees quite well with the plant data. In the analyses, PORVs(Power Operated Relief Valves) were simulated to open at 7.033 MPa (1020 psia). But the supply of the auxiliary feedwater alone provides sufficient secondary heat removal capability without the operation of the PORVs.

The primary loop coolant flowrate versus time is shown in Fig. 7, and as shown in Table 1 and Table 2, the reactor coolant pump-A(RCP-A) was tripped at 135sec and the RCP-B at 163sec. A rapid reduction in the RCS flowrate in the loop-A due to the pump trip caused the frictional resistance of the reactor vessel to decrease. Consequently the loop-B coolant flowrate increased until the subsequent trip of the RCP-B leading to the rapid reduction of loop-B flowrate. Meanwhile, the loop-A flowrate increases, due to the same reason as described above, just before flow reversal occurred and then decreased slowly. After 200 second, both loops showed an identical trend in the flow coastdown, and the natural circulation began to be established due to the hot-cold leg temperature difference. The overall trend in the calculated loop flowrates is in excellent agreement with the plant data as can be seen in Fig. 7.

Fig. 8 shows the RCS temperature variations and one can note that the hot leg temperature variations for both loops are identical in spite of different RCP trip times. This is reasonable since the present simulation is based on a single channel model for the core, allowing complete liquid mixing. Immediately after the reactor/turbine trips the hot leg temperature decreases rapidly, whereas the cold leg temperature increased due to the reduction in the heat removal capability of the S/G secondary side. After the RCP-A trip, loop-A hot leg temperature has little effect on the cold leg temperature due to delay in fluid transport, and hence the cold leg temperature stays at the saturation temperature corresponding to the S/G-A pressure. Similarly, the loop-B cold leg temperature also ceases its increase following the RCP-B trip. Afterwards, the cold leg temperatures slowly decrease as the S/G pressure decreases. The flow coastdown due to both RCP trips and the decay heat increase the hot-cold leg temperature difference until the establishment

of the natural circulation in the primary side. As this hot-cold temperature difference increases a driving force for heat transfer from primary to the secondary side increases. Recognizing above trend in the temperature variations, one can note that the hot leg temperature increases until the stable natural circulation is fully established, and afterwards it decreases along with the cold leg temperature. The simulated cold leg temperature agrees well with the plant data whereas the hot leg temperature behavior is rapid. It is caused by the plant measurement method which use RTD system. The RTD measurement depends strongly on the coolant flowrate, thus measurement was delayed by the pump coastdown. For comparison purpose the lag measure unit was simulated and the output from this unit showed good agreements with the data. For a time constant of a lag unit, it was estimated as 20 seconds.

The pressurizer level, shown in Fig. 9, is higher compared with the plant data. One of the causes may be a difficulty with calculating the accurate volume of the PZR bottom, in which the complex structures and PZR heaters are located. Another cause is a difficulty with predicting upper head temperature of reactor vessel. It is believed that the upper head temperature is between the hot leg temperature and the cold leg temperature due to 3 dimensional flow distribution in the upper part of the core. Using one dimensional code such as RELAP5, it is impossible to predict the upper head temperature correctly. If we consider the bypass flow through upper head nozzles, the predicted temperature should be same as the cold leg temperature. Thus the contraction effect due to RCS cool down may be under predicted and it results in the overprediction of pressurizer level.

The pressurizer pressure, shown in Fig. 10, has a similar trend as the pressurizer level and is higher also as compared with plant data. But the slope of pressure increase in the heatup phase is much higher. It may be due to the treatment of pressurizer vessel wall. If we consider the heat losses to atmosphere through the pressurizer vessel wall, the improved result was obtained. The details will be discussed in section 6.

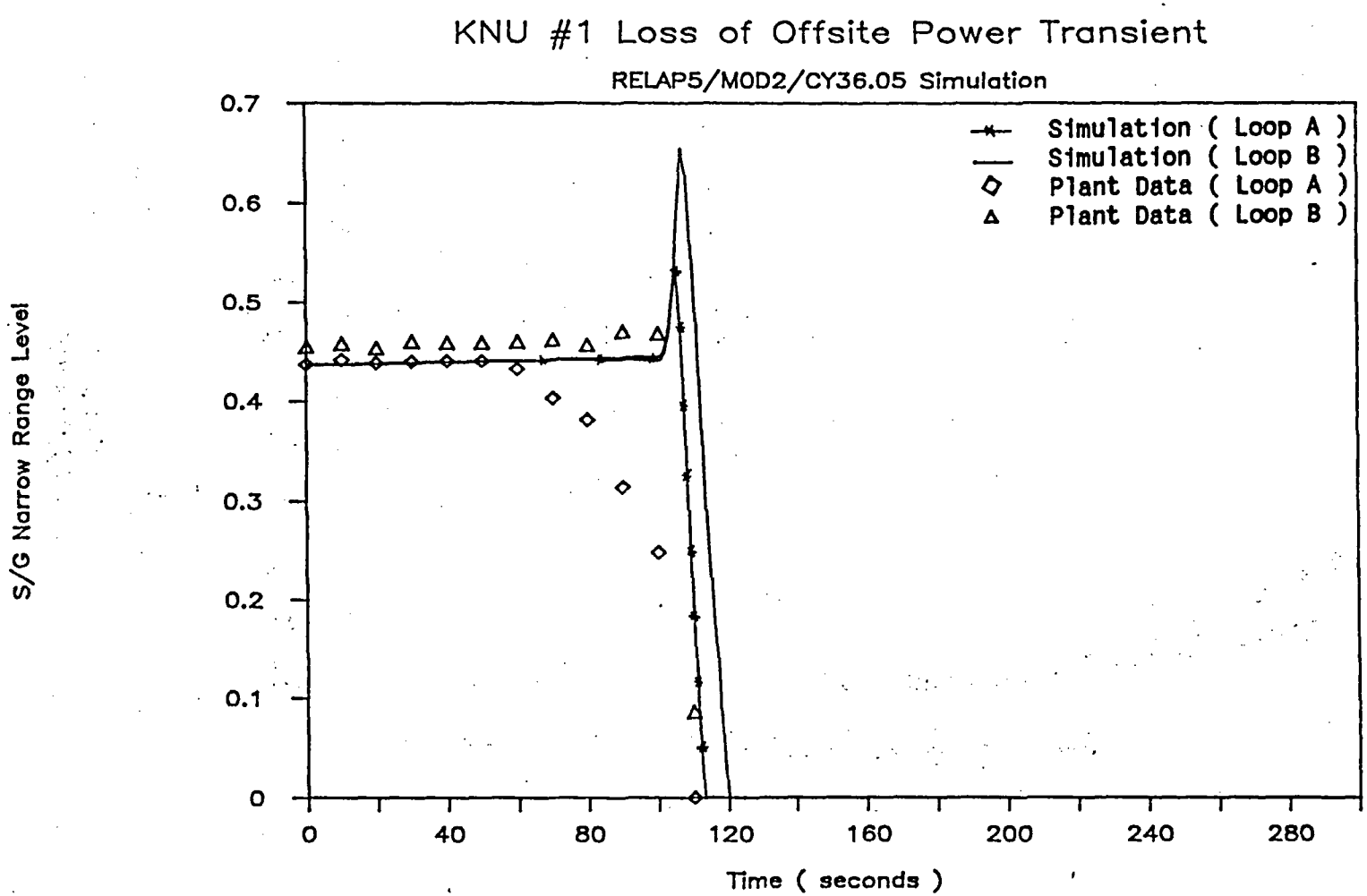


Fig.5 S/G Narrow Range Water Level versus Time

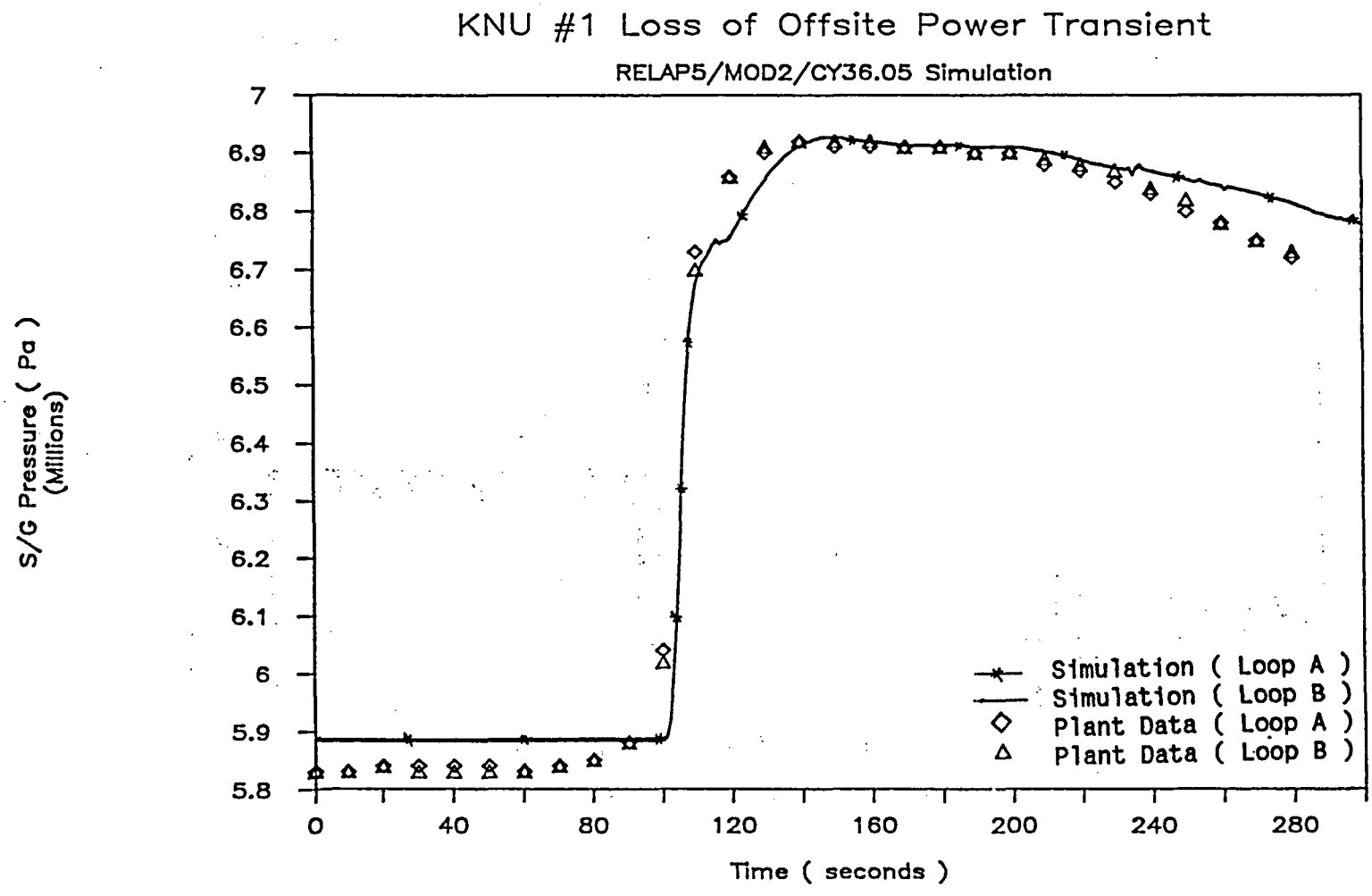


Fig.6 S/G Pressure versus Time

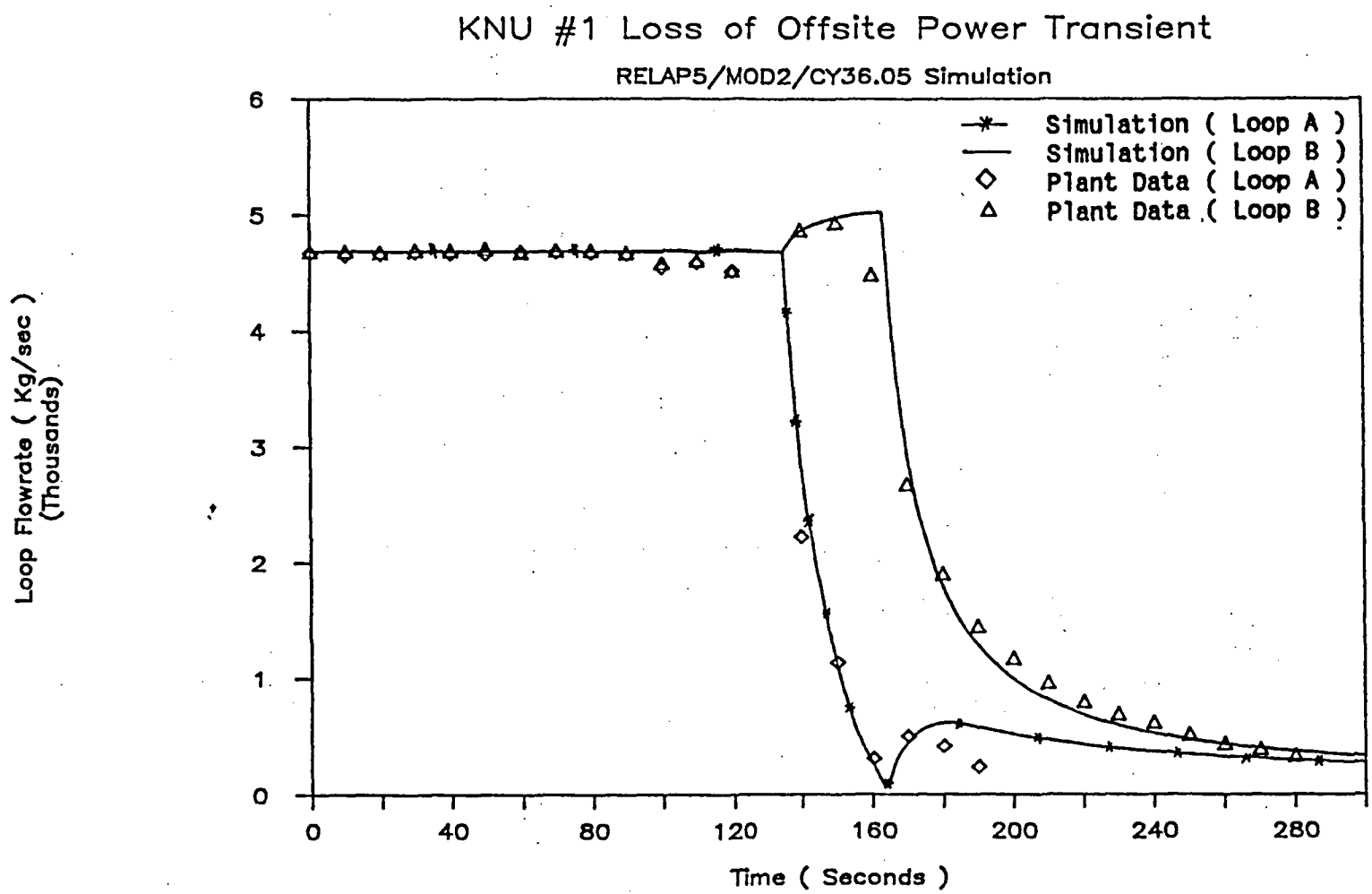


Fig.7 Loop Flowrate versus Time

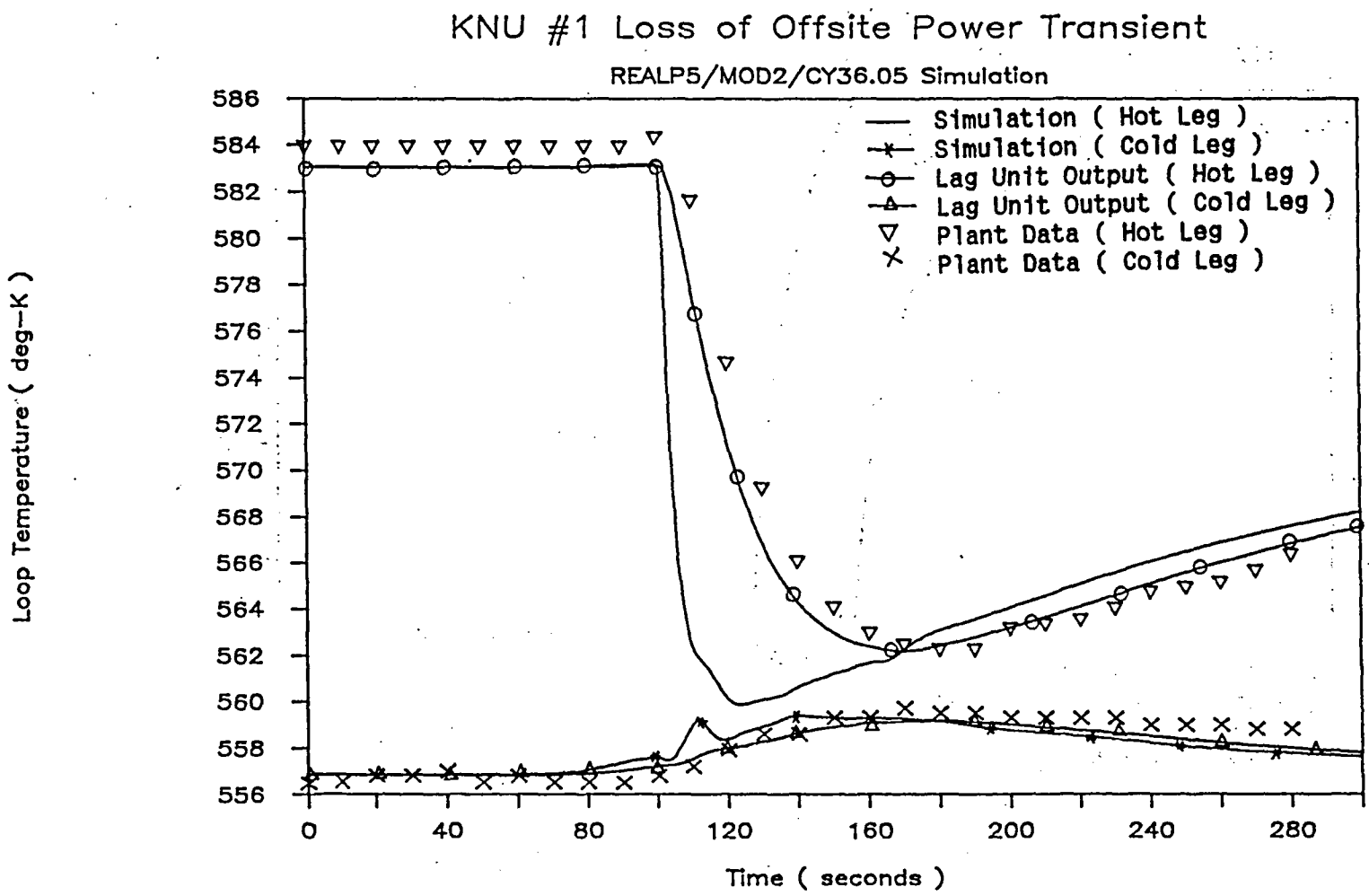


Fig.8 Loop Temperature versus Time

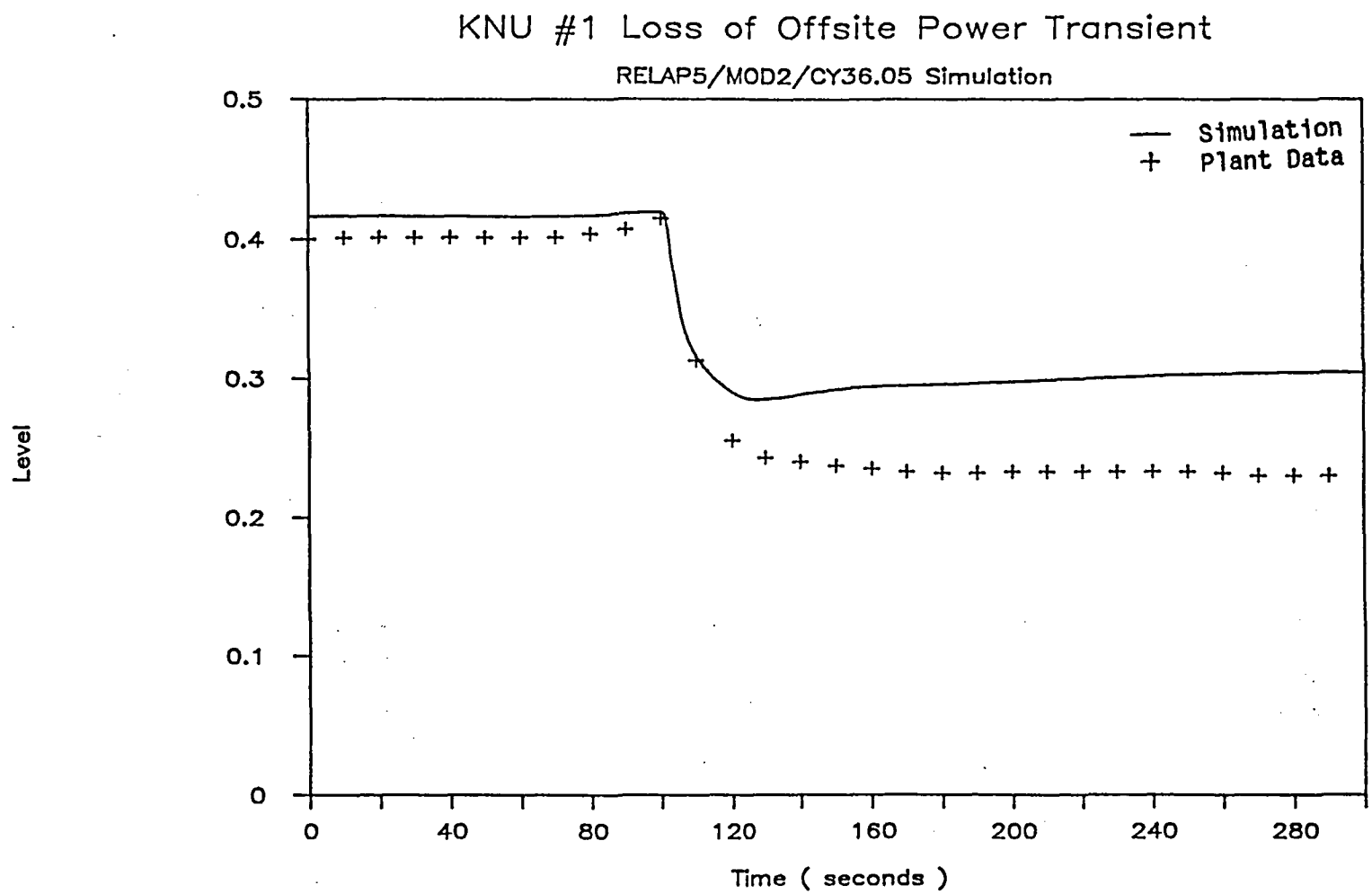


Fig.9 Collapsed PZR Water Level versus Time

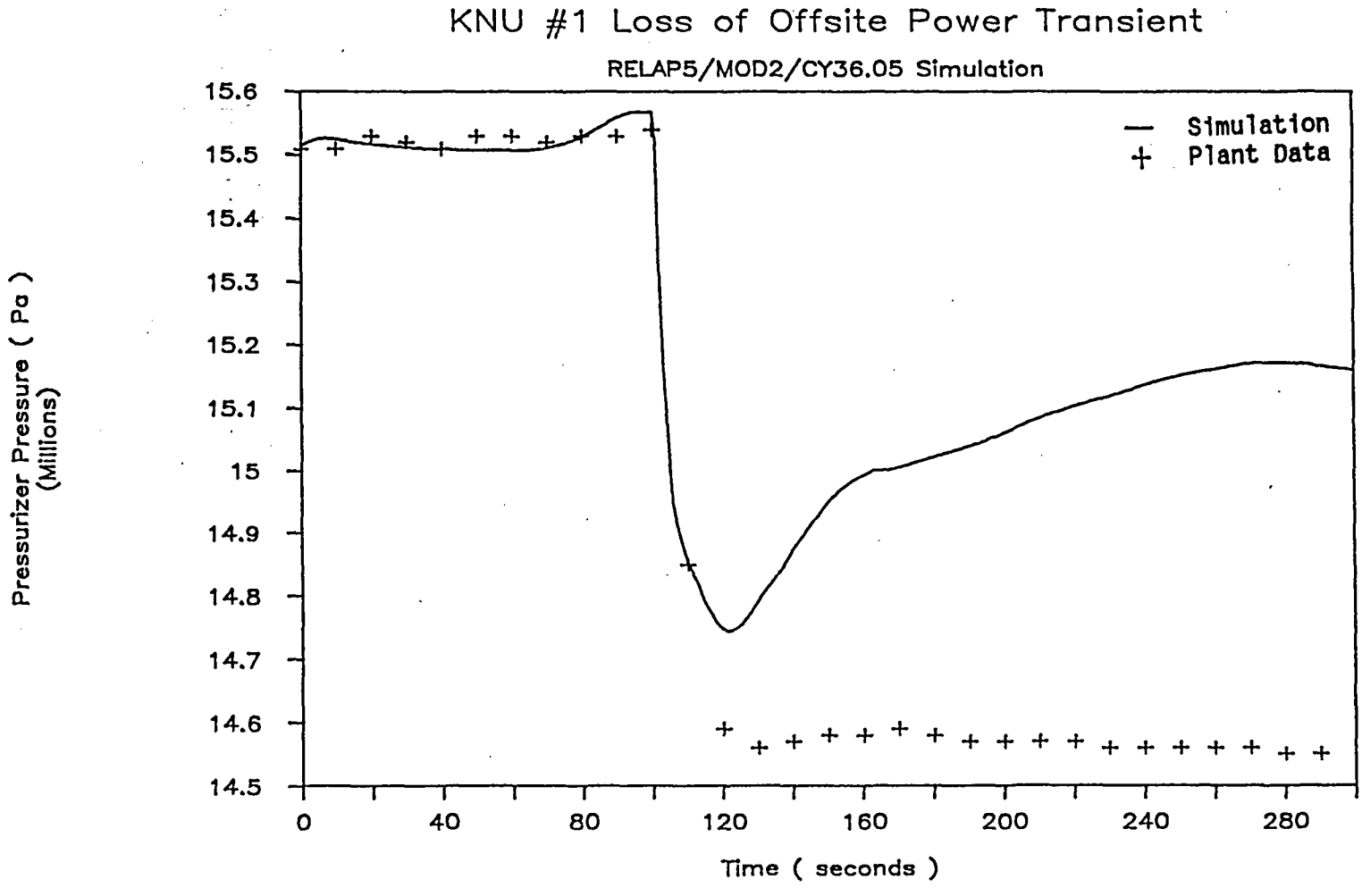


Fig.10 PZR Pressure versus Time

6. Discussion on the result of nodalization study

As shown in Fig. 5, the calculated S/G water levels did not decrease although the feedwater was decreasing. Moreover the spurious level peak was calculated at the turbine trip. The calculation results may have depended on the nodalization of steam generator, thus a study of nodalization for steam generator was performed.

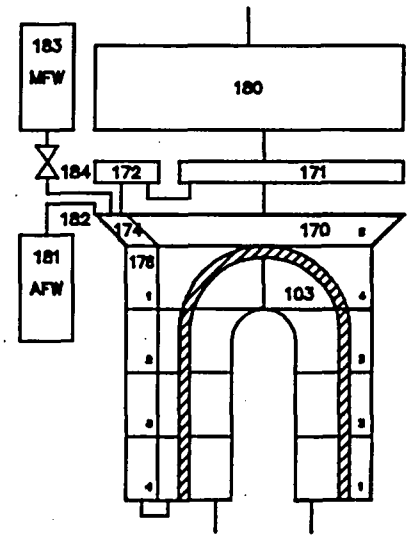
As shown in Fig. 11, there was no junctions between bypass plenum (volume 172) and steam dome (volume 180) in the base case (Case 1). So there was no steam pass for feedback of pressure spike at the turbine trip, and the pressure buildup at steam dome (volume 180) drove the flow of liquid into the volume 172 through separator (volume 171). This resulted in a spurious level peak. The water level decrease following decrease of feedwater flow was not simulated well because the flow stagnation occurred in volume 172.

Three different nodalizations (Case2, Case3, and Case4) were tested to evaluate the effect of junction orientation. As shown in Fig. 12, the effect of the junction orientation is negligible, and thus the comparisons of case 2 with the base case were done in this paper.

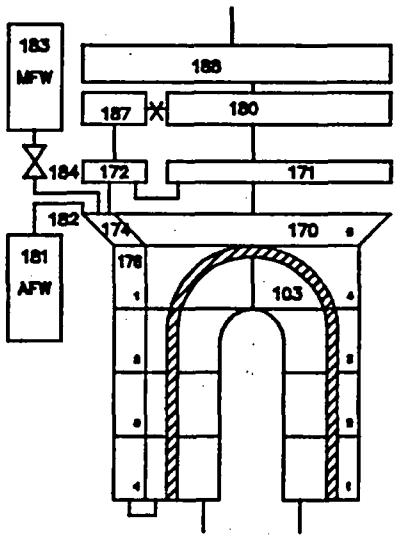
As shown in Fig. 13, the level decreasing is well predicted and the spurious level peak disappeared by connecting the cross flow junctions between bypass plenum volume (volume 187) and steam dome volume (volume 180). The case 2 nodalization had a little effect on the pressure of steam generators (Fig. 14), and no effect on the primary side parameters.

As shown in Fig. 10, the pressurizer pressure was predicted high. The main reason is the high prediction of pressurizer water level as described in section 5. But the other reason is the treatment of the heat losses through the pressurizer vessel wall. At the normal operating condition, the proportional heaters are partially kept on to compensate the heat losses. The amount is estimated as 167 KW. As shown in Fig. 15, the pressurizer heater is simulated as heat slab and shut off at the time of loss of offsite power. The heat loss through wall ia simulated as boundary condition of the wall heat slab and remains constant during the whole transient. As in Fig. 16 the pressure increase due to the insurge flow is much higher than the plant data, although the improved

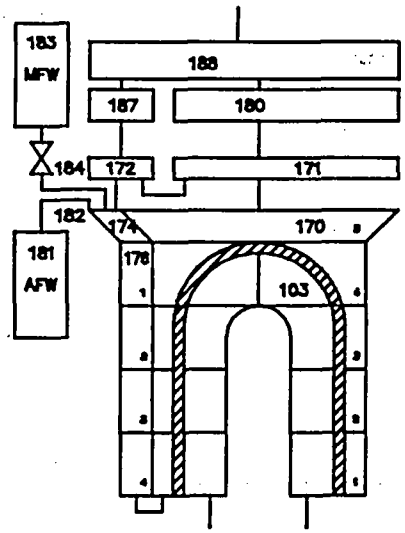
result was obtained compared with the base case. It is believed that the interface heat transfer in horizontal stratified flow regime may be estimated low, and thus the compression effect may be high.



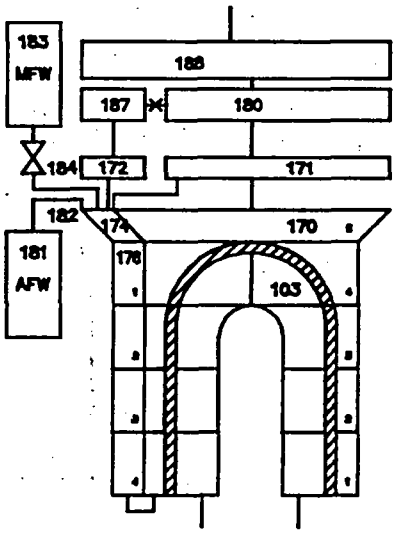
(CASE 1)



(CASE 2)



(CASE 3)



(CASE 4)

Fig.11 S/G Nodalization for Sensitivity Study

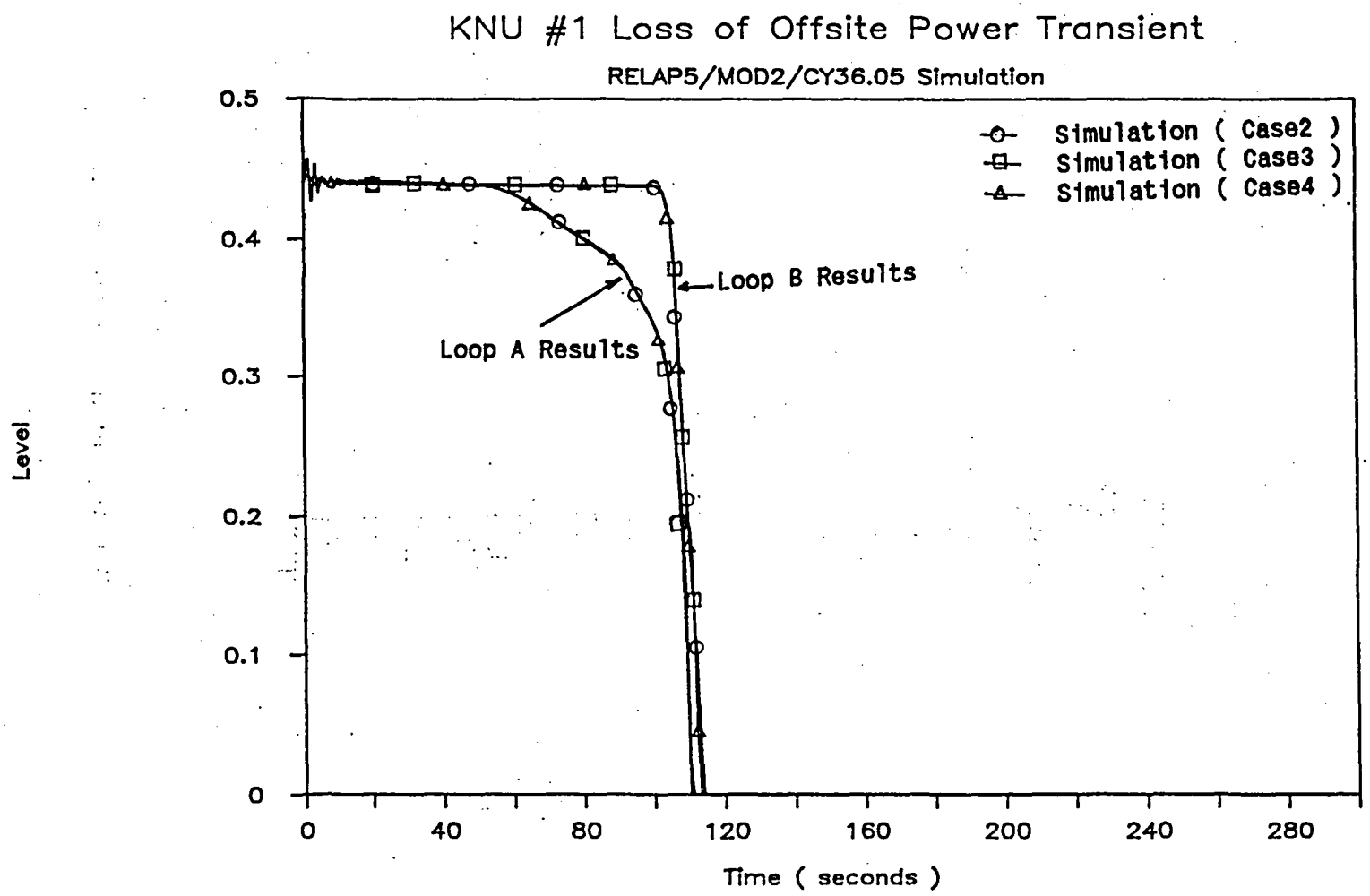


Fig.12 S/G Narrow Range Water Level (case 2, case3, case4)

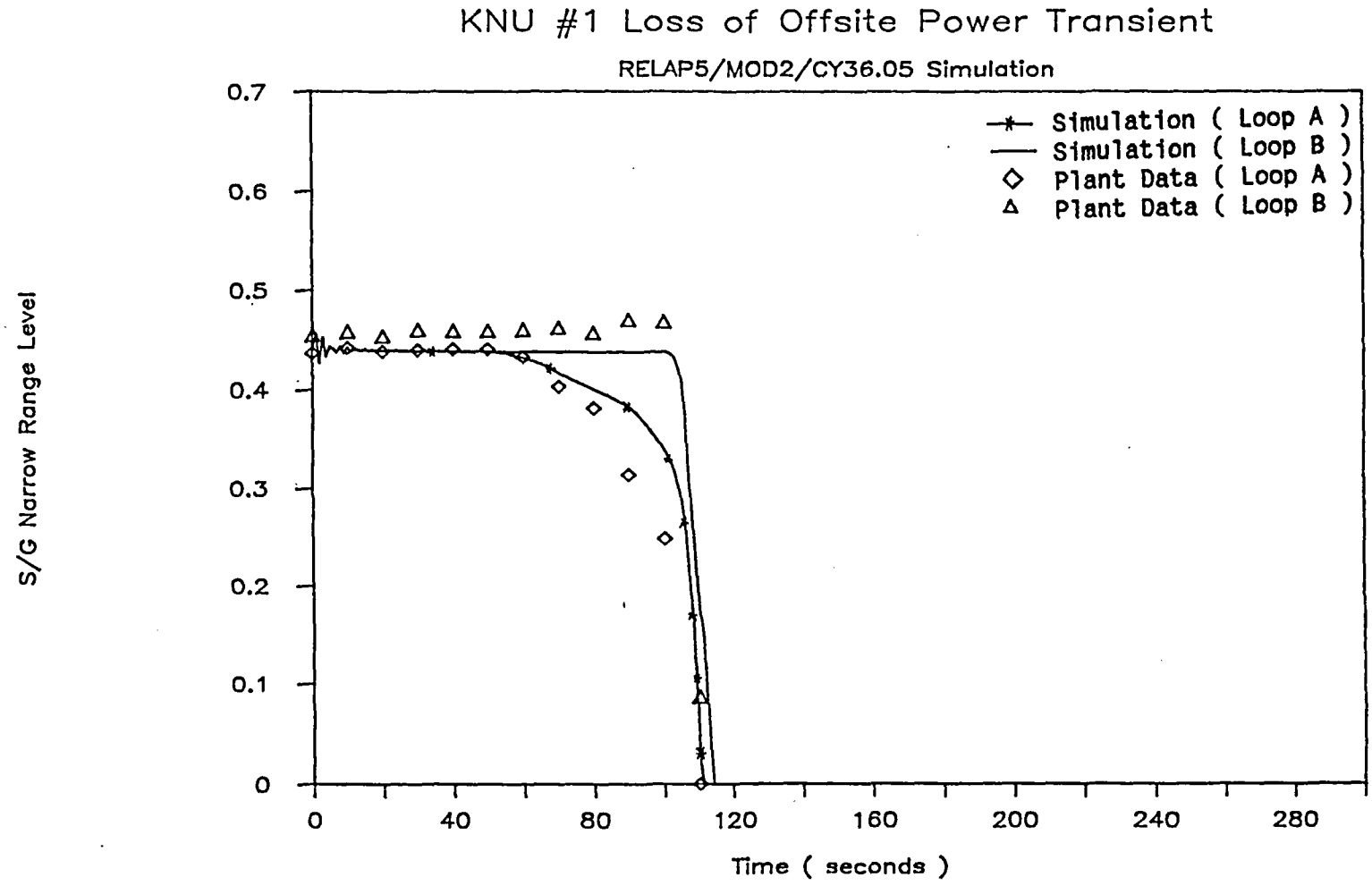


Fig.13 S/G Narrow Range Water Level versus Time (case2)

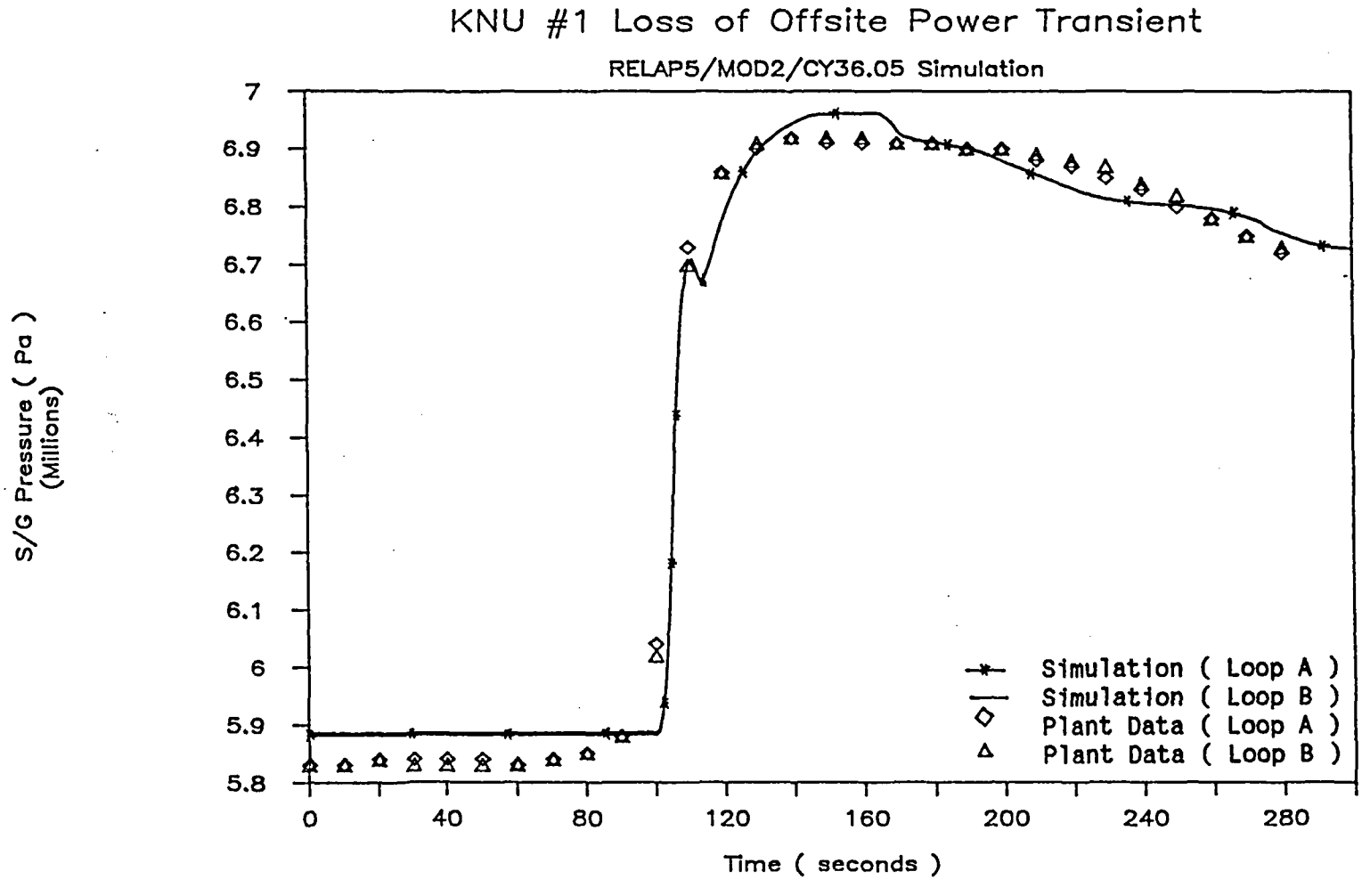


Fig.14 S/G Pressure versus Time (case2)

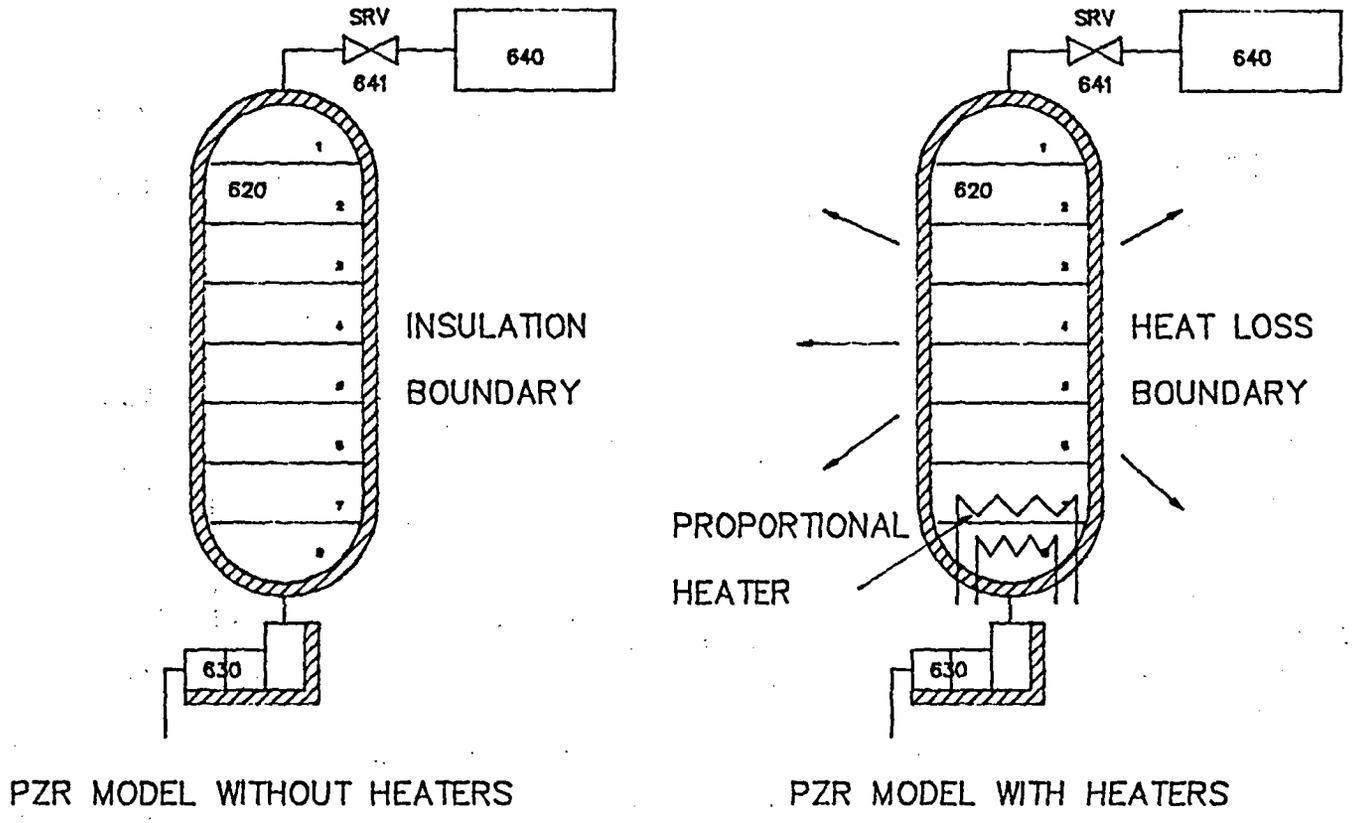


Fig.15 Pressurizer Model with Heat Loss

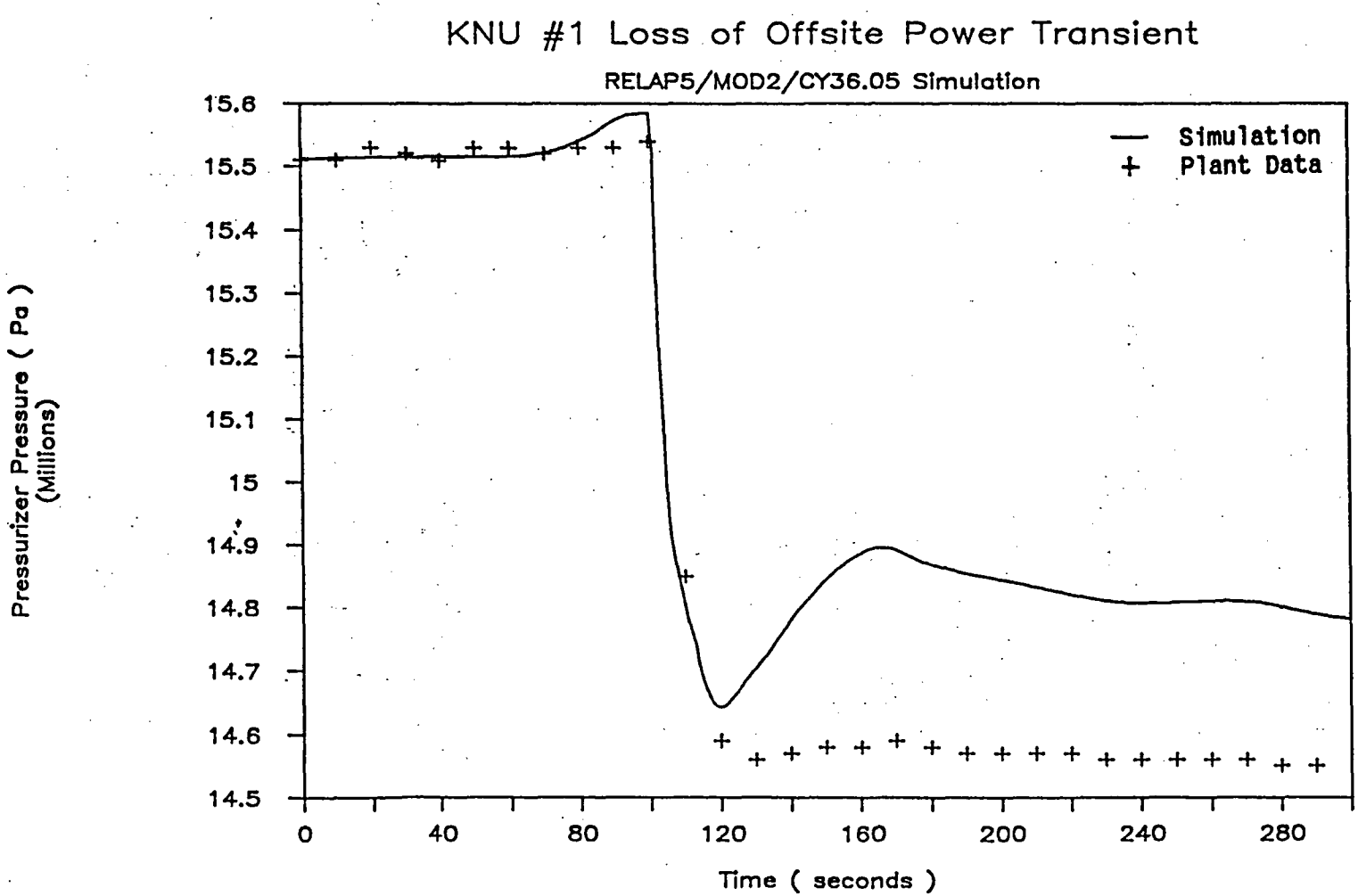


Fig.16 PZR Pressure versus Time with Heat Loss through Wall

7. Run Statistics

In order to compare the run times with other organization it should be mentioned that the computer type used is CDC CYBER 170-875 which has one unified extended memory unit. and the operating system is the NOS 2.6.1 level 700. As shown in Fig. 17 the time step size is mainly governed by the minimum Courant limit time. The Courant limit time increases due to the flow coastdown after the trip of reactor coolant pumps. The requested maximum time step size is 1.0 second. Thus the time step varies between the maximum time step and the Courant limit.

The total CPU time is shown in Fig. 18. In the figure it runs faster than the real time after the coastdown of flow. It is due to the increase of Courant time limit resulting in an increase of time step size as shown in Fig. 17.

The total CPU time required for simulation of the whole transient 300 seconds is 455.276 seconds and the total number of time steps is 3095. The input processing time is 7.87 second and the number of volumes is 118. Thus the grind time is 1.22 mili-second ; the grind time = (total CPU time - Input processing time)/(Number of time step X Nunmer of Volume) = (455.276-7.87)/(3095 X 118) = 0.00122.

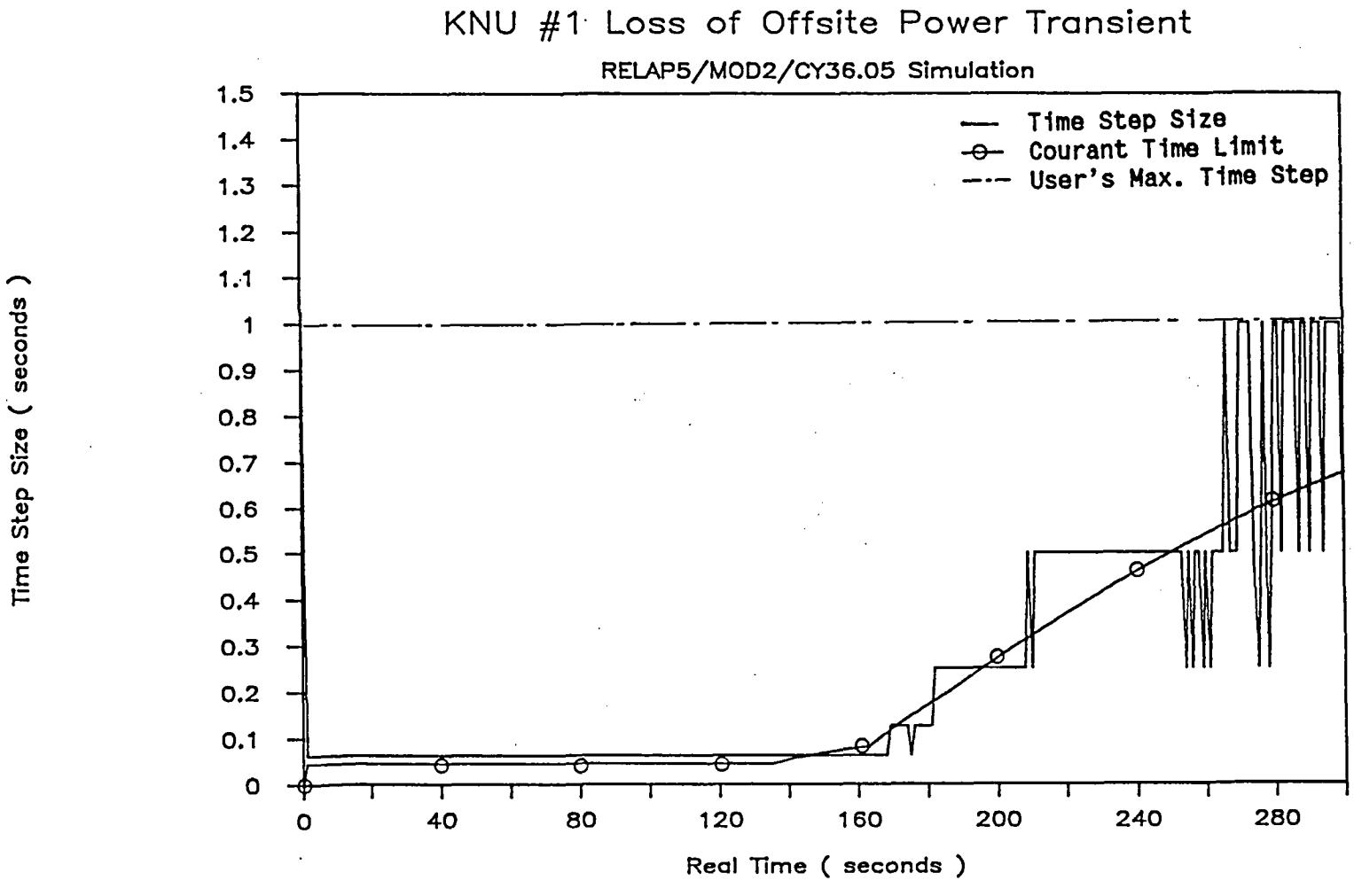


Fig.17 Time Step Size and Courant Time Limit versus Real Time

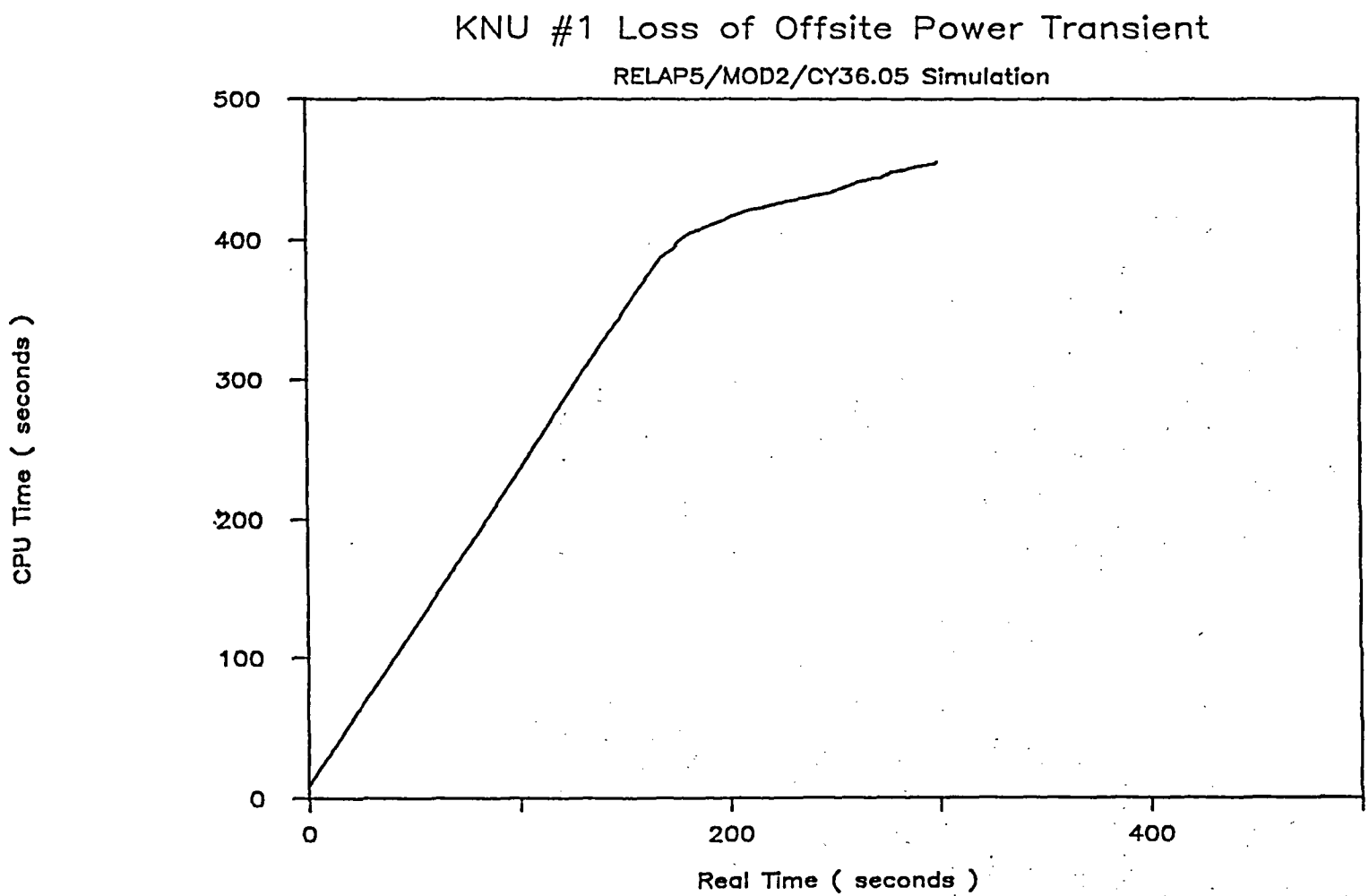


Fig.18 Total required CPU Time versus Real Time

8. Conclusion

An analysis of KNU #1 Loss of Offsite Power transient was carried out using the RELAP5/MOD2. It was found that the code gives stable steady-state results and accurate predictions for most of the plant behavior associated with the transient, indicating the excellent capability of the code for this type of transients. The establishment of stable natural circulation due to the hot-cold leg temperature difference after both reactor trips is confirmed. In particular, the calculated primary thermal behavior closely follows the plant data and this validates that the relevant thermal-hydraulic and decay power model in the RELAP5/MOD2 correctly describes the actual phenomena.

In the nodalization sensitivity study it was found that S/G noding with junctions between bypass plenum and steam dome is preferred. This nodalization allowed the simulation of the S/G water level decrease and avoided the spurious level peak at turbine trip.

The pressurizer pressure increase is sensitive to the insurge flow. It is believed that the interfacial heat transfer in a horizontal stratified flow regime may be estimated low and that the compression effect due to insurge flow may be high.

9. Reference

1. "Final Safety Analysis Report, Kori Nuclear Power Plant Unit No.1", Korea Electric Company.
2. Computed Daily Log Sheet of KNU1, on June 9, 1981.
3. Computed Post Trip Review Sheet of KNU1, 11:00 on June 9, 1981.
4. Computer Sequence of Events Record of KNU1, 11:00 on June 9, 1981.
5. Ransom, V.H., et al., "RELAP5/MOD2 Code Manual ; Volume 2 ", NUREG/CR-4312, EGG-2396, December 1985.

Appendix

The input file for steady/transient run of KNU #1 Loss of Offsite Power Transient is given. The geometric data and performance data was prepared in cooperation with the utility company (KEPCO) of KNU #1 Plant. The input file is the CASE2 input which contains the specific steam generator nodalization as discussed in section 6. The job control card at the top of input file is for KAERI computer system (CDC CYBER-170, NOS operating system).

```
/JOB
BRUN,T777.
/USER
ATTACH,REL36KX.
ATTACH,STH2XT.
RFL,CM=350000,EC=200.
REDUCE(-)
FILE,RSTPLT,SBF=NO.
FILE,RSTIN,SBF=NO.
DEFINE,PLOTFL=BBASEP2.
REL36KX(,*PL=90000)
SKIP,JOB4.
EXIT.
ENDIF,JOB4.
DAYFILE,DAYLEE.
REPLACE,DAYLEE.
/EOR
=KORI UNIT 1 STATION BLACK-OUT AT 77.5% POWER TRANSIENT
(14/NOV/1981)
*-----------------------------------------------------------------*
*    FILENAME IS   "BBASE2" (1985.DEC.10) - BASE CAL. BY LEE
*    ORIGINAL LOSS COEFF.  BUT MODIFICATION OF PUMP DATA
*    ATTACH PZR PRESSURE, & CORE KINETIS DATA
*    S/G NODALIZATION STUDY 2 (CASE 2)
*-----------------------------------------------------------------*
*              STANDALONE REACTOR                                 *
*-----------------------------------------------------------------*
*-----------------------------------------------------------------*
*-----------------------------------------------------------------
*         MISCELANOUS CONTROL CARDS
*-----------------------------------------------------------------
*       PROBLEM TYPE OPSTDY-ST/TRANSNT
100        NEW            TRANSNT
*       INP-CHK/RUN
101        RUN
*       INP-UNIT       OUT-UNIT    OUTPUT-UNIT
102        BRITISH         BRITISH
104     NOACTION
*          TIME 1         TIME 2
105      1.0            2.0
*-----------------------------------------------------------------
*         TIME STEP CONTROL CARDS
*-----------------------------------------------------------------
*      EDND.T  MIN.DT MAX.DT CNTL  MINOR.ED MAJOR.ED  RESTRT
201  300.0  1.E-7  1.00 14003   1        050       4000
*202  800.0  1.E-7  1.00     2   1        100       4000
*-----------------------------------------------------------------
*         MINOR EDIT REQUEST
*-----------------------------------------------------------------
301     P       301010000
```

```
302     TEMPF    301010000
303     P        356010000
304     TEMPF    356010000
305     P        335010000
306     TEMPF    335010000
307     P        335020000
308     TEMPF    335020000
309     P        335030000
310     TEMPF    335030000
311     P        620010000
312     TEMPF    220010000
313     TEMPF    201010000
314     MFLOWJ   300010000
315     MFLOWJ   300020000
316     MFLOWJ   325010000
317     MFLOWJ   325020000
318     MFLOWJ   355030000
319     MFLOWJ   345010000
320     MFLOWJ   355020000
321     MFLOWJ   220020000
322     MFLOWJ   120020000
323     MFLOWJ   621000000
324     RKTPOW       0
325     RKFIPOW      0
326     RKGAPOW      0
327     RKREAC       0
328     CNTRLVAR,051
329     CNTRLVAR,052
330     CNTRLVAR,057
331     CNTRLVAR,058
332     CNTRLVAR,061
333     CNTRLVAR,062
334     CNTRLVAR,067
335     CNTRLVAR,068
336     CNTRLVAR,060
337     CNTRLVAR,070
338     CNTRLVAR,122
339     CNTRLVAR,300
340     CNTRLVAR,401
341     CNTRLVAR,402
342     CNTRLVAR,403
343     CNTRLVAR,404
*-----------------------------------------------------------
* TRIP DATA
*-----------------------------------------------------------
501     TIME 0  GE  NULL  0 9999.0  L * CPU LIMIT
502     TIME 0  GE  NULL  0  0.0    L * INITIALIZATION
503     TIME 0  GE  NULL  0  50.00  L * ACCIDENT ACTUATION
504     TIME 0  GE  NULL  0 9999.0   L  * MSIV CLOSURE
*588     CNTRLVAR 057  LE  NULL 0 0.25 L * RX/TBN TRIP
```

```
* REPLACE RX TRIP BY TIME 89.2.18
588     TIME,0   GE   NULL,0   100.00 L * RX/TBN TRIP
589     CNTRLVAR 057  LE  NULL 0 0.11 L *S/G L-L (AUX. FEED)
590     CNTRLVAR 101  LE  NULL 0 554. L *MAIN FEED ISOLATION
592     TIME 0  GE   TIMEOF  589  9999.0  L *STEAM DUMP
601     588  AND   503  L
594     TIME 0  GE   TIMEOF  601  35.   L    * BROKEN LOOP PUMP TRIP
595     TIME 0  GE   TIMEOF  601  63.   L    * INTACT LOOP PUMP TRIP
*-----------------------------------------------------------------
*         ===  CORE    COMPONENTS  ===
*-----------------------------------------------------------------
*        HYDRODYNAMIC COMPONENT
*-----------------------------------------------------------------
*-------------------------------------------------------
* COMPONENT 300: REACTOR UPPER DOWNCOMER BRANCH                *
*-------------------------------------------------------
3000000     RX-U-DO     BRANCH
3000001     2      1
3000101     21.559  1.965  0. 0. -90. -1.965 0. 1.347  00
3000200     3     2299.7    542.71
3001101     300000000  308000000  21.559  0.4 0.4  0000
3002101     300010000  301000000  21.559  0.3 0.3  0000
3001201     63.597   0.0  0.0
3002201     20611.0  0.0  0.0
*-------------------------------------------------------
* COMPONENT 301: REACTOR MID DOWNCOMER BRANCH                  *
*-------------------------------------------------------
3010000     RX-M-DO     BRANCH
3010001     1        1
3010101     18.6475  2.0  0. 0. -90. -2. 0. 0.591  00
3010200     3     2298.9   542.71
3011101     301010000  315000000  18.6475  0.3 0.3 0000
3011201     20611.0     0.0  0.0
*-------------------------------------------------------
* COMPONENT 315: REACTOR LOWER DOWNCOMER ANNULUS               *
*-------------------------------------------------------
3150000     RX-L-DO     PIPE
3150001     5
3150101     17.934          5
3150201     17.934          4
3150301     1.08          1
3150302     4.0           4
3150303     3.239         5
3150601     -90.0           5
3150701     -1.08           1
3150702     -4.0            4
3150703     -3.239          5
3150801     0.0  0.568      5
3150901     0.3   0.3     4
3151001     00              5
```

```
3151101     0000            4
3151201     3     2298.3    542.71    0.  0.  0.   1
3151202     3     2298.1    542.71    0.  0.  0.   2
3151203     3     2298.4    542.71    0.  0.  0.  3
3151204     3     2298.6    542.71    0.  0.  0.  4
3151205     3     2298.8    542.71    0.  0.  0.  5
3151300     1
3151301     20611.0     0.0   0.0     4
*-------------------------------------------------------
* COMPONENT 322: REACTOR MID LOWER PLENUM                    *
*-------------------------------------------------------
3220000     RX-M-LP     BRANCH
3220001     3               1
3220101     79.639  2.8  0. 0. -90. -2.8 0. 0.  00
3220200     3     2297.8   542.71
3221101     315010000  322000000  17.934   1.32  1.32   0100
3222101     322000000  325000000  46.684   3.200  3.200   0100
3223101     322010000  321000000  31.118   0.0   0.0   0000
3221201     20611.0     0.0  0.0
3222201     20611.0     0.0  0.0
3223201     0.0          0.0  0.0
*-------------------------------------------------------
* COMPONENT 321: REACTOR BOTTOM LOWER PLENUM                 *
*-------------------------------------------------------
3210000     RX-B-LP     SNGLVOL
3210101     31.118  2.283  0.  0.  -90.  -2.283  0. 1.219  00
3210200     3     2298.7   542.55
*-------------------------------------------------------
* COMPONENT 325: REACTOR TOP LOWER PLENUM                    *
*-------------------------------------------------------
3250000     RX-T-LP     BRANCH
3250001     2               1
3250101     46.684  3.239  0. 0. 90. 3.239  0.  1.753  00
3250200     3     2295.0  542.70
3251101     325010000  335000000  26.938   4.1     5.4    0100
3252101     325010000  320000000  0.834   7.0970   7.0970  0100
3251201      19995.0        0.0      0.0
3252201     616.65          0.0      0.0
*-------------------------------------------------------
* COMPONENT 335: ACTIVE CORE                                 *
*-------------------------------------------------------*
3350000     CORE     PIPE
3350001     3
3350101     0.0                      3
3350301     4.0                      3
3350401     108.092                  3
3350601     90.0                     3
3350701     4.0                      3
3350801     5.E-5     0.0402         3
3350901     2.0   2.0   2
```

```
3351001     00                          3
3351101     0000                      2
3351201     3     2286.2  559.49       0   0   0.  1
3351202     3     2276.5  575.63       0   0   0.  2
3351203     3     2272.7  591.04       0   0   0.  3
3351300     1
3351301      19995.0     0.0   0.0   1
3351302      19995.0     0.0   0.0   2
*-------------------------------------------------------
* COMPONENT 340: CORE TOP                                  *
*-------------------------------------------------------
3400000     CORE-TOP     BRANCH
3400001     2     1
3400101     36.582  1.08  0. 0. 90.  1.08  0.  0.0402  00
3400200     3     2263.4   590.95
3401101     335010000  340000000  26.938  5.4   4.6   0100
3402101     340010000  344000000  36.582  1.0   1.0   0100
3401201      19995.0        0.0      0.0
3402201      19995.0        0.0      0.0
*-------------------------------------------------------
* COMPONENT 320: CORE BYPASS                               *
*-------------------------------------------------------
3200000     CORE-BYP     PIPE
3200001     4
3200101     11.9274     4
3200201     0.834       3
3200301     4.0         3
3200302     1.08        4
3200601     90.0        4
3200701     4.0         3
3200702     1.08        4
3200801     0.0     0.124         4
3200901     7.0970   7.0970         3
3201001     00          4
3201101     0000        3
3201201     3     2291.7   545.48   0.0   0.0    0.0  1
3201202     3     2283.0   550.41   0.0   0.0    0.0  2
3201203     3     2274.2   556.96   0.0   0.0    0.0  3
3201204     3     2265.8   558.59   0.0   0.0    0.0  4
3201300     1
3201301     616.65    0.0   0.0     3
*-------------------------------------------------------
* COMPONENT 344: BOTTOM UPPER PLENUM                       *
*-------------------------------------------------------
3440000     RX-B-UP      BRANCH
3440001     3                          1
3440101     49.7375  2.0  0. 0. 90. 2. 0. 0.7626  00
3440200     3     2262.3     589.97
3441101     320010000  344000000  0.834   7.0970    7.0970   0100
3442101     344010000  345000000  49.7345  0.0      0.0      0000
```

```
3443101     337010000  344000000  1.267    0.86    0.86     0100
3441201     616.65          0.0       0.0
3442201     20675.0         0.0       0.0
3443201     63.574          0.0       0.0
*-------------------------------------------------------
* COMPONENT 345: MID UPPER PLENUM                          *
*-------------------------------------------------------
3450000     RX-M-UP         BRANCH
3450001     3     1
3450101     54.657  1.965  0. 0. 90. 1.965  0.  0.838  00
3450200     3     2261.8     589.97
3451101     345010000  310000000  54.657  0.0   0.0   0000
3452101     345010000  101000000  4.587   0.05  0.05  0100
3453101     345010000  201000000  4.587   0.05  0.05  0100
3451201     0.0             0.0       0.0
3452201     10334.0         0.0       0.0
3453201     10334.0         0.0       0.0
*-------------------------------------------------------
* COMPONENT 310: REACTOR TOP UPPER PLENUM                  *
*-------------------------------------------------------
3100000     RX-T-UP     SNGLVOL
3100101     54.659  5.804  0. 0. 90. 5.804 0. 0.836  00
3100200     3     2260.9     575.19
*-------------------------------------------------------
* COMPONENT 308: REACTOR TOP DOWNCOMER                     *
*-------------------------------------------------------
3080000     RX-T-DO     SNGLVOL
3080101     26.004  6.146  0.  0.  90.  6.146  0.  1.625   00
3080200     3     2300.4     543.70
*-------------------------------------------------------
* COMPONENT 355: REACTOR UPPER HEAD                        *
*-------------------------------------------------------
3550000     RX-U-HD     BRANCH
3550001     3     1
3550101     69.927  2.476  0.0  0.0  90.0  2.476  0.0  2.309   00
3550200     3     2259.4     543.89
3551101     308010000  355000000  0.0247   11.0  11.0  0100
3552101     356010000  355010000  40.016  0.0   0.0   0000
3553101     355010000  337000000  1.267   0.86  0.86  0100
3551201     63.563          0.0       0.0
3552201     0.0             0.0       0.0
3553201     63.563          0.0       0.0
*-------------------------------------------------------
* COMPONENT 337:REACTOR GUIDE TUBES                        *
*-------------------------------------------------------
3370000     GID-TUB     SNGLVOL
3370101     1.267  12.587 0. 0. -90. -12.587 0. 0.221   00
3370200     3     2261.0     545.90
*-------------------------------------------------------
* COMPONENT 356: REACTOR UPPER HEAD DOME                   *
```

```
*-----------------------------------------------------
3560000     RX-UH-D     SNGLVOL
3560101     40.016  2.804  0.  0. -90. -2.804  0.  7.1379   00
3560200     3     2258.5     588.09
*-----------------------------------------------------------
*                 HEAT STRUCTURE INPUT
*-----------------------------------------------------------
*-----------------------------------------------------
* HEAT STRUCTURE 301: REACTOR VESSEL WALL (DOWNCOMER)        *
*-----------------------------------------------------
13010000     8   3   2   1   5.5
13010100     0              1
13010101     1              5.513
13010102     1              6.052
13010201     5              1
13010202     6              2
13010301     0.0            2
13010401     541.2          3
13010501     308010000  0  1  1  6.146   1
13010502     300010000  0  1  1  1.965   2
13010503     301010000  0  1  1  2.0     3
13010504     315010000  0  1  1  1.08    4
13010505     315020000  0  1  1  4.0     5
13010506     315030000  0  1  1  4.0     6
13010507     315040000  0  1  1  4.0     7
13010508     315050000  0  1  1  3.239   8
13010601     0          0  0  1  6.146   1
13010602     0          0  0  1  1.965   2
13010603     0          0  0  1  2.0     3
13010604     0          0  0  1  1.08    4
13010605     0          0  0  1  4.0     7
13010606     0          0  0  1  3.239   8
13010701     0     0.0  0.0  0.0         8
13010801     0     1.62   3.010   6.146  1
13010802     0     1.347  2.495   1.965  2
13010803     0     0.591  2.158   2.0    3
13010804     0     0.568  2.0758  1.08   4
13010805     0     0.568  2.0758  4.0    7
13010806     0     0.568  2.0758  3.239  8
*-----------------------------------------------------
* HEAT STRUCTURE 300: CORE BARREL                            *
*-----------------------------------------------------
13000000     8  2  2  1   4.5417
13000100     0                     1
13000101     1                     4.6875
13000201     5                     1
13000301     0.0                   1
13000401     541.26                2
13000501     310010000  0  1  1  6.146        1
13000502     345010000  0  1  1  1.965        2
```

```
13000503     344010000  0  1  1  2.0          3
13000504     320040000  0  1  1  1.08         4
13000505     320030000  0  1  1  4.0          5
13000506     320020000  0  1  1  4.0          6
13000507     320010000  0  1  1  4.0          7
13000508     325010000  0  1  1  3.239        8
13000601     308010000  0  1  1  6.146        1
13000602     300010000  0  1  1  1.965        2
13000603     301010000  0  1  1  2.0          3
13000604     315010000  0  1  1  1.08         4
13000605     315020000  0  1  1  4.0          5
13000606     315030000  0  1  1  4.0          6
13000607     315040000  0  1  1  4.0          7
13000608     315050000  0  1  1  3.239        8
13000701     0      0.0  0.0  0.0             8
13000801     0      0.836  7.662  6.146       1
13000802     0      0.838  7.661  1.965       2
13000803     0      0.763  6.971  2.0           3
13000804     0      0.028  0.321  1.08          4
13000805     0      0.028  0.321  4.0           7
13000806     0      1.753  6.544  3.239         8
13000901     0      1.62   3.532  6.146         1
13000902     0      1.347  2.928  1.965         2
13000903     0      0.591  2.533  2.0           3
13000904     0      0.568  2.436  1.08          4
13000905     0      0.568  2.436  4.0           7
13000906     0      0.568  2.436  3.239         8
*-------------------------------------------------------
* HEAT STRUCTURE 320: BYPASS (CORE BAFFLE AND GUIDE THIMBLES)  *
*-------------------------------------------------------
13200000     4   2   2   1   0.0910846
13200100     0                      1
13200101     1                      0.09625
13200201     5                      1
13200301     0.0                    1
13200401     550.0                  2
13200501     335010000  0  1  0  1214.96     1
13200502     335020000  0  1  0  1214.96     2
13200503     335030000  0  1  0  1214.96     3
13200504     340010000  0  1  0  328.039     4
13200601     320010000  0  1  0  1283.86     1
13200602     320020000  0  1  0  1283.86     2
13200603     320030000  0  1  0  1283.86     3
13200604     320040000  0  1  0  346.642     4
13200701     0      0.0  0.0  0.0             4
13200801     0   0.040   0.376   4.0          1
13200802     0   0.040   0.376   4.0          2
13200803     0   0.040   0.376   4.0          3
13200804     0   0.040   0.376   1.08         4
13200901     0   0.123   0.157   4.0          1
```

```
13200902     0   0.123   0.157   4.0          2
13200903     0   0.123   0.157   4.0          3
13200904     0   0.123   0.157   1.08         4
*-------------------------------------------------------
* HEAT STRUCTURE 333: ACTIVE CORE                        *
*-------------------------------------------------------
13330000     3  8  2  1  0.0
13330100     0   1
13330101     3      0.015246
13330102     1      0.015558
13330103     3      0.017583
13330201     1                3
13330202     2                4
13330203     3                7
13330301     0.955            1
13330302     1.085            2
13330303     1.275            3
13330304     0.0              7
13330401     2361.0           1
13330402     2159.0           2
13330403     1607.0           3
13330404     874.0            4
13330405     730.0            5
13330406     651.0            8
13330501     0   0   0   0   0.0                     3
13330601     335010000  0  1  0  9571.488            1
13330602     335020000  0  1  0  9571.488            2
13330603     335030000  0  1  0  9571.488            3
13330701     1000     0.33333     0.0   0.0          1
13330702     1000     0.33334     0.0   0.0          2
13330703     1000     0.33333     0.0   0.0          3
13330901     0      0.0402   0.04503     4.0         3
*-------------------------------------------------------
* HEAT STRUCTURE 356: UPPER HEAD DOME                    *
*-------------------------------------------------------
13560000     1   3    3    1    5.526
13560100     0   1
13560101     2                        5.97396
13560201     5                        1
13560202     6                        2
13560301     0.0                      2
13560401     590.0                    3
13560501     356010000     0   1   1   0.27          1
13560601     0             0   0   1   0.27          1
13560701     0      0.0   0.0   0.0                  1
13560801     0      7.1379   7.1379     2.804        1
*-------------------------------------------------------
* HEAT STRUCTURE 355: UPPER HEAD                         *
*-------------------------------------------------------
13550000     1   3   2   1   5.00833
```

```
13550100     0    1
13550101     2                          5.5510
13550201     5                          1
13550202     6                          2
13550301     0.0                        2
13550401     590.0                      3
13550501     355010000    0    1    1   2.476          1
13550601     0            0    0    1   2.476          1
13550701     0       0.0    0.0    0.0                 1
13550801     0      2.3089   10.454    2.476          1
*-----------------------------------------------------
* HEAT STRUCTURE 310: UPPER CORE SUPPORT PLATE                    *
*-----------------------------------------------------
13100000     1    2    1    1    0.0
13100100     0    1
13100101     1                          0.3417
13100201     5                          1
13100301     0.0                        1
13100401     600.0                      2
13100501     310010000    0    1    0   56.397         1
13100601     355010000    0    1    0   56.397         1
13100701     0         0.0     0.0    0.0              1
13100801     0        2.3089   2.8795   7.51          1
13100901     0        0.836    2.251    7.51          1
*-----------------------------------------------------
* HEAT STRUCTURE 337: GUIDE TUBES WALL                            *
*-----------------------------------------------------
13370000     4    2    2    1    0.11055
13370100     0    1
13370101     1                          0.3119437
13370201     5                          1
13370301     0.0                        1
13370401     590.0                      2
13370501     337010000    0    1    0   64.594         1
13370502     337010000    0    1    0   133.039        2
13370503     337010000    0    1    0   45.042         3
13370504     337010000    0    1    0   45.844         4
13370601     355010000    0    1    0   182.268        1
13370602     310010000    0    1    0   375.402        2
13370603     345010000    0    1    0   127.097        3
13370604     344010000    0    1    0   129.36         4
13370701     0      0.0    0.0    0.0                  4
13370801     0    0.2211    0.2211    2.818            1
13370802     0    0.2211    0.2211    5.804            2
13370803     0    0.2211    0.2211    1.965            3
13370804     0    0.2211    0.2211    2.0              4
13370901     0    2.3089    4.3245    2.818            1
13370902     0    0.836     3.3803    5.804            2
13370903     0    0.83806   3.3801    1.965            3
13370904     0    0.7626    3.0757    2.0              4
```

```
*-----------------------------------------------------
* HEAT STRUCTURE 321: BOTTOM LOWER PLENUM                    *
*                     (VESSEL WALL AND INTERNAL)             *
*-----------------------------------------------------
13210000     1   3   3   1   5.526
13210100     0   1
13210101     2                        5.86979
13210201     5                        1
13210202     6                        2
13210301     0.0                      2
13210401     543.667                  3
13210501     321010000   0   1   1   0.265          1
13210601     0           0   0   1   0.265          1
13210701     0        0.0   0.0   0.0               1
13210801     0      1.219   1.219   2.283           1
*-----------------------------------------------------
* HEAT STRUCTURE 322: TOP LOWER PLENUM                       *
*                     ( VESSEL WALL AND INTERNAL )           *
*-----------------------------------------------------
13220000     1   3   3   1   5.526
13220100     0   1
13220101     2                        5.86979
13220201     5                        1
13220202     6                        2
13220301     0.0                      2
13220401     543.667                  3
13220501     322010000   0  1   1   0.317          1
13220601     0           0  0   1   0.317          1
13220701     0     0.0     0.0     0.0              1
13220801     0     2.795   2.795   2.80             1
*-----------------------------------------------------------*
*-----------------------------------------------------------*
*              STANDALONE STEAM GENERATOR (BROKEN LOOP-A)   *
*-----------------------------------------------------------*
*-----------------------------------------------------------*
*-----------------------------------------------------------------
*         MINOR EDIT REQUEST
*-----------------------------------------------------------------
351     P       170010000
352     P       170050000
353     P       171010000
354     P       172010000
355     P       174010000
356     P       185010000
357     P       285010000
358     P       700010000
359     TEMPF   120010000
360     TEMPF   220010000
361     MFLOWJ  191000000
362     MFLOWJ  291000000
```

```
363     MFLOWJ  185010000
364     MFLOWJ  285010000
365     MFLOWJ  701000000
366     MFLOWJ  703000000
367     MFLOWJ  102030000
368     MFLOWJ  171010000
369     MFLOWJ  171020000
370     MFLOWJ  171030000
371     MFLOWJ  174010000
372     MFLOWJ  174020000
373     MFLOWJ  178000000
374     MFLOWJ  170020000
375     VOIDG   170010000
376     VOIDG   171010000
377     VOIDG   172010000
378     MFLOWJ  184000000
379     MFLOWJ  271010000
380     MFLOWJ  271020000
381     MFLOWJ  271030000
382     MFLOWJ  274010000
383     MFLOWJ  274020000
384     MFLOWJ  278000000
385     MFLOWJ  270020000
386     VOIDG   270010000
387     VOIDG   271010000
388     VOIDG   272010000
389     MFLOWJ  284000000
393     CNTRLVAR      121
394     CNTRLVAR      101
395     CNTRLVAR      102
396     MFLOWJ  182000000
397     MFLOWJ  282000000
398     MFLOWJ  186000000
399     MFLOWJ  286000000
*-----------------------------------------------------------------
*        HYDRODYNAMIC COMPONENT
*-----------------------------------------------------------------
*-------------------------------------------------------
* COMPONENT 105: BROKEN LOOP STEAM GENERATOR INLET PLENUM      *
*-------------------------------------------------------
1050000     B-SG-IP     SNGLVOL
1050101     24.0015  6.7417   0.0  0. 90. 1.704  0. 0.000  00
1050200     3  2239.9   589.85
*-------------------------------------------------------
* COMPONENT 106: BROKEN LOOP STEAM GENERATOR INLET PLENUM      *
*                TO PRIMARY TUBE JUNCTION                      *
*-------------------------------------------------------
1060000     B-IP-TUB          SNGLJUN
1060101     105010000   108000000  11.0988  0.69 0.69  0100
1060201     1     10334.0   0.0   0.0
```

```
*-------------------------------------------------------
* COMPONENT 108: BROKEN LOOP STEAM GENERATOR TUBES          *
*-------------------------------------------------------
1080000     B-SG-TUB     PIPE
1080001     8
1080101     11.0988                  8
1080201     11.0988                  7
1080301     9.91                     3
1080302     3.449                    5
1080303     9.91                     8
1080401     0.0                      8
1080601     90.0                     3
1080602     40.0                     4
1080603     -40.0                    5
1080604     -90.0                    8
1080701     9.91                     3
1080702     2.196                    4
1080703     -2.196                   5
1080704     -9.91                    8
1080801     0.0   0.0646             8
1080901     0.0   0.0                7
1081001     00                       8
1081101     0000                     3
1081102     0000                     4
1081103     0000                     7
1081201     3    2232.4    576.83   0.0      0.0   0.   1
1081202     3    2225.5    567.20   0.0      0.0   0.   2
1081203     3    2218.7    559.91   0.0      0.0   0.   3
1081204     3    2214.3    557.48   0.0      0.0   0.   4
1081205     3    2213.0    555.25   0.0      0.0   0.   5
1081206     3    2212.5    550.29   0.0      0.0   0.   6
1081207     3    2212.1    545.96   0.0      0.0   0.   7
1081208     3    2211.7    542.22   0.0      0.0   0.   8
1081300     1
1081301     10334.0     0.0  0.0    7
*-------------------------------------------------------
* COMPONENT 109: BROKEN LOOP STEAM GENERATOR PRIMARY TUBES    *
*                TO PRIMARY OUTLET PLENUM                     *
*-------------------------------------------------------
1090000     B-TU-OP      SNGLJUN
1090101     108010000     110000000  11.0988  0.69  0.69  0100
1090201     1     10334.0  0.0  0.0
*-------------------------------------------------------
* COMPONENT 110: BROKEN LOOP STEAM GENERATOR OUTLET PLENUM    *
*-------------------------------------------------------
1100000     B-SG-OP      SNGLVOL
1100101     24.0015  6.7417  0.0  0. -90. -1.704 0. 0.  00
1100200     3     2211.4     542.22
*-------------------------------------------------------
* COMPONENT 111: BROKEN LOOP STEAM GENERATOR OUTLET PLENUM    *
```

```
*                TO PUMP SUCTION LEG                                  *
*-------------------------------------------------------------
1110000     B-SG-O-P     SNGLJUN
1110101     110010000   112000000  5.2414 0.000 0.000   0100
1110201     1     10334.0   0.0  0.0
*-------------------------------------------------------------
* COMPONENT 174: BROKEN LOOP STEAM GENERATOR MID DOWNCOMER      *
*-------------------------------------------------------------
1740000     BSG-M-DO     BRANCH
1740001     2
1740101     60.3  6.752  0. 0. -90. -6.752 2.42189E-5 0.     00
1740200     3     857.37  501.730
1741101     172000000  174000000  60.3    1.0   1.0    0000
1742101     174010000  176000000  19.352  0.1   0.1    0000
1741201     1.7223 -4.2282  0.0
1742201     3.6356   3.6356 0.0
*-------------------------------------------------------------
* COMPONENT 176: BROKEN LOOP STEAM GENERATOR BOTTOM DOWNCOMER  *
*-------------------------------------------------------------
1760000     BSG-B-DO     PIPE
1760001     4
1760101     19.352                  1
1760102     7.0965                  4
1760201     7.0965                  3
1760301     2.196                   1
1760302     9.91                    4
1760401     0.0                     4
1760601     -90.0                   4
1760701     -2.196     1
1760702     -9.91      4
1760801     5.E-5   0.0             4
1760901     0.1    0.1              3
1761001     00                      4
1761101     0000                    3
1761201     3     858.84   501.740     0   0   0   1
1761202     3     860.39   501.740     0   0   0   2
1761203     3     863.68   501.760     0   0   0   3
1761204     3     866.98   501.770     0   0   0   4
1761301     9.9140   9.9140   0.0                   1
1761302     9.9139   9.9139   0.0                   2
1761303     9.9139   9.9139   0.0                   3
*-------------------------------------------------------------
* COMPONENT 178: BROKEN LOOP STEAM GENERATOR BOTTOM DOWNCOMER  *
*                TO RISER JUNCTION                                   *
*-------------------------------------------------------------
1780000     BSG-D-RI     SNGLJUN
1780101     176010000   170000000  2.8700  1.000  1.000  0100
1780201     0     9.9146   11.069   0.0
*-------------------------------------------------------------
* COMPONENT 170: BROKEN LOOP STEAM GENERATOR EVAPORATOR RISER  *
```

```
*-----------------------------------------------------
1700000     B-SG-RIS       PIPE
1700001     5
1700101     54.893                    3
1700102     47.164                    4
1700103     77.79                     5
1700201     54.893                    2
1700202     47.164                    4
1700301     9.91                      3
1700302     2.196                     4
1700303     6.752                     5
1700401     0.0                       5
1700601     90.0                      5
1700801     5.E-5     0.0             5
1700901     2.5       2.5             3
1700902     1.0       1.0             4
1701001     00                        5
1701101     0000                      4
1701201     0     860.41  512.17  1115.8  0.32765  0.0   1
1701202     0     858.74  516.09  1114.6  0.72765  0.0   2
1701203     0     857.84  516.37  1114.2  0.83908  0.0   3
1701204     0     857.26  516.30  1114.1  0.84332  0.0   4
1701205     0     856.94  516.25  1114.0  0.83804  0.0   5
1701301     1.8407   6.0283   0.0                   1
1701302     4.1842   6.1268   0.0                   2
1701303     7.5892   9.3246   0.0                   3
1701304     7.5386   10.473   0.0                   4
*-----------------------------------------------------
* COMPONENT 171: BROKEN LOOP STEAM GENERATOR SEPERATOR          *
*-----------------------------------------------------
1710000     B-SG-SEP     SEPARATR
1710001     3
1710101     97.070  6.937 0. 0. 90. 6.937 0.0 4.667   01
1710200     0     855.70   516.05  1113.9  .500
1711101     171010000  180000000  63.8  0.864 0.864 1020    0.00
1712101     171000000  172000000  30.000  0.0  0.0  1000    0.00
1713101     170010000  171000000  77.790  21.0 21.0 1000
1711201     6.7470   6.7470     0.0
1712201     1.9472   7.5366     0.0
1713201     4.5731   6.6075     0.0
*-----------------------------------------------------
* COMPONENT 172: BROKEN LOOP STEAM GENERATOR TOP DOWNCOMER      *
*-----------------------------------------------------
1720000     BSG-T-DO     SNGLVOL
1720101     88.87  6.937  0. 0. 90. 6.937 0. 4.014  01
1720200     0   855.70   516.05  1113.9  .500
*-----------------------------------------------------
* COMPONENT 180: BROKEN LOOP STEAM GENERATOR STEAM DOME         *
*-----------------------------------------------------
1800000     B-SG-DOM     PIPE
```

```
1800001     1
1800101     63.80000                1
1800301     7.2095                  1
1800401     0.0                     1
1800601     90.0                    1
1800701     7.2095                  1
1800801     0.0     0.0             1
1801001     00                      1
1801201     2    855.10  1.0000  0.0  0.0   0.0   1
*-------------------------------------------------------
1870000 B-SG-DOM  BRANCH
1870001  2  1
1870101  50.0  7.2095  0.   0.   90.   7.2095  0.  0.  00
1870200  2  855.10  1.0
1871101  172010000  187000000  50.0  0.  0.  0000
1872101  187000000  180000000  204.0 0.  0.  0003
1871201  0.0  0.0  0.0
1872201  0.0  0.0  0.0
*
1880000  B-SG-DOM  BRANCH
1880001  1  1
1880101  63.8  7.2095  0.  0.  90.  7.2095  0.  0.  00
1880200  2  855.00  1.0
1881101  180010000  188000000  63.8  0.0  0.0  0000
1881201  0.0  786.65  0.0
*-------------------------------------------------------
* COMPONENT 185: STEAM LINE                                  *
*-------------------------------------------------------
1850000     B-SG-SL     BRANCH
1850001     1  1
1850101     5.585  137.0  0. 0. 0. 0. 0. 2.667  00
1850200     2     853.64  1.0000
1851101     188010000  185000000  5.585  0.0  0.0  0000
1851201     0.0000  786.65 0.0
*-------------------------------------------------------
* COMPONENT 186: MAIN STEAM ISOLATION VALVE                  *
*-------------------------------------------------------
1860000     B-MSIV     VALVE
1860101     185010000  700000000  5.585  0.0  0.0  0100
1860201    1    0.0   786.65  0.0
1860300     MTRVLV
1860301     501  504  0.2  1.0  0.0
*-------------------------------------------------------
* COMPONENT 191: PORV                                        *
*-------------------------------------------------------
1910000  B-PORV  TMDPJUN
1910101  185000000  192000000  1.0
1910200  1 503 P  185010000
1910201  0.0     0.0     0.0     0.0
1910202  1019.0  0.0     0.0     0.0
```

```
1910203  1021.0  0.0   109.7     0.0
*
*-----------------------------------------------------------------
1920000  B-PORV  TMDPVOL
1920101  1.0  0.0  100.0  0.0  0.0  0.0  0.0  0.0  00
1920200  3
1920201  0.0  14.7  100.0
*
*-----------------------------------------------------------*
*  COMPONENT 193  SAFETY VALVES
*-----------------------------------------------------------*
1930000  B-SRV  TMDPJUN
1930101  185000000  194000000  1.0
1930200  1  0  P  185010000
1930201  0.0      0.0      0.0      0.0
1930202  1089.0  0.0      0.0      0.0
1930203  1091.0  0.0    219.4      0.0
1930204  1102.0  0.0    219.4      0.0
1930205  1104.0  0.0    443.0      0.0
1930206  1116.0  0.0    443.0      0.0
1930207  1118.0  0.0    670.8      0.0
1930208  1129.0  0.0    670.8      0.0
1930209  1131.0  0.0    901.3      0.0
1930210  1143.0  0.0    901.3      0.0
1930211  1145.0  0.0   1134.7      0.0
*
*-----------------------------------------------------------------
1940000  B-SRV  TMDPVOL
1940101  1.0  0.0  100.0  0.0  0.0  0.0  0.0  0.0  00
1940200  3
1940201  0.0  14.7  100.0
*-----------------------------------------------------
* COMPONENT 183: BROKEN LOOP MAIN FEEDWATER SOURCE VOLUME      *
*-----------------------------------------------------
1830000     B-MFW     TMDPVOL
1830101     10.0  0.0  100.0  0. 0. 0. 0. 0.  00
1830200     3
1830201     0.0     500.0   413.0
*-----------------------------------------------------
* COMPONENT 184: BROKEN LOOP MAIN FEEDWATER JUNCTION           *
*-----------------------------------------------------
1840000     B-MFW-J     TMDPJUN
1840101     183000000     174000000   5.0
1840200     1   503
1840201     -1.0     786.65    0.0   0.0
1840202      0.000   786.65    0.0   0.0
1840203      10.0    630.00    0.0   0.0
1840204      20.0    391.20    0.0   0.0
1840205      30.0    340.00    0.0   0.0
1840206      40.0    290.70    0.0   0.0
```

```
1840207      50.0    270.00    0.0   0.0
1840208      60.0      0.00    0.0   0.0
1840209      70.0      0.00    0.0   0.0
1840210     81.10      0.00    0.0   0.0
1840211  10000.00      0.00    0.0   0.0
*-------------------------------------------------------*
* COMPONENT 181:BROKEN LOOP AUXILIARY FEEDWATER                *
*                    SOURCE VOLUME                            *
*-------------------------------------------------------
1810000     B-AFEED      TMDPVOL
1810101     1.0  0.0  100.0  0.  0.   0.  0.  0.  00
1810200     3
1810201     0.0   500.0    100.0
*-------------------------------------------------------
* COMPONENT 182: BROKEN AUX-FEED WATER JUNCTION                *
*-------------------------------------------------------
*  MOTOR DRIVEN + TBN DRIVEN
*
1820000     B-FEED-J     TMDPJUN
1820101     181000000   174000000   1.0
1820200     1           589
1820201     0.0    0.0   0.0   0.0
1820202     20.0   0.0   0.0   0.0
1820203     50.0   58.08 0.0   0.0
*-----------------------------------------------------------------
*            HEAT STRUCTURE INPUT
*-----------------------------------------------------------------
*-------------------------------------------------------
* HEAT STRUCTURE 108: STEAM GENERATOR U-TUBES                  *
*-------------------------------------------------------
11081000     8  4  2  1  0.032292
11081100     0  1
11081101     3  0.036458
11081201     4      3
11081301     0.0     3
11081401     520.0     4
11081501     108010000  0       1   0   8382.1469     1
11081502     108020000  0       1   0   8382.1469     2
11081503     108030000  0       1   0   8382.1469     3
11081504     108040000  0       1   0   2917.1839     4
11081505     108050000  0       1   0   2917.1839     5
11081506     108060000  0       1   0   8382.1469     6
11081507     108070000  0       1   0   8382.1469     7
11081508     108080000  0       1   0   8382.1469     8
11081601     170010000  0       1   0   9463.5300     1
11081602     170020000  0       1   0   9463.5300     2
11081603     170030000  0       1   0   9463.5300     3
11081604     170040000  0       1   0   3293.5306     4
11081605     170040000  0       1   0   3293.5306     5
11081606     170030000  0       1   0   9463.5300     6
```

```
11081607     170020000  0        1   0   9463.5300     7
11081608     170010000  0        1   0   9463.5300     8
11081701     0     0.0  0.0  0.0                      8
11081801     0     0.0646  0.0646  9.91               3
11081802     0     0.0646  0.0646  3.449              5
11081803     0     0.0646  0.0646  9.91               8
11081901     0     0.12618  0.12618  9.91             3
11081902     0     0.119    0.1215  3.449            5
11081903     0     0.12618  0.12618  9.91             8
*-------------------------------------------------------------*
*-----------------------------------------------------
* CONTROL VARIABLE  51  BROKEN LOOP STEAM GENERATOR          *
*                      SECONDARY SIDE MASS INVENTORY         *
*-----------------------------------------------------
20505100     BSG-MAS      SUM   0.062428   0.0   1
20505101     0.0   544.0   RHO 170010000   544.0   RHO 170020000
20505102           544.0   RHO 170030000   103.572 RHO 170040000
20505103           525.252 RHO 170050000   608.83  RHO 171010000
20505104           616.5   RHO 172010000   407.145 RHO 174010000
20505105           42.498  RHO 176010000   70.3265 RHO 176020000
20505106           70.3265 RHO 176030000   70.3265 RHO 176040000
20505107          1611.200 RHO 180010000
*-------------------------------------------------------------
*-----------------------------------------------------
* CONTROL VARIABLE  52: BROKEN LOOP STEAM GENERATOR          *
*                      SECONDARY SIDE WATER VOLUME INVENTORY *
*-----------------------------------------------------
20505200     IBG-VOF      SUM   1.000000   0.0   1
20505201     0.0   544.0   VOIDF 170010000   544.0   VOIDF 170020000
20505202           544.0   VOIDF 170030000   103.572 VOIDF 170040000
20505203           525.252 VOIDF 170050000   608.83  VOIDF 171010000
20505204           616.5   VOIDF 172010000   407.145 VOIDF 174010000
20505205           42.498  VOIDF 176010000   70.3265 VOIDF 176020000
20505206           70.3265 VOIDF 176030000   70.3265 VOIDF 176040000
20505207          1611.200 VOIDF 180010000
*-----------------------------------------------------
* CONTROL VARIABLE  53: BROKEN LOOP STEAM GENERATOR          *
*          WIDE RANGE  SECONDARY SIDE WATER VOLUME INVENTORY *
*-----------------------------------------------------
20505300     WBWRVOF      SUM   1.000000   0.0   1
20505301     0.0   616.5   VOIDF 172010000   407.145 VOIDF 174010000
20505302           42.498  VOIDF 176010000   70.3265 VOIDF 176020000
20505303           70.3265 VOIDF 176030000   70.3265 VOIDF 176040000
20505304          1611.200 VOIDF 180010000
*-----------------------------------------------------
* CONTROL VARIABLE  54: BROKEN LOOP STEAM GENERATOR          *
*        NARROW RANGE  SECONDARY SIDE WATER VOLUME INVENTORY *
*-----------------------------------------------------
20505400     BNR-VOF      SUM   1.000000   0.0   1
20505401     0.0   616.5   VOIDF 172010000   108.178 VOIDF 174010000
```

```
*
*-----------------------------------------------------------------
20505500  XXC3  SUM  1.3797-03  0.8  1  3  0.0  1.0
20505501  -552.33  1.00  CNTRLVAR,53
*-----------------------------------------------------------------
20505600  XXC4  SUM  1.3797-03  0.44  1  3  0.0  1.0
20505601  0.000    1.00  CNTRLVAR,54
*-----------------------------------------------------------------
* NARROW RANGE LEVEL REDUCED FROM WIDE RANGE WATER VOLUME
20505700  BWR-LEVL  FUNCTION  1.0  0.44  1  3  0.0  1.0
20505701  CNTRLVAR,55  501
*
*-----------------------------------------------------------------
* NARROW RANGE LEVEL REDUCED FROM NARROW RANGE WATER VOLUME
20505800  BNR-LEVL  FUNCTION  1.0  0.44  1  3  0.0  1.0
20505801  CNTRLVAR,56  501
*-----------------------------------------------------------------
* S/G FLUID VOLUME FROM BOTTOM
20505900   BSGVOL   SUM   0.0003498   0.66   1
20505901    0.0   1.0   CNTRLVAR,52
*-----------------------------------------------------------------
* S/G WATER LEVEL FROM BOTTOM
20506000   BSGLVL   FUNCTION  44.942  39.2  1
20506001    CNTRLVAR,59   502
*
*-----------------------------------------------------------------
*
*      G E N E R A L   T A B L E   D E C K
*
*-----------------------------------------------------------------
* NARROW RANGE WATER LEVEL VERSUS NR WATER VOLUME
20250100  NORMAREA
20250101    0.0    0.0
20250102    0.149  0.1500
20250103    1.00   0.730
*-----------------------------------------------------------------
* S/G VOLUME VS. LEVEL
20250200   NORMAREA
20250201    0.0       0.0
20250202    0.215     0.662
20250203    0.266     0.710
20250204    0.592     0.860
20250205    1.0       1.0
*
*-----------------------------------------------------------------*
*              STANDALONE STEAM GENERATOR (INTACT LOOP-B)         *
*-----------------------------------------------------------------*
*-----------------------------------------------------------------*
*-----------------------------------------------------------------
*         MINOR EDIT REQUEST
```

```
*-----------------------------------------------------------------
*-----------------------------------------------------------------
*        HYDRODYNAMIC COMPONENT
*-----------------------------------------------------------------
*-------------------------------------------------------
* COMPONENT 205: INTACT LOOP STEAM GENERATOR INLET PLENUM      *
*-------------------------------------------------------
2050000     I-SG-IP     SNGLVOL
2050101     24.0015  6.7417   0.0  0. 90. 1.704  0. 0.000  00
2050200     3  2239.9   589.85
*-------------------------------------------------------
* COMPONENT 206: INTACT LOOP STEAM GENERATOR INLET PLENUM      *
*                TO PRIMARY TUBE JUNCTION                      *
*-------------------------------------------------------
2060000     I-IP-TUB          SNGLJUN
2060101     205010000   208000000  11.0988  0.69 0.69  0100
2060201     1     10334.0   0.0   0.0
*-------------------------------------------------------
* COMPONENT 208: INTACT LOOP STEAM GENERATOR TUBES             *
*-------------------------------------------------------
2080000     I-SG-TUB     PIPE
2080001     8
2080101     11.0988                 8
2080201     11.0988                 7
2080301     9.91                    3
2080302     3.449                   5
2080303     9.91                    8
2080401     0.0                     8
2080601     90.0                    3
2080602     40.0                    4
2080603     -40.0                   5
2080604     -90.0                   8
2080701     9.91                    3
2080702     2.196                   4
2080703     -2.196                  5
2080704     -9.91                   8
2080801     0.0   0.0646            8
2080901     0.0   0.0               7
2081001     00                      8
2081101     0000                    3
2081102     0000                    4
2081103     0000                    7
2081201     3    2232.4    576.83   0.0      0.0  0.0   1
2081202     3    2225.5    567.20   0.0      0.0  0.0   2
2081203     3    2218.7    559.91   0.0      0.0  0.0   3
2081204     3    2214.3    557.48   0.0      0.0  0.0   4
2081205     3    2213.0    555.25   0.0      0.0  0.0   5
2081206     3    2212.5    550.29   0.0      0.0  0.0   6
2081207     3    2212.1    545.96   0.0      0.0  0.0   7
2081208     3    2211.7    542.22   0.0      0.0  0.0   8
```

```
2081300     1
2081301     10334.0     0.0  0.0    7
*-------------------------------------------------------
* COMPONENT 209: INTACT LOOP STEAM GENERATOR PRIMARY TUBES     *
*                TO PRIMARY OUTLET PLENUM                      *
*-------------------------------------------------------
2090000     I-TU-OP     SNGLJUN
2090101     208010000     210000000  11.0988  0.69  0.69  0100
2090201     1     10334.0  0.0  0.0
*-------------------------------------------------------
* COMPONENT 210: INTACT LOOP STEAM GENERATOR OUTLET PLENUM     *
*-------------------------------------------------------
2100000     I-SG-OP     SNGLVOL
2100101     24.0015  6.7417  0.0  0. -90. -1.704 0. 0.  00
2100200     3     2211.4     542.22
*-------------------------------------------------------
* COMPONENT 211: INTACT LOOP STEAM GENERATOR OUTLET PLENUM     *
*                TO PUMP SUCTION LEG                           *
*-------------------------------------------------------
2110000     I-SG-O-P     SNGLJUN
2110101     210010000   212000000  5.2414 0.000 0.000   0100
2110201     1     10334.0   0.0  0.0
*-------------------------------------------------------
* COMPONENT 274: BROKEN LOOP STEAM GENERATOR MID DOWNCOMER     *
*-------------------------------------------------------
2740000     BSG-M-DO     BRANCH
2740001     2
2740101     60.3  6.752  0. 0. -90. -6.752 2.42189E-5 0.     00
2740200     3     857.37  501.730
2741101     272000000  274000000  60.3    1.0   1.0    0000
2742101     274010000  276000000  19.352  0.1   0.1    0000
2741201     1.7223 -4.2282  0.0
2742201     3.6356   3.6356 0.0
*-------------------------------------------------------
* COMPONENT 276: BROKEN LOOP STEAM GENERATOR BOTTOM DOWNCOMER  *
*-------------------------------------------------------
2760000     BSG-B-DO     PIPE
2760001     4
2760101     19.352                  1
2760102     7.0965                  4
2760201     7.0965                  3
2760301     2.196                   1
2760302     9.91                    4
2760401     0.0                     4
2760601     -90.0                   4
2760701     -2.196     1
2760702     -9.91      4
2760801     5.E-5   0.0             4
2760901     0.1    0.1              3
2761001     00                      4
```

```
2761101     0000                        3
2761201     3     858.84    501.740     0    0    0    1
2761202     3     860.39    501.740     0    0    0    2
2761203     3     863.68    501.760     0    0    0    3
2761204     3     866.98    501.770     0    0    0    4
2761301     9.9140    9.9140    0.0                    1
2761302     9.9139    9.9139    0.0                    2
2761303     9.9139    9.9139    0.0                    3
*-------------------------------------------------------
* COMPONENT 278: BROKEN LOOP STEAM GENERATOR BOTTOM DOWNCOMER  *
*                TO RISER JUNCTION                             *
*-------------------------------------------------------
2780000     BSG-D-RI      SNGLJUN
2780101     276010000   270000000  2.8700  1.000  1.000  0100
2780201     0     9.9146    11.069    0.0
*-------------------------------------------------------
* COMPONENT 270: BROKEN LOOP STEAM GENERATOR EVAPORATOR RISER  *
*-------------------------------------------------------
2700000     B-SG-RIS        PIPE
2700001     5
2700101     54.893                      3
2700102     47.164                      4
2700103     77.79                       5
2700201     54.893                      2
2700202     47.164                      4
2700301     9.91                        3
2700302     2.196                       4
2700303     6.752                       5
2700401     0.0                         5
2700601     90.0                        5
2700801     5.E-5      0.0              5
2700901     2.5       2.5               3
2700902     1.0       1.0               4
2701001     00                          5
2701101     0000                        4
2701201     0     860.41   512.17  1115.8  0.32765  0.0   1
2701202     0     858.74   516.09  1114.6  0.72765  0.0   2
2701203     0     857.84   516.37  1114.2  0.83908  0.0   3
2701204     0     857.26   516.30  1114.1  0.84332  0.0   4
2701205     0     856.94   516.25  1114.0  0.83804  0.0   5
2701301     1.8407    6.0283    0.0                    1
2701302     4.1842    6.1268    0.0                    2
2701303     7.5892    9.3246    0.0                    3
2701304     7.5386    10.473    0.0                    4
*-------------------------------------------------------
* COMPONENT 271: BROKEN LOOP STEAM GENERATOR SEPERATOR         *
*-------------------------------------------------------
2710000     B-SG-SEP      SEPARATR
2710001     3
2710101     97.070  6.937 0. 0. 90. 6.937 0.0 4.667   01
```

```
2710200     0     855.70   516.05  1113.9  .500
2711101     271010000  280000000  63.8  0.864 0.864 1020    0.00
2712101     271000000  272000000  30.000  0.0  0.0  1000    0.00
2713101     270010000  271000000  77.790  21.0 21.0 1000
2711201     6.7470   6.7470     0.0
2712201     1.9472   7.5366     0.0
2713201     4.5731   6.6075     0.0
*-------------------------------------------------------
* COMPONENT 272: BROKEN LOOP STEAM GENERATOR TOP DOWNCOMER     *
*-------------------------------------------------------
2720000     BSG-T-DO     SNGLVOL
2720101     88.87  6.937  0. 0. 90. 6.937 0. 4.014  01
2720200     0   855.70   516.05  1113.9  .500
*-------------------------------------------------------
* COMPONENT 280: BROKEN LOOP STEAM GENERATOR STEAM DOME        *
*-------------------------------------------------------
2800000     B-SG-DOM     PIPE
2800001     1
2800101     63.80000                  1
2800301     7.2095                    1
2800401     0.0                       1
2800601     90.0                      1
2800701     7.2095                    1
2800801     0.0     0.0               1
2801001     00                        1
2801201     2    855.10  1.0000  0.0  0.0   0.0   1
*-------------------------------------------------------
2870000 B-SG-DOM  BRANCH
2870001  2  1
2870101  50.0  7.2095  0.   0.   90.   7.2095  0.  0.  00
2870200  2  855.10  1.0
2871101  272010000  287000000  50.0  0.  0.  0000
2872101  287000000  280000000  204.0 0.  0.  0003
2871201  0.0  0.0  0.0
2872201  0.0  0.0  0.0
*
2880000  B-SG-DOM  BRANCH
2880001  1  1
2880101  63.8  7.2095  0.  0.  90.  7.2095  0.  0.  00
2880200  2  855.00  1.0
2881101  280010000  288000000  63.8  0.0  0.0  0000
2881201  0.0  786.65  0.0
*-------------------------------------------------------
* COMPONENT 285: STEAM LINE                                    *
*-------------------------------------------------------
2850000     I-SG-SL     BRANCH
2850001     1  1
2850101     5.585  137.0  0. 0. 0. 0. 0. 2.667  00
2850200     2     853.64  1.0000
2851101     288010000  285000000  5.585  0.0  0.0  0000
```

```
2851201     0.0000  786.65 0.0
*-------------------------------------------------------
* COMPONENT 286: MAIN STEAM ISOLATION VALVE                 *
*-------------------------------------------------------
2860000     I-MSIV     VALVE
2860101     285010000  700000000  5.585  0.0  0.0  0100
2860201    1    0.00  786.65  0.0
2860300     MTRVLV
2860301     501  504  0.2  1.0  0.0
*-------------------------------------------------------
* COMPONENT 291: PORV                                      *
*-------------------------------------------------------
2910000  I-PORV  TMDPJUN
2910101  185000000  292000000  1.0
2910200  1 503 P  185010000
2910201  0.0      0.0      0.0      0.0
2910202  1019.0  0.0      0.0      0.0
2910203  1021.0  0.0    109.7      0.0
*
*-----------------------------------------------------------------
2920000  I-PORV  TMDPVOL
2920101  1.0  0.0  100.0  0.0  0.0  0.0  0.0  0.0  00
2920200  3
2920201  0.0  14.7  100.0
*
*-------------------------------------------------------*
*  COMPONENT 293  SAFETY VALVES
*-------------------------------------------------------*
2930000  I-SRV  TMDPJUN
2930101  185000000  294000000  1.0
2930200  1  0  P  185010000
2930201  0.0      0.0      0.0      0.0
2930202  1089.0  0.0      0.0      0.0
2930203  1091.0  0.0    219.4      0.0
2930204  1102.0  0.0    219.4      0.0
2930205  1104.0  0.0    443.0      0.0
2930206  1116.0  0.0    443.0      0.0
2930207  1118.0  0.0    670.8      0.0
2930208  1129.0  0.0    670.8      0.0
2930209  1131.0  0.0    901.3      0.0
2930210  1143.0  0.0    901.3      0.0
2930211  1145.0  0.0   1134.7      0.0
*
*-------------------------------------------------------------------
2940000  I-SRV  TMDPVOL
2940101  1.0  0.0  100.0  0.0  0.0  0.0  0.0  0.0  00
2940200  3
2940201  0.0  14.7  100.0
*-------------------------------------------------------
* COMPONENT 283: INTACT LOOP MAIN FEEDWATER SOURCE VOLUME      *
```

```
*-----------------------------------------------------
2830000     I-MFW     TMDPVOL
2830101     10.0  0.0  100.0  0. 0. 0. 0. 0.  00
2830200     3
2830201     0.0     500.0   413.0
*-----------------------------------------------------
* COMPONENT 284: INTACT LOOP MAIN FEEDWATER JUNCTION          *
*-----------------------------------------------------
2840000     I-MFW-J     TMDPJUN
2840101     283000000     274000000   5.0
2840200     1   590
2840201    -1.00    786.650    0.0   0.0
2840202       0.0   786.65    0.0   0.0
2840203      10.0       0.0   0.0    0.0
2840204     10000.      0.0   0.0    0.0
*-----------------------------------------------------*
* COMPONENT 281:INTACT LOOP AUXILIARY FEEDWATER               *
*                     SOURCE VOLUME                           *
*-----------------------------------------------------
2810000     I-AFEED      TMDPVOL
2810101     1.0  0.0  100.0  0.  0.   0.  0.  0.  00
2810200     3
2810201     0.0   500.0    100.0
*-----------------------------------------------------
* COMPONENT 282: INTACT AUX-FEED WATER JUNCTION               *
*-----------------------------------------------------
*  MOTOR DRIVEN + TBN DRIVEN
*
2820000     I-FEED-J     TMDPJUN
2820101     281000000   274000000   1.0
2820200     1           589
2820201     0.0    0.0   0.0   0.0
2820202     20.0   0.0   0.0   0.0
2820203     50.0   58.08 0.0   0.0
*-----------------------------------------------------------
*            HEAT STRUCTURE INPUT
*-----------------------------------------------------------
*-----------------------------------------------------
* HEAT STRUCTURE 208: STEAM GENERATOR U-TUBES                 *
*-----------------------------------------------------
12081000     8  4  2  1  0.032292
12081100     0  1
12081101     3  0.036458
12081201     4       3
12081301     0.0       3
12081401     520.0     4
12081501     208010000  0       1   0   8382.1469     1
12081502     208020000  0       1   0   8382.1469     2
12081503     208030000  0       1   0   8382.1469     3
12081504     208040000  0       1   0   2917.1839     4
```

```
12081505     208050000  0        1   0   2917.1839     5
12081506     208060000  0        1   0   8382.1469     6
12081507     208070000  0        1   0   8382.1469     7
12081508     208080000  0        1   0   8382.1469     8
12081601     270010000  0        1   0   9463.5300     1
12081602     270020000  0        1   0   9463.5300     2
12081603     270030000  0        1   0   9463.5300     3
12081604     270040000  0        1   0   3293.5306     4
12081605     270040000  0        1   0   3293.5306     5
12081606     270030000  0        1   0   9463.5300     6
12081607     270020000  0        1   0   9463.5300     7
12081608     270010000  0        1   0   9463.5300     8
12081701     0      0.0  0.0  0.0                     8
12081801     0      0.0646  0.0646  9.91               3
12081802     0      0.0646  0.0646  3.449              5
12081803     0      0.0646  0.0646  9.91               8
12081901     0      0.12618  0.12618  9.91             3
12081902     0      0.119    0.1215  3.449            5
12081903     0      0.12618  0.12618  9.91             8
*
*-----------------------------------------------------------------*
*  CONTROL VARIABLE 300 : U-TUBE HEAT TRANSFER RATE               *
*-----------------------------------------------------------------*
20530000      UT-HEAT    SUM    1.0E-6        0.0    1
20530001      0.0        1.0    Q             108010000
20530002                 1.0    Q             108020000
20530003                 1.0    Q             108030000
20530004                 1.0    Q             108040000
20530005                 1.0    Q             108050000
20530006                 1.0    Q             108060000
20530007                 1.0    Q             108070000
20530008                 1.0    Q             108080000
20530009                 1.0    Q             208010000
20530010                 1.0    Q             208020000
20530011                 1.0    Q             208030000
20530012                 1.0    Q             208040000
20530013                 1.0    Q             208050000
20530014                 1.0    Q             208060000
20530015                 1.0    Q             208070000
20530016                 1.0    Q             208080000
*-----------------------------------------------------------------
*-----------------------------------------------------------------
*         LOOP A-B INTERCONNECTION
*-----------------------------------------------------------------
* COMPONENT  700 ;  STEAM HEAD
*-----------------------------------------------------------------
7000000     STHEAD   SNGLVOL
7000101     5.585  0.0  100.0  0.  0.  0.  0.  0.  10
7000200     2   849.39  1.0
*-----------------------------------------------------------------
```

```
* COMPONENT  701; TURBINE STOP VALVE
*-----------------------------------------------------------------
7010000     TBNSTOP   VALVE
7010101     700010000   702000000  5.585  0.  0.  0100
7010201     1  0.0   1573.3   0.0
7010300     MTRVLV
7010301     501   601   0.2   1.0   0.0
*-----------------------------------------------------------------
* COMPONENT  702; TBN
*-----------------------------------------------------------------
7020000     TBN   TMDPVOL
7020101     5.585  0.0  100.0  0.  0.  0.  0.  0.  00
7020200     2
7020201     0.0   850.00 1.0
*-----------------------------------------------------------------
*        CONTROL SYSTEM INPUT DATA
*-----------------------------------------------------------------
*-----------------------------------------------------------
* CONTROL VARIABLE 61: INTACT LOOP STEAM GENERATOR            *
*                      SECONDARY SIDE MASS INVENTORY          *
*-----------------------------------------------------------
20506100     ISG-MAS      SUM   0.062428   0.0   1
20506101     0.0   544.0   RHO 270010000   544.0   RHO 270020000
20506102           544.0   RHO 270030000   103.572 RHO 270040000
20506103           525.252 RHO 270050000   608.83  RHO 271010000
20506104           616.5   RHO 272010000   407.145 RHO 274010000
20506105           42.498  RHO 276010000   70.3265 RHO 276020000
20506106           70.3265 RHO 276030000   70.3265 RHO 276040000
20506107          1611.200 RHO 280010000
*-----------------------------------------------------------------
*-----------------------------------------------------------
* CONTROL VARIABLE 62: INTACT LOOP STEAM GENERATOR            *
*                      SECONDARY SIDE WATER VOLUME INVENTORY  *
*-----------------------------------------------------------
20506200     ISG-VOF      SUM   1.000000   0.0   1
20506201     0.0   544.0   VOIDF 270010000   544.0   VOIDF 270020000
20506202           544.0   VOIDF 270030000   103.572 VOIDF 270040000
20506203           525.252 VOIDF 270050000   608.83  VOIDF 271010000
20506204           616.5   VOIDF 272010000   407.145 VOIDF 274010000
20506205           42.498  VOIDF 276010000   70.3265 VOIDF 276020000
20506206           70.3265 VOIDF 276030000   70.3265 VOIDF 276040000
20506207          1611.200 VOIDF 280010000
*-----------------------------------------------------------
* CONTROL VARIABLE 63: INTACT LOOP STEAM GENERATOR            *
*          WIDE RANGE  SECONDARY SIDE WATER VOLUME INVENTORY  *
*-----------------------------------------------------------
20506300     IWR-VOF      SUM   1.000000   0.0   1
20506301     0.0   616.5   VOIDF 272010000   407.145 VOIDF 274010000
20506302           42.498  VOIDF 276010000   70.3265 VOIDF 276020000
20506303           70.3265 VOIDF 276030000   70.3265 VOIDF 276040000
```

```
20506304          1611.200 VOIDF 280010000
*-------------------------------------------------------
* CONTROL VARIABLE 64: INTACT LOOP STEAM GENERATOR              *
*        NARROW RANGE  SECONDARY SIDE WATER VOLUME INVENTORY  *
*-------------------------------------------------------
20506400     INR-VOF      SUM   1.000000   0.0   1
20506401     0.0   616.5   VOIDF 272010000   108.178 VOIDF 274010000
*
*-----------------------------------------------------------------
20506500  XXC3  SUM  1.3797-03  0.8  1  3  0.0  1.0
20506501  -552.33  1.00  CNTRLVAR,63
*-----------------------------------------------------------------
20506600  XXC4  SUM  1.3797-03  0.44  1  3  0.0  1.0
20506601  0.000    1.00  CNTRLVAR,64
*-----------------------------------------------------------------
* NARROW RANGE LEVEL REDUCED FROM WIDE RANGE WATER VOLUME
20506700  IWR-LEVL  FUNCTION  1.0  0.44  1  3  0.0  1.0
20506701  CNTRLVAR,65  501
*
*-----------------------------------------------------------------
* NARROW RANGE LEVEL REDUCED FROM NARROW RANGE WATER VOLUME
20506800  INR-LEVL  FUNCTION  1.0  0.44  1  3  0.0  1.0
20506801  CNTRLVAR,66  501
*
*-----------------------------------------------------------------
* S/G LIQUID VOLUME FROM BOTTOM
20506900    ISGVOL   SUM   0.0003498   0.66  1
20506901     0.0   1.0   CNTRLVAR,62
*-----------------------------------------------------------------
* S/G WATER LEVEL FROM BOTTOM
20507000    ISGLVL   FUNCTION   44.942   39.2   1
20507001     CNTRLVAR,69   502
*-----------------------------------------------------------------
*
*-----------------------------------------------------------------*
*-----------------------------------------------------------------*
*                REACTOR COOLANT SYSTEM                           *
*-----------------------------------------------------------------*
*-----------------------------------------------------------------*
*-------------------------------------------------*
* COMPONENT 101; BROKEN LOOP HOT LEG #1 VOLUME                    *
*-------------------------------------------------*
1010000     B-HL-1   SNGLVOL
1010101     4.587  0.0  39.6824  0. 0. 0. 0.  2.417  00
1010200     3   2244.0   589.86
*-------------------------------------------------*
* COMPONENT 102; BROKEN LOOP HOT LEG #2 VOLUME                    *
*-------------------------------------------------*
1020000     B-HL-2   BRANCH
1020001     3     1
```

```
1020101     4.587  0.0  40.0  0. 0. 0. 0.  2.417  00
1020200     3   2243.7  589.87
1021101     101010000  102000000  4.587  0.0  0.0  0000
1022101     102010000  103000000  4.587  0.2  0.2  0000
1023101     630010000  102000000  0.7854 1.92 1.70 0100
1021201     10334.0  0.0  0.0
1022201     10334.0  0.0  0.0
1023201     0.0000  0.0  0.0
*-----------------------------------------------------*
* COMPONENT 103; BROKEN LOOP HOT LEG #3 VOLUME                *
*-----------------------------------------------------*
1030000     B-HL-3   SNGLVOL
1030101     4.587  0.0  31.8933  0.  90.0 5.144  0.  2.417  00
1030200     3   2240.3   589.85
*-----------------------------------------------------*
* COMPONENT 104; BROKEN LOOP HOT LEG 3 TO INLET PLENUM        *
*-----------------------------------------------------*
1040000     B-HL-IP   SNGLJUN
1040101     103010000  105000000  4.587  0.25 0.25   0100
1040201     1    10334.0   0.0   0.0
*-----------------------------------------------------*
* COMPONENT 112; BROKEN LOOP PUMP SUCTION LEG                 *
*-----------------------------------------------------*
1120000     B-P-SUC   PIPE
1120001     3
1120101     5.2414     3
1120201     5.2414     2
1120301     15.456     1
1120302     11.886     2
1120303     4.5        3
1120401     0.0        3
1120601     -90.0      1
1120602     0.0        2
1120603     90.0       3
1120701     -15.456    1
1120702     0.0        2
1120703     4.5        3
1120801     0.0   2.583      3
1120901     0.0   0.0        2
1121001     00               3
1121101     0000             2
1121201     3    2202.4   542.18   0.0  0.0  0.0   1
1121202     3    2204.7   542.20   0.0  0.0  0.0   2
1121203     3    2203.8   542.19   0.0  0.0  0.0   3
1121300     1
1121301     10334.0   0.0  0.0  2
*-----------------------------------------------------*
* COMPONENT 114; BROKEN LOOP REACTOR COOLANT PUMP VOLUME      *
*-----------------------------------------------------*
1140000     B-PUMP    PUMP
```

```
1140101     0.0  5.812  57.0
1140102     0.0  90.0    5.812
1140103     00
1140108     112010000  5.2414  0.0  0.0  0100
1140109     116000000  4.1247  0.0  0.0  0100
1140200     3     2258.3   542.53
1140201     1     10334.0   0.0  0.0
1140202     1     10334.0   0.0  0.0
1140301     0  0  0  -1  -1  594  0
1140302     1190.0  1.0  98214.00 314.93 32668.85  82000.0
1140303     0.0     0.0  1925.0   0.0    0.0   0.0
1140310     1.0E6   1190.0   -1.0
*-----------------------------------------------------*
* COMPONENT 116; BROKEN LOOP COLD LEG PIPIG 1                *
*-----------------------------------------------------*
1160000     B-CL-1   SNGLVOL
1160101     4.1247  0.0  19.6843  0. 0. 0. 0.  2.292  00
1160200     3     2293.2   542.68
*-----------------------------------------------------*
* COMPONENT 120; BROKEN LOOP COLD LEG PIPING 2               *
*-----------------------------------------------------*
1200000     B-CL-2    BRANCH
1200001     2     1
1200101     4.1247  0.0  56.4362  0. 0. 0. 0.  2.292  00
1200200     3     2292.8   542.68
1201101     116010000  120000000  4.1247  0.0  0.0  0000
1202101     120010000  300000000  4.1247  0.0044 0.0044  0100
1201201     10334.0     0.0   0.0
1202201     10334.0     0.0   0.0
*-----------------------------------------------------*
* COMPONENT 201; INTACT LOOP HOT LEG #1 VOLUME               *
*-----------------------------------------------------*
2010000     I-HL-1   SNGLVOL
2010101     4.587  0.0  39.6824  0. 0. 0. 0.  2.417  00
2010200     3   2244.0   589.86
*-----------------------------------------------------*
* COMPONENT 202; INTACT LOOP HOT LEG #2 VOLUME               *
*-----------------------------------------------------*
2020000     I-HL-2   BRANCH
2020001     2   1
2020101     4.587  0.0  40.0  0. 0. 0. 0.  2.417  00
2020200     3   2243.7  589.87
2021101     201010000  202000000  4.587  0.0  0.0  0000
2022101     202010000  203000000  4.587  0.2  0.2  0000
2021201     10334.0   0.0   0.0
2022201     10334.0   0.0   0.0
*-----------------------------------------------------*
* COMPONENT 203; INTACT LOOP HOT LEG #3 VOLUME               *
*-----------------------------------------------------*
2030000     I-HL-3   SNGLVOL
```

```
2030101     4.587  0.0  31.8933  0.   90.0 5.144  0.  2.417  00
2030200     3   2240.3   589.85
*-----------------------------------------------------*
* COMPONENT 204; INTACT LOOP HOT LEG 3 TO INLET PLENUM        *
*-----------------------------------------------------*
2040000     I-HL-IP   SNGLJUN
2040101     203010000  205000000  4.587   0.25 0.25  0100
2040201     1    10334.0   0.0   0.0
*-----------------------------------------------------*
* COMPONENT 212; INTACT LOOP PUMP SUCTION LEG                 *
*-----------------------------------------------------*
2120000     I-P-SUC   PIPE
2120001     3
2120101     5.2414     3
2120201     5.2414     2
2120301     15.456     1
2120302     11.886     2
2120303     4.5        3
2120401     0.0        3
2120601     -90.0      1
2120602     0.0        2
2120603     90.0       3
2120701     -15.456    1
2120702     0.0        2
2120703     4.5        3
2120801     0.0   2.583      3
2120901     0.0   0.0        2
2121001     00               3
2121101     0000             2
2121201     3    2202.4   542.18   0.0  0.0  0.0  1
2121202     3    2204.7   542.20   0.0  0.0  0.0  2
2121203     3    2203.8   542.19   0.0  0.0  0.0  3
2121300     1
2121301     10334.0   0.0  0.0  2
*-----------------------------------------------------*
* COMPONENT 214; INTACT LOOP REACTOR COOLANT PUMP VOLUME      *
*-----------------------------------------------------*
2140000     I-PUMP    PUMP
2140101     0.0  5.812  57.0
2140102     0.0  90.0    5.812
2140103     00
2140108     212010000  5.2414  0.0  0.0  0100
2140109     216000000  4.1247  0.0  0.0  0100
2140200     3     2258.3   542.53
2140201     1     10334.0   0.0  0.0
2140202     1     10334.0   0.0  0.0
2140301     114 114 114 -1 -1  595  0
2140302     1190.0  1.0  98214.00 314.93 32668.85  82000.0
2140303     0.0     0.0  1925.0   0.0    0.0   0.0
2140310     1.0E6   1190.0   -1.0
```

```
*-----------------------------------------------------*
* COMPONENT 216; INTACT LOOP COLD LEG PIPIG 1                *
*-----------------------------------------------------*
2160000     I-CL-1   SNGLVOL
2160101     4.1247  0.0  19.6843  0. 0. 0. 0.  2.292  00
2160200     3     2293.2   542.68
*-----------------------------------------------------*
* COMPONENT 220; INTACT LOOP COLD LEG PIPING 2               *
*-----------------------------------------------------*
2200000     I-CL-2    BRANCH
2200001     2     1
2200101     4.1247  0.0  56.4362  0. 0. 0. 0.  2.292  00
2200200     3     2292.8   542.68
2201101     216010000  220000000  4.1247  0.0  0.0  0000
2202101     220010000  300000000  4.1247  0.0044 0.0044  0100
2201201     10334.0     0.0   0.0
2202201     10334.0     0.0   0.0
*-----------------------------------------------------*
* COMPONENT 620; PRESSURIZER (LOCATED AT BROKEN LOOP)        *
*                  CHECK #1023101                            *
*-----------------------------------------------------*
6200000     PREZ     PIPE
6200001     8
6200101     24.926          1
6200102     36.794        7
6200103     24.926        8
6200301     3.94            1
6200302     3.64    7
6200303     3.94    8
6200401     0.0           8
6200601     -90.0           8
6200801     0.0   0.000     8
6200901     0.0   0.0       7
6201001     00              8
6201101     0000            7
6201201     2     2250.1   1.0   0.0  0.0   0.0   1
6201202     2     2250.3   1.0   0.0  0.0   0.0   2
6201203     2     2250.4   1.0   0.0  0.0   0.0  3
6201204     2     2250.6   1.0   0.0  0.0   0.0  4
6201205     2     2250.9  0.1484 0.0  0.0   0.0  5
6201206     2     2251.7   0.0   0.0  0.0   0.0  6
6201207     2     2252.6   0.0   0.0  0.0   0.0  7
6201208     2     2253.6   0.0   0.0  0.0   0.0  8
6201300     1
6201301     0.0   0.0   0.0   7
*-----------------------------------------------------*
* COMPONENT 621; PRESSURIZER TO SURGELINE JUNCTION           *
*-----------------------------------------------------*
6210000     PRZ-SUR     SNGLJUN
6210101     620010000  630000000  0.7854  6.19  7.655  0100
```

```
6210201     1    0.0    0.0    0.0
*-----------------------------------------------------*
* CMPONENT 630; PRESSURIZER SURGE LINE                          *
*-----------------------------------------------------*
6300000     PRZ-SUR    PIPE
6300001     3
6300101     0.7854     3
6300301     8.125      1
6300302     22.567     3
6300401     0.0        3
6300601     -90.0      1
6300602     0.0        3
6300701     -8.125     1
6300702     0.0        3
6300801     0.0   1.0   3
6301001     00          3
6301101     0000        2
6301201     3   2255.2   636.66 0.0  0.0   0.0  1
6301202     3   2256.3   624.03 0.0  0.0   0.0  2
6301203     3   2256.3   609.74 0.0  0.0   0.0  3
6301300     1
6301301     0.0   0.0   0.0   2
*-----------------------------------------------------*
*    TIME DEPENDENT VOLUME FOR PRESSURIZER SAFETY VALVE        *
*-----------------------------------------------------*
6400000     PZRSRV   TMDPVOL
6400101     1.0  0.0  100.0  0. 0. 0. 0. 0.  00
6400200     3
6400201     0.0   14.700   100.0
*-----------------------------------------------------*
*    TIME DEPENDENT JUNCTION FOR PZR SAFETY VALVES                  *
*-----------------------------------------------------*
6410000     PZRSRV    TMDPJUN
6410101     640000000  620000000  1.0
6410200  1  0  P  620010000
6410201     0.0    0.0    0.0    0.0
6410202  2499.0  0.0     0.0     0.0
6410203  2501.0  211.2   0.0     0.0
**-------------------------------------------------------------
*6400000     SS-VOL   TMDPVOL
*6400101     1.0  0.0  100.0  0. 0. 0. 0. 0.  00
*6400200     2
*6400201     0.0   2250.0   1.000
**-------------------------------------------------------------
*6410000     SS-JUN    SNGLJUN
*6410101     640000000  620000000  1.0  0.0  0.0  0000
*6410201  1  0.0    0.0    0.0
*-----------------------------------------------------------
*-----------------------------------------------------------
*                     HEAT STRUCTURE INPUT
```

```
*-------------------------------------------------------------
*-----------------------------------------------------*
* HEAT STRUCTURE 101: INTACT LOOP HOT LEG                    *
*-----------------------------------------------------*
11010000     1  2  2  1  2.417
11010100     0        1
11010101     1        3.2833
11010201     5        1
11010301     0.0      1
11010401     601.45    2
11010501     101010000  0  1  1  8.6506   1
11010601     0          0  0  1  8.6506   1
11010701     0      0.0  0.0   0.0        1
11010801     0      2.417  2.417  8.6506  1
*-----------------------------------------------------*
* HEAT STRUCTURE 102: INTACT LOOP HOT LEG 2                  *
*-----------------------------------------------------*
11020000     1  2  2  1  2.417
11020100     0        1
11020101     1        2.8854
11020201     5        1
11020301     0.0      1
11020401     601.45    2
11020501     102010000  0  1  1  8.7203  1
11020601     0          0  0  1  8.7203  1
11020701     0        0.0  0.0  0.0      1
11020801     0     2.417  2.417  8.7203  1
*-----------------------------------------------------*
* HEAT STRUCTURE 103: INTACT LOOP HOT LEG 3                  *
*-----------------------------------------------------*
11030000     1  2  2  1  2.417
11030100     0        1
11030101     1        2.8524
11030201     5        1
11030301     0.0      1
11030401     601.45    2
11030501     103010000   0  1  1  6.953   1
11030601     0           0  0  1  6.953   1
11030701     0     0.0   0.0   0.0        1
11030801     0     2.417  2.417  6.953    1
*-----------------------------------------------------
* HEAT STRUCTURE 105: INTACT LOOP S/G INLET PLENUM           *
*-----------------------------------------------------
11050000     1  2  3  1    5.2342
11050100     0        1
11050101     1        5.7342
11050201     5        1
11050301     0.0      1
11050401     601.41   2
11050501     105010000  0  1  1  0.25  1
```

```
11050601     0          0  0  1  0.25  1
11050701     0    0.0  0.0  0.0        1
11050801     0   5.5281  5.5281  6.7417  1
*-------------------------------------------------------
* HEAT STRUCTURE 110: INTACT LOOP S/G OUTLET PLENUM                *
*-------------------------------------------------------
11100000     1  2  3  1   5.2342
11100100     0        1
11100101     1        5.7342
11100201     5        1
11100301     0.0      1
11100401     540.99   2
11100501     110010000  0  1  1  0.25  1
11100601     0          0  0  1  0.25  1
11100701     0     0.0  0.0  0.0       1
11100801     0     5.5281  5.5281  6.7417  1
*-----------------------------------------------------------
* HEAT STRUCTURE 112: INTACT LOOP PUMP SUCTION LEG                 *
*-----------------------------------------------------------
11120000     3  2  2  1  2.583
11120100     0        1
11120101     1        3.038
11120201     5        1
11120301     0.0      1
11120401     541.0    2
11120501     112010000  0  1  1  15.456  1
11120502     112020000  0  1  1  11.886  2
11120503     112030000  0  1  1  4.5     3
11120601     0          0  0  1  15.456  1
11120602     0          0  0  1  11.886  2
11120603     0          0  0  1  4.5     3
11120701     0   0.0  0.0  0.0          3
11120801     0   2.583  2.583  15.456    1
11120802     0   2.583  2.583  11.886    2
11120803     0   2.583  2.583  4.5       3
*-----------------------------------------------------------*
* HEAT STRUCTURE 116: INTACT LOOP COLD LEG 1                       *
*-----------------------------------------------------------*
11160000     1  2  2  1  2.2917
11160100     0        1
11160101     1        2.7396
11160201     5        1
11160301     0.0      1
11160401     541.2    2
11160501     116010000  0  1  1  4.7723   1
11160601     0          0  0  1  4.7723   1
11160701     0      0.0  0.0  0.0        1
11160801     0     2.292  2.292  4.7723   1
*-------------------------------------------------------
* HEAT STRUCTURE 120: INTACT LOOP COLD LEG 2                       *
```

```
*-------------------------------------------------------
11200000     1  2  2  1  2.2917
11200100     0        1
11200101     1        3.0006
11200201     5        1
11200301     0.0      1
11200401     541.2    2
11200501     120010000  0  1  1  13.6825   1
11200601     0          0  0  1  13.6825   1
11200701     0      0.0   0.0  0.0         1
11200801     0  2.292  2.292  13.6825      1
*-------------------------------------------------------*
* HEAT STRUCTURE 201: BROKEN LOOP HOT LEG 1                *
*-------------------------------------------------------*
12010000     1  2  2  1  2.417
12010100     0        1
12010101     1        3.2833
12010201     5        1
12010301     0.0      1
12010401     601.45    2
12010501     201010000  0  1  1  8.6506   1
12010601     0          0  0  1  8.6506   1
12010701     0      0.0  0.0   0.0        1
12010801     0      2.417  2.417  8.6506  1
*-------------------------------------------------------*
* HEAT STRUCTURE 202: BROKEN LOOP HOT LEG 2                *
*-------------------------------------------------------*
12020000     1  2  2  1  2.417
12020100     0        1
12020101     1        2.8854
12020201     5        1
12020301     0.0      1
12020401     601.45    2
12020501     202010000  0  1  1  8.7203  1
12020601     0          0  0  1  8.7203  1
12020701     0        0.0  0.0  0.0      1
12020801     0     2.417  2.417  8.7203  1
*-------------------------------------------------------*
* HEAT STRUCTURE 203: BROKEN LOOP HOT LEG 3                *
*-------------------------------------------------------*
12030000     1  2  2  1  2.417
12030100     0        1
12030101     1        2.8524
12030201     5        1
12030301     0.0      1
12030401     601.45    2
12030501     203010000   0  1  1  6.953   1
12030601     0           0  0  1  6.953   1
12030701     0     0.0   0.0   0.0        1
12030801     0     2.417  2.417  6.953    1
```

```
*-----------------------------------------------------------
* HEAT STRUCTURE 205: BROKEN LOOP S/G INLET PLENUM                *
*-----------------------------------------------------------
12050000     1  2  3  1    5.2342
12050100     0        1
12050101     1        5.7342
12050201     5        1
12050301     0.0      1
12050401     606.41   2
12050501     205010000  0  1  1  0.25  1
12050601     0          0  0  1  0.25  1
12050701     0    0.0  0.0  0.0       1
12050801     0   5.5281  5.5281  6.7417  1
*-----------------------------------------------------------
* HEAT STRUCTURE 210: BROKEN LOOP S/G OUTLET PLENUM               *
*-----------------------------------------------------------
12100000     1  2  3  1   5.2342
12100100     0        1
12100101     1        5.7342
12100201     5        1
12100301     0.0      1
12100401     540.99   2
12100501     210010000  0  1  1  0.25  1
12100601     0          0  0  1  0.25  1
12100701     0     0.0  0.0  0.0       1
12100801     0     5.5281  5.5281  6.7417  1
*-----------------------------------------------------------
* HEAT STRUCTURE 212: BROKEN LOOP PUMP SUCTION LEG                *
*-----------------------------------------------------------
12120000     3  2  2  1  2.583
12120100     0        1
12120101     1        3.038
12120201     5        1
12120301     0.0      1
12120401     541.0    2
12120501     212010000  0  1  1  15.456  1
12120502     212020000  0  1  1  11.886  2
12120503     212030000  0  1  1  4.5     3
12120601     0          0  0  1  15.456  1
12120602     0          0  0  1  11.886  2
12120603     0          0  0  1  4.5     3
12120701     0   0.0  0.0  0.0          3
12120801     0   2.583  2.583  15.456    1
12120802     0   2.583  2.583  11.886    2
12120803     0   2.583  2.583  4.5       3
*-----------------------------------------------------------*
* HEAT STRUCTURE 216: BROKEN LOOP COLD LEG 1                      *
*-----------------------------------------------------------*
12160000     1  2  2  1  2.2917
12160100     0        1
```

```
12160101     1          2.7396
12160201     5          1
12160301     0.0        1
12160401     541.2      2
12160501     216010000  0  1  1  4.7723   1
12160601     0          0  0  1  4.7723   1
12160701     0       0.0  0.0  0.0        1
12160801     0      2.292  2.292  4.7723  1
*-------------------------------------------------------
* HEAT STRUCTURE 220: BROKEN LOOP COLD LEG 2                    *
*-------------------------------------------------------
12200000     1  2  2  1  2.2917
12200100     0          1
12200101     1          3.0006
12200201     5          1
12200301     0.0        1
12200401     541.2      2
12200501     220010000  0  1  1  13.6825   1
12200601     0          0  0  1  13.6825   1
12200701     0       0.0   0.0  0.0        1
12200801     0  2.292  2.292  13.6825      1
*-----------------------------------------*
* HEAT STRUCTURE 620: PRESSURIZER                    *
*-----------------------------------------*
16200000     8  2  2  1  7.625
16200100     0          1
16200101     1          8.0
16200201     5          1
16200301     0.0        1
16200401     652.5      2
16200501     620010000  0       1  1  3.94  1
16200502     620020000  0       1  1  3.64  2
16200503     620030000  0       1  1  3.64  3
16200504     620040000  0       1  1  3.64  4
16200505     620050000  0       1  1  3.64  5
16200506     620060000  0       1  1  3.64  6
16200507     620070000  0       1  1  3.64  7
16200508     620080000  0       1  1  3.94  8
16200601     0          0       0  1  3.94  1
16200602     0          0       0  1  3.64  2
16200603     0          0       0  1  3.64  3
16200604     0          0       0  1  3.64  4
16200605     0          0       0  1  3.64  5
16200606     0          0       0  1  3.64  6
16200607     0          0       0  1  3.64  7
16200608     0          0       0  1  3.94  8
16200701     0      0.0  0.0  0.0                8
16200801     0      0.000  0.000  3.94       1
16200802     0  0.0  0.0  3.64   7
16200803     0  0.0  0.0  3.94   8
```

```
*-----------------------------------------------
* HEAT STRUCTURE 630: PRESSURIZER SURGE LINE          *
*-----------------------------------------------
16300000     3  2  2  1  1.0
16300100     0        1
16300101     1        1.1
16300201     5        1
16300301     0.0      1
16300401     635.0    2
16300501     630010000  0  1  1  8.125   1
16300502     630020000  0  1  1  22.567  2
16300503     630030000  0  1  1  22.567  3
16300601     0          0  0  1  8.125   1
16300602     0          0  0  1  22.567  2
16300603     0          0  0  1  22.567  3
16300701     0   0.0  0.0  0.0           3
16300801     0   1.0  1.0  8.125         1
16300802     0   1.0  1.0  22.567        2
16300803     0   1.0  1.0  22.567        3
*-----------------------------------------------------------------
* CALCULATING TIME STEP INTERVAL
*-----------------------------------------------------------------
20500100     T1  MULT  1.0  0.0  0
20500101     TIME  0
*
20500200     DELT  SUM  1.0  0.0  0
20500201     0.0  1.0  CNTRLVAR 001  -1.0 CNTRLVAR 999
*
20599900     TO  MULT 1.0  0.0  0
20599901     CNTRLVAR  001
*-----------------------------------------------------------------
*                TRIP DATA
*-----------------------------------------------------------------
591     CNTRLVAR 103  GE  NULL  0  -1.0E-6   N
*-----------------------------------------------------------------
* MEASURED PZR LEVEL - BASED ON VOID FRACTION
*-----------------------------------------------------------------
20512100      PZRLVL SUM  0.166667 0.4762  0  3   0.   1.
20512101     0.0      1.0     VOIDF  620020000  1.0   VOIDF  620030000
20512102              1.0     VOIDF  620040000  1.0   VOIDF  620050000
20512103              1.0     VOIDF  620060000  1.0   VOIDF  620070000
*-----------------------------------------------------------------
* MEASURED PZR WATER VOLUME
20512200   PZRVOF   SUM   1.0   476.2  0
20512201   0.0    98.2084  VOIDF  620010000  133.93   VOIDF 620020000
20512202         133.93    VOIDF  620030000  133.93   VOIDF 620040000
20512203         133.93    VOIDF  620050000  133.93   VOIDF 620060000
20512204         133.93    VOIDF  620070000   98.2084 VOIDF 620080000
*-----------------------------------------------------------------
* TO CALCULATE AUCTIONEERED T AVERAGE
```

```
*-----------------------------------------------------------------
20510100     TAVG-A  SUM  1.0  574.0  0
20510101     -459.67      0.9  TEMPF 101010000
20510102                  0.9  TEMPF 116010000
*
20510200     TAVG-B  SUM  1.0  574.0     0
20510201     -459.67      0.9  TEMPF 201010000
20510202                  0.9  TEMPF 216010000
*
20510300     HTX1    SUM  1.0  0.0   0
20510301     0.0          1.0  CNTRLVAR    101
20510302                 -1.0  CNTRLVAR    102
*
*
20510400     HTX2    TRIPUNIT   1.0   1.0  0
20510401     591
*
20510500     HTX3    SUM   1.0  0.0   0
20510501     1.0  -1.0  CNTRLVAR  104
*
20510600     HTX4    MULT   1.0   0.0  0
20510601     CNTRLVAR   104     CNTRLVAR   101
*
20510700     HTX5    MULT   1.0   574.0   0
20510701     CNTRLVAR   105     CNTRLVAR   102
*
20510800     TAVG-H  SUM    1.0   574.0   0
20510801     0.0     1.0    CNTRLVAR   106
20510802             1.0    CNTRLVAR   107
*
20510900     DELTEM  SUM  1.0  0.0  0
20510901     -574.0  1.0  CNTRLVAR  108
*-----------------------------------------------------------------
*       STEAM DUMP CONTROL
*-----------------------------------------------------------------
*       TURBINE TRIP
*-----------------------------------------------------------------
* STEAM DUMP SIGNAL BY TURBINE TRIP
*-----------------------------------------------------------------
* AUCTIONEERED TEMPERATURE LEAD LAG UNIT
*-----------------------------------------------------------------
20531100     DENOM SUM  1.0  1.0  0
20531101     1.0     0.5  CNTRLVAR  002
*
20531200  DT/2A    SUM  1.0  0.0  0
20531201     0.0  0.5  CNTRLVAR  002
*
20531300     VV  SUM  1.0  0.0  0
20531301     0.0  3.0  CNTRLVAR  109  1.0  CNTRLVAR  326
*
```

```
20531400     VV1  SUM  1.0  0.0  0
20531401     0.0  1.0  CNTRLVAR 324  1.0  CNTRLVAR 109
*
20531500     V-YO  SUM  1.0  0.0  0
20531501     0.0  1.0  CNTRLVAR  314  -1.0  CNTRLVAR 325
*
20531600     NUMER  MULT  1.0  0.0  0
20531601     CNTRLVAR  312  CNTRLVAR  315
*
20531700     NUMERT  SUM  1.0  0.0  0
20531701     0.0  1.0  CNTRLVAR  313  1.0  CNTRLVAR  316
*
20531800     LEADLAG  DIV  1.0  0.0  0
20531801     CNTRLVAR  311  CNTRLVAR  317
*
20531900     VVV   SUM  1.0  0.0  0
20531901     0.0  1.0  CNTRLVAR 324  1.0  CNTRLVAR 109
*
20532000     YY  SUM  1.0  0.0  0
20532001     0.0 -1.0  CNTRLVAR 318 -1.0  CNTRLVAR 325
*
20532100     DEL  SUM  1.0  0.0  0
20532101     0.0  1.0  CNTRLVAR  319  1.0  CNTRLVAR  320
*
20532200     DELI  MULT  1.0  0.0  0
20532201     CNTRLVAR  321  CNTRLVAR  312
*
20532300     I1  SUM  1.0  0.0  0
20532301     0.0  1.0  CNTRLVAR 326  1.0  CNTRLVAR 322
*
20532400     VO  MULT  1.0  0.0  0
20532401     CNTRLVAR  109
*
20532500     YO  MULT  1.0  0.0  0
20532501     CNTRLVAR  318
*
20532600     IO  MULT  1.0  0.0  0
20532601     CNTRLVAR  323
*
20532700     LEADAUC  SUM  1.0  574.0  0
20532701     574.0  1.0  CNTRLVAR  318
*-----------------------------------------------------------------
* REFERNCE AVERAGE TEMPERATURE
*-----------------------------------------------------------------
20533100  TAV  TRIPUNIT  1.0  0.0  0
20533101     588
*
20533200   TAVER  SUM  1.0  574.0  0
20533201   574.0  -27.0  CNTRLVAR 331
*-----------------------------------------------------------------
```

```
* TEMPERATURE ERROR  (BROKEN LOOP)
*-----------------------------------------------------------
20534100   TEMERR  SUM  0.037037  0.0     0  3   0.0  1.0
20534101   0.0  1.0  CNTRLVAR 327  -1.0  CNTRLVAR 332
* FACTOR TO DETERMINE STEAM DUMP FLOWRATE
20534200     STM-P  MULT  1.45037E-4  805.0  0
20534201     P     700010000
*
20534300     DELP  SUM  1.26534E-3  1.0  0
20534301     -14.7   1.0    CNTRLVAR  342
*
20534400     DELPFNC   STDFNCTN   1.0  1.0   0
20534401     SQRT   CNTRLVAR   343
*
20534500     FACTOR   MULT  1.0  0.0  0  3  0.0  1.0
20534501     CNTRLVAR  341   CNTRLVAR  344
*
*   LAG= 20.0 SEC OF T-COLD OR T-HOT / LOOP A AND B
*
20540100     TCOLDA   LAG  1.0  557.0  1
20540101     20.00     TEMPF  120010000
20540200     TCOLDB   LAG  1.0  557.0  1
20540201     20.00     TEMPF  220010000
20540300     THOT-A   LAG  1.0  583.0  1
20540301     20.00     TEMPF  101010000
20540400     THOT-B   LAG  1.0  583.0  1
20540401     20.00     TEMPF  201010000
*-------------------------------------------------------
* COMPONENT 703: STEAM DUMP VALVE                        *
*-------------------------------------------------------
7030000     DUMP-V    TMDPJUN
7030101     700010000   704000000   5.585
7030200     1   592  CNTRLVAR   345
7030201     0.0         0.0       0.0  0.0
7030202     1.0         0.0   834.56  0.0
*-------------------------------------------------------
* COMPONENT 704: CONDENSER                               *
*-------------------------------------------------------
7040000     CONDEN    TMDPVOL
7040101     1.0  0.0  100.0   0. 0. 0. 0. 0.   00
7040200     2
7040201     1.0   14.7  1.0
*-----------------------------------------------------------
*        REACTIVITY DATA
*-----------------------------------------------------------
*-----------------------------------------------------------
*        TOTAL POWER VS. TIME
*-----------------------------------------------------------
*-------------------------------------------------------
*   SCRAM TABLE                                         *
```

```
*-------------------------------------------------
20210100       REAC-T     601
*                TIME              DOLLAR
20210101         0.0                 0.0
20210102         0.2                 -0.1205
20210103         0.4                 -0.4567
20210104         0.6                 -1.5978
20210105         0.8                 -7.48546
20210106         1.0                 -9.6304
20210107         1.2                -10.6992
20210108         1.4                -11.2282
20210109         1.6                -11.5210
20210110         1.8                -11.7130
20210111         2.0                -11.8670
20210112         2.2                -11.9295
20210113         2.4                -11.9898
20210114         2.6                -12.0500
20210115         2.E20              -12.0500
*0000000000000000000000000000000000000000000000000000000000000000000000
* REACTOR KINETICS TYPE CARD
30000000      POINT
30000001      GAMMA-AC     1335.7E6    0.0   321.0000      1.0
30000002   ANS79-1
30000011      101
30000401   0.0        50.0   HR
30000402   2.6714+8   40.0   HR
30000403   5.3428+8   30.0   HR
30000404   8.0142+8   20.0   HR
30000405   1.0186+9   10.0   HR
30000406   1.3357+9   0.00   HR
30000401   1.6378+9   50.0   HR
30000402   1.3012+9   6.00   HR
30000403   9.5657+8   12.0   HR
30000404   9.6425+8   2.00   HR
30000405   9.9680+8   2.00   HR
30000406   1.0293+9   2.00   HR
30000407   1.0619+9   2.00   HR
30000408   1.0944+9   2.00   HR
30000409   1.1270+9   2.00   HR
30000410   1.1595+9   2.00   HR
30000411   1.1921+9   2.00   HR
30000412   1.2246+9   2.00   HR
30000413   1.2237+9   6.00   HR
30000414   1.2339+9   2.00   HR
30000415   1.2542+9   2.00   HR
30000416   1.2746+9   2.00   HR
30000417   1.2950+9   2.00   HR
30000418   1.3153+9   2.00   HR
30000419   1.3357+9   1.00   HR
*------------------------------------------------------------
```

```
* DENSITY REACTIVITY TABLE                                                  *
*-----------------------------------------------------------------
*                    DENSITY        REACTIVITY (DOLLAR)
30000501             42.2817        -1.700
30000502             42.9136        -1.198
30000503             43.7370        -0.599
30000504 44.4981 0.0 44.5070         0.000  44.5159 0.0
30000505             44.6939         0.150
30000506             44.7028         0.291
30000507             45.0544         0.396
30000508             45.2325         0.484
30000509             45.4060         0.564
30000510             45.5796         0.643
30000511             45.7532         0.722
30000512             45.9179         0.802
30000513             46.0870         0.872
30000514             46.2517         0.942
30000515             46.4119         1.013
30000516             46.5721         1.075
30000517             46.7324         1.127
30000518             46.8881         1.145
30000519             49.4517         2.037
30000520             53.9692         3.358
30000521             57.4496         4.018
30000522             60.1601         4.415
30000523             62.0116         4.767
*30000501              0.95           0.000
*30000502              1.00           0.000
*30000503              1.39           0.000
**
30000701             335010000   0   0.3333   0.
30000702             335020000   0   0.3334   0.
30000703             335030000   0   0.3333   0.
*-----------------------------------------------------------------*
* DOPPLER REACTIVITY TABLE                                                  *
*-----------------------------------------------------------------*
*                 TEMPERATURE (FUEL)        REACTIVITY (DOLLAR)
30000601             545.                        2.13
30000602             586.5                       2.00
30000603             628.0                       1.95
30000604             669.5                       1.74
30000605             711.0                       1.62
30000606             752.5                       1.48
30000607             794.0                       1.37
30000608             835.5                       1.25
30000609             877.0                       1.13
30000610             918.5                       1.02
30000611             960.0                       0.92
30000612            1001.0                       0.82
30000613            1043.0                       0.72
```

```
30000614          1084.5                    0.62
30000615          1126.0                    0.53
30000616          1167.5                    0.43
30000617          1209.0                    0.33
30000618          1250.5                    0.19
30000619          1292.0                    0.16
30000620          1333.5                    0.07
30000621          1375.0                    0.00
30000622          1400.0                   -0.04
30000623          1500.0                   -0.21
30000624          1600.0                   -0.69
*30000601           545.0                     0.00
*30000602          1375.0                     0.00
*30000603          1600.0                     0.00
*
30000801          3330001     0    0.3333   0.
30000802          3330002     0    0.3334   0.
30000803          3330003     0    0.3333   0.
*-----------------------------------------------------------------
*        HEAT STRUCTURE THERMAL PROPERTY DATA
*-----------------------------------------------------------------
*-------------------------------------------------------
*        COMPOSITION TYPE AND DATA FORMAT                          *
*-------------------------------------------------------
20100100     TBL/FCTN     1     1     * CORE FUEL
20100200     TBL/FCTN     1     1     * CORE FUEL GAP
20100300     TBL/FCTN     1     1     * CORE FUEL CLADDING
20100400     TBL/FCTN     1     1     * INCONEL
20100500     TBL/FCTN     1     1     * STAINLESS STEEL
20100600     TBL/FCTN     1     1     * CARBON STEEL
*-----------------------------------------------------------------
*        THERMAL CONDUCTIVITY DATA (BTU/SEC-FT/DEG F)  AND
*        VOLUMETRIC HEAT CAPACITY DATA (BTU/FT**3-DEG F)
*-----------------------------------------------------------------
*-------------------------------------------------------
*        CORE FUEL                                                 *
*-------------------------------------------------------
*                TEMP                THERMAL CONDUCTIVITY
20100101        188.6               1.284E-3
20100102        332.6               1.1235E-3
20100103        440.6               9.951E-4
20100104        500.0               9.2806E-4
20100105        650.0               7.4194E-4
20100106        800.0               7.4361E-4
20100107        950.0               6.7750E-4
20100108        1100.0              6.2278E-4
20100109        1250.0              5.7722E-4
20100110        1400.0              5.3889E-4
20100111        1500.0              5.0639E-4
20100112        1700.0              4.7889E-4
```

```
20100113          1850.0              4.5528E-4
20100114          2000.0              4.3556E-4
20100115          2150.0              4.1861E-4
20100116          2300.0              4.0472E-4
20100117          2450.0              3.9306E-4
20100118          2600.0              3.8389E-4
20100119          3100.0              3.6750E-4
20100120          3600.0              3.7028E-4
20100121          4100.0              3.9056E-4
20100122          4600.0              4.2722E-4
20100123          5100.0              4.8056E-4
*
*                 TEMP                HEAT CAPACITY
*
20100151          32.0                34.45
20100152          122.0               38.35
20100153          212.0               40.95
20100154          392.0               43.55
20100155          752.0               46.80
20100156          2012.0              51.35
20100157          2732.0              52.65
20100158          3092.0              56.55
20100159          3452.0              63.05
20100160          3812.0              72.80
20100161          4352.0              89.70
20100162          4532.0              94.25
20100163          4712.0              98.15
20100164          4892.0              100.10
20100165          5144.0              101.40
20100166          8000.0              101.40
*-------------------------------------------------------
*        CORE FUEL GAP                                  *
*-------------------------------------------------------
*
*                 TEMP                THERMAL CONDUCTIVITY
*
20100201          32.0                3.0487788E-4
20100202          5400.0              3.0487788E-4
*
*                 TEMP                HEAT CAPACITY
20100251          32.0                0.000075
20100252          5400.0              0.000075
*-------------------------------------------------------
*        FUEL CLADDING                                  *
*-------------------------------------------------------
*
*                 TEMP                THERMAL CONDUCTIVITY
*
20100301          32.0                1.9267E-3
20100302          392.0               1.9267E-3
```

```
20100303          752.0              2.2478E-3
20100304          1112.0             2.7297E-3
20100305          1472.0             3.0508E-3
20100306          1832.0             3.5325E-3
20100307          2192.0             4.0142E-3
20100308          2552.0             4.8169E-3
20100309          2912.0             5.7803E-3
20100310          3272.0             7.0647E-3
20100311          3632.0             8.8311E-3
20100312          3992.0             1.0918E-3
*
*                 TEMP               HEAT CAPACITY
*
20100351          0.0                28.392
20100352          1480.3             34.476
20100353          1675.0             85.176
20100354          1787.5             34.370
20100355          3500.0             34.476
*-------------------------------------------------------
*        INCONEL                                        *
*-------------------------------------------------------
*
*                 TEMP               THERMAL CONDUCTIVITY
*
20100401          32.0               2.1167E-3
20100402          1050.0             4.0394E-3
*
*                 TEMP               HEAT CAPACITY
*
20100451          100.0              57.180
20100452          400.0              61.140
20100453          600.0              63.770
20100454          800.0              66.410
*-------------------------------------------------------
*        STAINLESS STEEL                                *
*-------------------------------------------------------
*
*                 TEMP               THERMAL CONDUCTIVITY
*
20100501          32.0               2.0833E-3
20100502          1700.0             4.0294E-3
20100503          10000.0            4.0294E-3
*
*                 TEMP               HEAT CAPACITY
*
20100551          200.0              57.114
20100552          300.0              59.118
20100553          400.0              61.122
20100554          500.0              63.126
20100555          600.0              64.629
```

```
20100556          700.0              66.130
20100557          800.0              67.134
20100558          1000.0             69.138
20100559          2000.0             80.160
20100560          10000.0            80.160
*-------------------------------------------------------
*        CARBON STEEL                                    *
*-------------------------------------------------------
*
*                 TEMP               THERMAL CONDUCTIVITY
*
20100601          80.0               0.01126
20100602          440.33             0.01009
20100603          800.33             0.00908
20100604          1160.33            0.00824
20100605          1520.33            0.00756
20100606          1880.33            0.00705
20100607          2240.33            0.00670
20100608          2600.33            0.00652
20100609          2960.33            0.00649
*
*                 TEMP               HEAT CAPACITY
*
20100651          80.0               57.29
20100652          200.03             57.29
20100653          1600.07            82.04
20100654          2600.33            104.71
20100655          2960.33            112.49
*
*-------------------------------------------------------------
*       PUMP INPUT DATA
*-------------------------------------------------------------
*                 CURVE TYPE         CURVE REGIME          HAN
1141100           1                  1
*                 V/A                H/A2
1141101           0.0                1.75
1141102           0.05               1.71
1141103           0.2                1.61
1141104           0.4                1.36
1141105           0.6                1.27
1141106           0.8                1.24
1141107           1.0                1.00
*                 TYPE               REGIME          BAN
1141200           2                  1
*                 V/A                B/A2
1141201           0.0                0.95
1141202           0.05               0.95
1141203           0.2                0.95
1141204           0.4                0.95
1141205           0.6                0.97
```

1141206	0.8	1.02	
1141207	1.0	1.0	
*	TYPE	REGIME	HVN
1141300	1	2	
*	A/V	H/V2	
1141301	0.0	-1.55	
1141302	0.05	-1.46	
1141303	0.1	-1.37	
1141304	0.2	-1.13	
1141305	0.4	-0.65	
1141306	0.54	-0.3	
1141307	0.58	-0.2	
1141308	0.64	-0.05	
1141309	0.66	0.0	
1141310	0.68	0.05	
1141311	0.8	0.35	
1141312	0.9	0.65	
1141313	1.0	1.0	
*	TYPE	REGIME	BVN
1141400	2	2	
*	A/V	B/V2	
1141401	0.0	-1.46	
1141402	0.05	-1.3	
1141403	0.1	-1.15	
1141404	0.2	-0.87	
1141405	0.4	-0.4	
1141406	0.54	-0.05	
1141407	0.58	0.03	
1141408	0.64	0.15	
1141409	0.66	0.2	
1141410	0.68	0.25	
1141411	0.8	0.54	
1141412	0.9	0.75	
1141413	1.0	1.0	
*	TYPE	REGIME	HAD
1141500	1	3	
*	V/A	H/A2	
1141501	-1.0	4.25	
1141502	-0.8	3.58	
1141503	-0.6	3.02	
1141504	-0.4	2.50	
1141505	-0.2	2.05	
1141506	-0.05	1.8	
1141507	0.0	1.75	
*	TYPE	REGIME	BAD
1141600	2	3	
*	V/A	B/A2	
1141601	-1.0	3.10	
1141602	-0.8	2.5	
1141603	-0.6	1.92	

```
1141604          -0.4              1.38
1141605          -0.2              1.16
1141606          -0.05             0.95
1141607          0.0               0.95
*                TYPE              REGIME        HVD
1141700          1                 4
*                A/V               H/V2
1141701          -0.8              3.58
1141702          -0.6              2.95
1141703          -0.4              2.4
1141704          -0.2              1.95
1141705          -0.1              1.75
1141706          -0.05             1.70
1141707          0.0               1.65
*                TYPE              REGIME        BVD
1141800          2                 4
*                A/V               B/V2
1141801          -0.8              2.55
1141802          -0.6              2.09
1141803          -0.4              1.75
1141804          -0.2              1.55
1141805          -0.1              1.5
1141806          -0.05             1.49
1141807          0.0               1.48
*                EXTRAP INDIC
1143000          0
*                VOID FRACTION     HEAD MULT.
1143001          0.0               0.0
1143002          0.15              0.0
1143003          0.2               0.3
1143004          0.4               0.8
1143005          0.45              1.0
1143006          0.8               1.0
1143007          0.9               0.8
1143008          1.0               0.0
*
*                    EXTRAP.INDIC
1143100          0
*                VOID              TORQUE MULT.
1143101          0.0               0.0
1143102          0.3               0.0
1143103          0.4               0.4
1143104          0.5               1.0
1143105          0.8               1.0
1143106          0.9               0.8
1143107          1.0               0.0
*
*                TYPE              REGIME        HAN
1144100          1                 1
*                V/A               H/A2
```

```
1144101          0.0              1.0
1144102          0.03             1.0
1144103          0.2              1.11
1144104          0.4              1.06
1144105          0.6              1.07
1144106          0.8              1.08
1144107          1.0              0.9
*                TYPE             REGIME        HVN
1144200          1                2
*                A/V              H/V2
1144201          0.0              0.0
1144202          0.1              0.05
1144203          0.2              0.17
1144204          0.4              0.25
1144205          0.6              0.25
1144206          0.66             0.26
1144207          0.8              0.3
1144208          0.9              0.58
1144209          1.0              0.9
*                TYPE             REGIME        BAN
1144300          2                1
*                V/A              B/A2
1144301          0.0              0.55
1144302          0.4              0.55
1144303          0.6              0.52
1144304          0.8              0.52
1144305          1.0              0.45
*                TYPE             REGIME        BVN
1144400          2                2
*                A/V              B/V2
1144401          0.0              0.0
1144402          0.2              0.03
1144403          0.4              0.04
1144404          0.6              0.07
1144405          0.66             0.08
1144406          0.8              0.14
1144407          1.0              0.45
*-----------------------------------------------------
* SEMISCALE TWO PHASE DIFFERENCE CURVES FOR HAD HVD BAD BND    *
*-----------------------------------------------------
*                TYPE             REGIME        HAD
1144500          1                3
*                V/A              V/A2
1144501          -1.0             -1.16
1144502          -0.9             -1.24
1144503          -0.8             -1.77
1144504          -0.7             -2.36
1144505          -0.6             -2.79
1144506          -0.5             -2.91
1144507          -0.4             -2.67
```

```
1144508          -0.25            -1.69
1144509          -0.1             -0.5
1144510          0.0              0.0
*                TYPE             REGIME        HVD
1144600          1                4
*                A/V              H/V2
1144601          -1.0             -1.16
1144602          -0.9             -0.78
1144603          -0.8             -0.5
1144604          -0.7             -0.31
1144605          -0.6             -0.17
1144606          -0.5             -0.08
1144607          -0.35            0.0
1144608          -0.2             0.05
1144609          -0.1             0.08
1144610          0.0              0.11
*                TYPE             REGIME        BAD
1144700          2                3
*                V/A              B/A2
1144701          -1.0             0.62
1144702          -0.8             0.68
1144703          -0.6             0.53
1144704          -0.4             0.46
1144705          -0.2             0.49
1144706          0.0              0.54
*                TYPE             REGIME        BVD
1144800          2                4
*                A/V              B/V2
1144801          -1.0             0.62
1144802          -0.8             0.53
1144803          -0.6             0.46
1144804          -0.4             0.42
1144805          -0.2             0.39
1144806          0.0              0.36
*
* TERMINATION CARD
*-----------------------------------------------------------------------
*    PLOT DATA
*-----------------------------------------------------------------
20300100  P       185010000      * S/G A PRESS.
20300200  P       285010000      * S/G B PRESS.
20300300  CNTRLVAR       57      * S/G A WIDE RANGE LEVEL
20300400  CNTRLVAR       67      * S/G B WIDE RANGE LEVEL
20300500  CNTRLVAR       58      * S/G A NARROW RANGE LEVEL
20300600  CNTRLVAR       68      * S/G B NARROW RANGE LEVEL
20300700  MFLOWJ 184000000       * S/G A FEED FLOW
20300800  MFLOWJ 284000000       * S/G B FEED FLOW
20300900  MFLOWJ 185010000       * S/G A STEAM FLOW
20301000  MFLOWJ 285010000       * S/G B STEAM FLOW
20301100  P       620010000      * PZR PRESS.
```

```
20301200  CNTRLVAR      121        * PZR LEVEL (%)
20301300  TEMPF  120010000         * LOOP-A T-COLD
20301400  TEMPF  220010000         * LOOP-B T-COLD
20301500  CNTRLVAR      101        * LOOP-A T-AVG
20301600  CNTRLVAR      102        * LOOP-B T-AVG
20301700  RKTPOW          0        * POWER
20301800  MFLOWJ 182000000         * AUX. FEEDWATER FLOW
20301900  P      700010000         * STEAM HEADER PRESSURE
20302000  MFLOWJ 701000000         * STEAM FLOW TO TURBINE
20302100  MFLOWJ 703000000         * STEAM DUMP FLOW
20302200  MFLOWJ 191000000         * S/G A PORV
20302300  MFLOWJ 291000000         * S/G B PORV
20302400  MFLOWJ 120020000         * LOOP-A RCS FLOW
20302500  MFLOWJ 220020000         * LOOP-B RCS FLOW
20302600  TEMPF  101010000         * LOOP-A T-HOT
20302700  TEMPF  201010000         * LOOP-B T-HOT
20302800  CNTRLVAR      401        * LOOP-A T-COLD
20302900  CNTRLVAR      402        * LOOP-B T-COLD
20303000  CNTRLVAR      403        * LOOP-A T-HOT
20303100  CNTRLVAR      404        * LOOP-B T-HOT
* TERMINATION CARD
```

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

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-0030

2. TITLE AND SUBTITLE

Assessment of RELAP5/MOD2 Code Using Loss of Offsite Power Transient Data of KNU #1 Plant

3. DATE REPORT PUBLISHED

MONTH	YEAR
April	1990

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

Bub-Dong Chung
Young-Jin Lee
Hho-Jung 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 Nuclear Safety Center (KNSC)
Korea Advanced Energy Research Institute (KAERI)
P.O. Box 7, Daeduk-Danji
Daejon - Korea

Department of Nuclear Eng.
Seoul National University

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.)

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

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less.)

This report presents a code assessment study based on a real plant transient that occurred on June 9, 1981 at the KNU #1 (Korea Nuclear Unit Number 1). KNU #1 is a two-loop Westinghouse PWR plant of 587 Mwe. The Loss of offsite power transient occurred at the 77.5% reactor power with 0.5 %/hr power ramp. The real plant data were collected from available on-line plant records and computer diagnostics.

The transient was simulated by RELAP5/MOD2/36.05 and the results were compared with the plant data to assess the code weaknesses and strengths. Some nodalization studies were performed to contribute to developing a guideline for PWR nodalization for the transient analysis.

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

CODE ASSESSMENT STUDY OF RELAP5/MOD2

13. AVAILABILITY STATEMENT

Unlimited

14. SECURITY CLASSIFICATION

(This Page)

Unclassified

(This Report)

Unclassified

15. NUMBER OF PAGES

16. PRICE

NRC FORM 335 (2-89)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

SPECIAL FOURTH-CLASS RATE
POSTAGE & FEES PAID
USNRC

PERMIT No. G-67