APT BLANKET SYSTEM LOSS-OF-COOLANT ACCIDENT (LOCA) BASED ON INITIAL CONCEPTUAL DESIGN -

Case 4: External Pressurizer Surge Line Break Near Inlet Header

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WSRC-TR-98-0062

KEYWORDS:

*Accelerator Production of Tritium
Blanket System
Conceptual Design
TRAC Code
FLOWTRAN-TF Code
System Model
Detailed Bin Model
Safety Analysis*
RETENTION - Permanent

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Prepared for the U.S. Department of Energy under Contract No. DE-AC09-96SR18500

DOCUMENT: WSRC-TR-98-0062
TITLE: APT BLANKET SYSTEM LOSS-OF-COOLANT ACCIDENT
(LOCA) BASED ON INITIAL CONCEPTUAL DESIGN -
Case 4: External Pressurizer Surge Line Break Near
Inlet Header

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1 Introduction

This report is one of a series of reports documenting accident scenario simulations for the Accelerator Production of Tritium (APT) blanket heat removal systems [1-7]. The simulations were performed in support of the Preliminary Safety Analysis Report (PSAR) for the APT. This report contains the results from the analysis of large break Loss-Of-Coolant-Accident (LOCA) Case 4 which is a double ended guillotine break in the APT pressurizer surge line near the inlet header external to the APT cavity vessel. The calculations are based on the initial conceptual design of the APT

The APT blanket system has about 57 MW of thermal energy deposited within the blanket region under normal operating conditions from the release of neutrons and the interaction of the high energy particles with the blanket materials. It corresponds to about 48% of the total thermal energy deposited in the APT target/blanket system [8]. This deposited thermal energy under normal operating conditions is an important input parameter used in the thermal-hydraulic design and accident analysis. After the APT system shutdown, decay power drops rapidly. Figure 1-1 shows transient decay power after shutdown as a fraction of steady-state power for the 1700 MeV APT design with 13 tungsten ladders [9]. Thus, it is necessary to provide a heat removal system to prevent structural damage of the blanket system following severe accidents such as the double-ended guillotine break (DEGB) accident. Major components of a typical blanket heat removal system include heat exchangers, piping, and pumps. The blanket heat removal system is comprised of the primary heat removal (HR) system with pressurizer, the secondary heat removal system, the primary residual heat removal (RHR) system, and the secondary RHR system. These systems provide the heat removal function for all the thermal energy deposited within the blanket modules. The current blanket cooling system has one primary HR, one secondary HR, two 100% primary RHR, and two 100% secondary RHR systems. Five cases of external loss-of-coolant accident (LOCA) scenarios were simulated for large pipe breaks in the primary heat removal (HR) and residual heat removal (RHR) systems external to the cavity vessel in order to identify worst transient accident scenarios [10]. In this report, Case 4, as one of the five cases of the external LOCA's, simulates a pipe break in the pressurizer surge line near the inlet fixed header using a one-dimensional TRAC system model with 6 lumped modules. The break location for Case 4 is shown in Fig. 1-2. The model results are used to determine thermal-hydraulic safety margins. The results also provide boundary conditions for detailed FLOWTRAN-TF bin model calculations. Results of the Case 4 simulation are documented in this report.

Figure 1-1 Decay heat power fractions of full power for various types of blanket modules.

Figure 1-2 Break location for the external LOCA Case 4 (pressurizer surge line break) simulation.

2 TRAC 1-D System Model

The current blanket system model consists of six lumped blanket modules based on the existing cruciform-type design components (the necessary design specifications required to develop a plate-type set of modules are not currently available but will be used in future revisions to these calculations). Each module is separately connected to the two fixed coolant headers. Detailed descriptions of the blanket module lumping strategy and the one-dimensional TRAC system model are provided in Ref. [10]. The six lumped modules are, respectively: the first-row lateral modules; the second-row lateral modules; the decoupler / Row 1 downstream module; the Row 1 / Row 2 downstream module; the Row 2 / Row 2 downstream module; and the remaining low-power modules, which consist of the upstream module, the four bottom modules, and the two top modules. Figure 2-1 shows a cross-sectional face map for the six module blanket system. Table 2-1 summarizes module description, thermal deposited power, and connection pipe size for each of the six blanket modules as modeled in the one-dimensional lumped approach. Figure A-1 shows the locations of all the six modules and the internal piping connections as included in the 1-D TRAC system model. The TRAC components and piping connections for the HR, pressurizer, RHR blanket coolant systems, and cavity vessel flood system are also shown in Figs. A-2 to A-6. Table A-1 lists all the blanket system components, number of cells for the components, and component descriptions for the present one-dimensional lumped blanket system model. The present blanket system model using the six lumped modules includes 170 components and 152 junctions with 10 trip control signals used for the transient LOCA accident simulations.

2.1 Scenario Description

As one of design basis accidents, a large break LOCA of the pressurizer surge line external to the cavity vessel was simulated by restarting steady-state normal operation results of the one-dimensional six module blanket system model in a transient mode. Normal operation conditions for the key blanket system parameters are shown in Table A-2.

The current design of the blanket cooling system includes one primary HR, one secondary HR, two 100% primary RHR, and two 100% secondary RHR systems. Under steady-state normal operating conditions the blanket module system is connected to a single main primary loop, with three 50% pumps in parallel. Two pumps are normally operating and the remaining pump is available for immediate startup in the event of failure of a running pump. The cooling loop has two 50% heat exchangers in parallel. The two RHR primary loops are both sized to accommodate 100% of the decay heat removal requirements. Currently, the RHR components are sized for approximately 4% of the full power flow, 1569 kg/sec. Each of the RHR primary loops has one heat exchanger and one pump. The current baseline design has the RHR systems shutdown in standby mode during normal operation to enhance the system's response to some design basis accident scenarios such as LOCA's. During the design basis accidents only one RHR system is operated under the current conceptual design specifications.

As one of design basis accidents, a loss of coolant accident due to the double-ended pipe break in the pressurizer surge line was simulated by restarting steady-state normal operation results performed by the one-dimensional six integrated module blanket system model in a transient mode. The break location in the layout of the TRAC system

model is PIPE component 764 which is shown in Fig. A-3. When PIPE component 764 is broken for the Case 4 LOCA simulation, the system will rapidly depressurize and the RHR pump will reach full speed about 15 seconds after the start of the accident. The two primary HR pumps are tripped off with time delays after the accident starts. Detailed control signals for the key component operations are provided in Section 2.5.

2.2 Model Upgrades

Component action tables for the check valves were updated for the Case 4 accident simulation. Component action tables for the HR and RHR check valves were based on the S-shaped forcing function values. Constrained steady-state (CSS) capabilities were added to the TRAC normal operation system model. For the initiation of the accident, PIPE component 764 was replaced by two BREAK components on both ends of the broken component. The BREAK components were set to ramp down from steady-state pressure to one atmospheric pressure in 0.1 second. Signal variables and trip signals of the system model are also updated by using the control procedure for the Case 4 accident scenario described in Ref. [10].

2.3 Initial Conditions

Before simulating the accident condition, steady-state results under normal operating conditions are required to provide initial input to the transient LOCA simulation model of Case 4. The initial steady-state normal operation (NO) conditions of the APT blanket system were obtained by specifying maximum pump rotational speeds for the two HR pumps with the desired total liquid flowrate under the constrained steady-state (CSS) controller option. The initial temperatures for the pressurizer and the RHR system components are 40 C. Table A-2 shows the initial steady-state values for the key thermal-hydraulic system parameters of the blanket system.

2.4 Transient Boundary Conditions

The TRAC system model is documented in the report for the steady state NO calculations [1]. The steady-state NO TRAC run was restarted in transient mode to initiate the LOCA simulation of Case 4. The BREAK component was a single-cell PIPE component (component 764) located on the pressurizer surge line external to the cavity vessel wall. The break location was selected to be close to the cavity vessel as shown in Fig. 1-2. For the LOCA initiation, PIPE component 764 was replaced with two BREAK components using transient pressure boundary conditions at both ends of the broken component to simulate a double-ended break. The BREAK components were set to ramp down from the NO steady-state pressure to one atmospheric pressure in 0.1 second after the accident. Additionally, the pressurizer boundary condition was changed from a constant pressure break boundary to a zero fill (no flow) boundary. This is done to remove possible pressure control of the pressurizer during the LOCA Case 4 accident.

2.5 Trips and Controls

Power to the two HR pumps and the beam were tripped 0.2 seconds after the pressurizer surge line pressure dropped to 0.68745 MPa (99.70 psia) corresponding to 95% of the NO surge line pressure close to the inlet fixed header. The delay time

chosen for the accident simulations was obtained by doubling the estimated response time for the signal transducers to actuate the component hardware. The beam trip was simulated by changing the steady-state NO power in the heat structure of each blanket module to the time dependent decay power curve. Figure 1-1 shows transient decay power curves for the blanket module heat structures. The beam and the two HR pump power trips actually occurred about 0.21 seconds after the initiation of the transient accident. The RHR pump power signal was set to actuate without delay after a 5% reduction of the pressurizer surge line pressure. The RHR pump was modeled to attain full speed (94.35 rad/sec) within 15 seconds after the start of the accident by using a component action table with S-shaped forcing function values. Check valves on the discharge sides of the HR and RHR pumps are actuated to avoid flow reversal immediately after the initiation of the LOCA accident. If flow reversal occurs during the accident, the HR and RHR check valves are set to be closed immediately. Table 2.5-1 lists all the trip signals and controls used for the Case 4 accident simulation.

2.6 TRAC Version

This transient model was run using TRAC-PF1/MOD2 version 5.4.28a [16]. A modified version of TRAC to generate graphics files was employed [15]. Light water properties were used. The TRAC Case 4 LOCA model input file is listed in Appendix C, and the graphics input file is listed in Appendix D.

Table 2-1 Six lumped blanket module system model used for the present PSAR analysis.

6 Lumped Modules	Prototypic 16 Full Blanket Modules	Thermal Deposited Power Downflow / Upflow / Total Power	Pipe Size (inch)
Module 1	Front 1 st Lateral Dec. / Row 1 Module Back 1 st Lateral Dec. / Row 1 Module	8.222 MW / 15.768 MW / 23.990 MW	7.500
Module 2	Front 2 nd Lateral Row 2 / Row 3 Modules Back 2 nd Lateral Row 2 / Row 3 Modules	3.060 MW / 7.660 MW / 10.720 MW	4.750
Module 3	1 st Downstream Dec. / Row 1 Module	0.744 MW / 2.812 MW / 3.556 MW	3.750
Module 4	2 nd Downstream Row 1 / Row 2 Module	3.924 MW / 5.412 MW / 9.336 MW	5.375
Module 5	3 rd Downstream Row 2 / Row 2 Module	1.355 MW / 1.811 MW / 3.167 MW	6.000
Module 6	Low Power Modules Blanket Upstream Dec. / Row 2 Module Lower Front Dec. / Row 2 Module Lower Front Row 2 / Row 2 Module Lower Back Dec. / Row 2 Module Lower Back Row 2 / Row 2 Module Upper Front Row 2 / Row 2 Module Upper Back Row 2 / Row 2 Module	(Horizontal Flow) 0 MW / 5.712 MW / 5.712 MW	3.875
Total Deposited Power		17.305 MW / 39.175 MW / 56.480 MW	

Table 2.5-1 Trip signals used in the LOCA simulation of Case 4.

Trip Signal ID	Control Component	Signal Variables ID Number (Control Variable)	Signal Values
101	Fill boundary for secondary heat exchanger side	1 (time)	1.0e-06 sec
102	Cavity flood system valve	10 (cavity vessel pressure)	valve closed
103	RHR check valve	1 (time) and action table (S-shaped forcing function)	1.0e-06 sec
104	Heat structure	7 (pressurizer pressure) and time delay	0.2 sec delay after 5% reduction of pressurizer surge line pressure
105	RHR pump	7 (pressurizer pressure) and time	full speed in 15 sec. after 5% reduction of pressurizer surge line pressure
106	Primary HR pump	7 (pressurizer pressure) and time delay	0.2 sec delay after 5% reduction of pressurizer surge line pressure
107	Primary HR check valve	1 (time) and action table (S-shaped forcing function)	1.0e-06 sec
108	Cavity vessel check valve	1 (time)	valve closed
109	Cavity vessel check valve on the HR side	1 (time)	valve closed
110	Cavity vessel vent valve	7 (pressurizer pressure)	valve closed

Figure 2-1 Top cross-sectional face map of six lumped blanket system modules.

3 TRAC System Model Results

The LOCA simulation model for the external pressurizer surge line break near the fixed header (Case 4) was run for 600 seconds after initiation of the accident. The simulation results show that a single RHR system can mitigate this design basis accident without any damage to the blanket module system and structure. The Case 4 accident scenario simulated that the pressurizer component was completely disconnected from the primary HR loop system by breaking the surge line of the pressurizer. The results show that liquid coolant in the pressurizer was not drained completely during the accident so that gas inside the pressurizer was not entrained into the pressurizer surge line break. The temperature of the coolant water surrounding the blanket modules does not reach

saturation temperature leading to phase change inside the blanket system under the isolation of the pressurizer system during the accident transients. The following subsections provide descriptions of the transient phenomena for the key blanket component systems observed in the accident simulation in more detail.

Results from the TRAC system model calculations are presented in graphical form in Appendix B. Appendix B1 shows output for the TRAC PLENUM components, Appendix B2 contains the output for PIPE, PUMP and VALVE components while Appendix B3 shows output for the heat structures. A listing of the TRAC standard input file for LOCA Case 4 is in Appendix C and a listing of the graphics input file used to create the graphical output is given in Appendix D.

3.1 Modules

Figure A-1 shows the component layout of the internal blanket module system used in the TRAC system model. Transient results for coolant hydraulic parameters through the six blanket upward flow regions are graphically shown in Figs. B2-24a through B2-24e for the external LOCA Case 4 simulation. From the results, it was noted that steep transient thermal-hydraulic behavior for the flow channels of all the six blanket modules occurred up to about 100 seconds after initiation of the LOCA. During the first 26 seconds of rapid depressurization in the primary HR system, pump cavitation occurred at the two HR pump suction sides. Coolant liquid at the pump suction side boiled due to the flashing phenomenon caused by the loss in pressure. After boiling occurred at the pump suction sides, all the blanket modules started to have non-zero but very small void fractions (max. 8.5% void) at 30 seconds transient time (i.e. about 4 seconds after the pump cavitation). Void residence time within the blanket module was approximately 60 seconds as shown in Fig. B2-24e. At about 90 seconds there was no void observed in the internal blanket modules. After this period, total liquid flowrate within the six blanket module channels was reduced to less than 2% of NO full liquid flowrate (1569 kg/sec) and remained stabilized at this value for the remainder of the simulation.

Figs. B3-26 through B3-42 show detailed graphical results for the solid structures of the six blanket modules. Generally, solid temperatures decreased quickly during the first 50 seconds after the accident, and then, after rising up about 2 to 3 C for about 50 seconds, solid temperatures slowly declined following the trend of the decay heat curve shown in Fig. 1-1. The maximum surface temperature of the aluminum cladding was 93.5 C during normal operating conditions at the mid-plane of the blanket module #1 and dropped to the minimum value (about 45 C) at the transient time of 50 seconds. After the HR and RHR cavitation (about 100 seconds), the aluminum surface temperatures started to approach a stabilized cooling condition.

3.2 HR Loop and Pressurizer

Figure A-2 shows the HR system component layout used for the one-dimensional TRAC system model. With the initiation of the pressurizer surge line break (using component 764) shown in Fig. 1-1, the pressurizer component was completely disconnected from the primary HR system, and the system pressure in the primary HR loop decreased rapidly. Figure B1-1a shows fixed header fluid pressures for the Case 4 LOCA simulation. The results show that pressures in the hot and cold legs drop steeply

following the initiation of the accident. It was noted that the cold-leg fixed header pressure decreased to one atmospheric pressure in 7.0 seconds and the hot-leg fixed header pressure dropped to less than one atmospheric pressure within 0.2 second. After pump coast-down at about 35 seconds, the hot-leg fixed header pressure rose to near one atmosphere pressure. Pressures of both fixed headers were stabilized at about 60 seconds after the accident as shown in Fig. B1-1.

Transient thermal-hydraulic behavior for the two primary HR heat exchangers are graphically shown in Figs. B2-12a to B2-13e. Model results showed that the two heat exchangers had asymmetrical thermal/hydraulic behavior. From the results, flow reversal was initiated in heat exchanger (HX) #1 at about 90 seconds after the accident and continued throughout the remaining transient time. When flow reversal occurred, it was also noted that fluid temperature in the last cell of the HX inlet PIPE component was higher than the upstream cells by about 1 C under the transient accident conditions. A large cell volume and large flow area difference between the HX inlet and the HX main component allowed this cell to accumulate thermal energy during the transient. The flow reversal and inverse temperature gradient caused the heat exchanger #1 inlet temperature to increase by about 0.6 C at 80 seconds and then to decrease continuously as shown in Fig. B2-12b.

Figure A-3 shows the TRAC component layout for the pressurizer system. Figs. B2-15b to B2-15e show transient behavior of the key thermal-hydraulic parameters for the pressurizer and surge line during the LOCA Case 4 accident. During the first 10 seconds after the accident coolant water was drained quickly through the pressurizer surge line and air started to be entrained into the primary coolant loop from the surge line break. There was near-stagnant liquid flow in the primary HR loop at about 100 seconds. At this time the RHR flowrate was established with the full capacity (about 4% of NO full flowrate). From the results shown in Fig. B2-15d, the liquid in the pressurizer was not drained completely during the accident so that gas inside the pressurizer was not entrained into the surge line break. Void fraction in the surge line of the pressurizer was zero during the entire transient time of the accident satisfying the design requirement for the pressurizer component.

3.3 RHR Loop

Figure A-4 shows the component layout of the TRAC system model for the RHR system. The initial temperature for the RHR system was about 40 C. Maximum RHR flowrate was about 4% of total full power liquid flowrate. The RHR system has a check valve on the RHR pump discharge to prevent flow reversal during the LOCA accident. The transient responses of the RHR system to the LOCA Case 4 scenario are shown in Figs. B2-16a to B2-16e and B2-17a to B2-17e. Figure B2-16a shows system pressures at the RHR pump suction and discharge sides. Flow reversal occurred at the RHR pump suction side immediately after the initiation of the accident, and the RHR check valve closed to avoid backflow in the RHR system. Consequently, the RHR flowrate was actually zero for about 8 seconds. After that time, the RHR valve started to open. Void formation at the RHR pump suction side was initiated by pump cavitation at about 10 seconds as shown in Fig. B2-16e. At about 100 seconds after the accident started the RHR system reached full flowrate as shown in Fig. B2-16d. The RHR water slowly approached a steady-state temperature of about 50 C as soon as the RHR pump

circulated the cooling water at full capacity through the blanket modules internal to the cavity vessel.

3.4 Cavity Vessel and Flood System

Figure A-5 shows the TRAC component layout for the heat transfer connections between the blanket module heat structures and the cavity vessel. Figure A-6 shows the TRAC component layout for the cavity vessel and flood system. During the external LOCA Case 4 accident, the cavity flood system pool is stagnant with an ambient temperature of 40 C. The cavity vessel has no liquid phase with the gas phase saturated at ambient temperature and a pressure of about 5 psia during the external LOCA accident.

4 FLOWTRAN-TF Detailed Bin Model

The basic FLOWTRAN-TF model is described in Refs. [12, 13] and was used in this version for the LOCA Case 4 analyses. The FLOWTRAN-TF model was developed to simulate the thermal-hydraulic conditions in a lateral Row 1 blanket module using the reference 1 plate-type design [11]. The areal mesh of the bin model is shown in Figure 4-1 along with the location and indexing used for the 12 discrete flow channels.

4.1 Model Upgrades

No modifications to the original model were required for the LOCA Case 4 analysis.

4.2 Initial Conditions

Initial conditions for all of the flow transients are the normal operating conditions reported in Ref. [1]. The TRAC supplied initial conditions used in the FLOWTRAN-TF calculations are listed in Table 4.2-1.

4.3 Transient Boundary Conditions

Results from the TRAC external large-break LOCA transient were used to supply boundary conditions to the FLOWTRAN-TF code for detailed calculations of the thermal-hydraulic behavior of a single row-1 blanket plate. The TRAC transient results used in these calculations were:

1. Total coolant flow to the lateral row-1 blanket module taken from TRAC PIPE component 454. The pre-incident flow to a single blanket plate was taken to be 1.488 kg/s and the normalized coolant flow transient from TRAC was used to supply a time dependent shape for the total coolant flow. That is, absolute values of the TRAC coolant flow were not used in the FLOWTRAN-TF calculations only the relative transient behavior.
2. Inlet cooling water temperature, pressure and void fraction taken from TRAC PLENUM component 350. The calculations used inlet flow as an applied boundary condition and inlet pressure was used only for physical property evaluations.

3. Outlet pressure taken from TRAC PLENUM component 330.

Normalized inlet conditions derived from the TRAC system analysis are shown in Fig. 4.3-1 where the boundary conditions are plotted as transient values relative to the pre-incident conditions. Since void fraction naturally falls between zero and one, absolute values of void fraction are plotted in the figure. For LOCA Case 4, no void fraction appears at the inlet to the coolant flow channels during the transient.

Table 4.2-1 Initial conditions for FLOWTRAN-TF LOCA analysis.

	Pressure (MPa)	Temperature (C)	Void
Channel Inlet	0.686	53.04	0
Channel Outlet	0.584

Figure 4-1 Finite element mesh of APT reference 1 blanket plate.

Figure 4.3-1 Inlet boundary conditions for LOCA Case 4.

5 FLOWTRAN-TF Bin Model Results

A listing of the input deck used for the FLOWTRAN-TF calculations of LOCA Case 4 is given in Appendix E. Some results from the FLOWTRAN-TF calculations are shown in Fig. 5-1 where the maximum aluminum temperature found anywhere in the plate cladding is plotted as a function of time into the loss-of-coolant accident transient. The initial maximum temperature of 100.0 C is indicated on the ordinate since it is difficult to see the sudden temperature decrease that occurs within the first few seconds on the transients. Initially, the maximum aluminum temperature occurs on the side of the plate nearest the decoupler region and closest to the point of beam impact. It is assumed that the power is tripped 1.0 second after the start of the accident and that the pre-incident power is the nominal value 61.5 kW.

It is clear from the metal temperatures shown in Fig. 5-1 that surface temperatures in the flow channels following beam trip are not close to local boiling conditions. To further illustrate the safety margins, operating surface heat fluxes (q_{ohf}) were compared to the heat fluxes predicted for onset of nucleate boiling (q_{onb}), onset of significant void formation (q_{osv}) and the critical heat flux (q_{CHF}). Since each of the 12 flow channels has 20 axial cells and at each axial level the surface is composed of from 8 to 17 surface nodes there are many (2760) surface heat fluxes at any time in the calculation. To reduce the number of data points, we have taken the approach of reporting the maximum heat flux at each axial position within each channel irrespective of the particular surface node where the maximum occurs. Further we can restrict the

examination to the location of the peak axial heat fluxes. The axial power shape for the blanket module is shown in Fig. 5-2 along with the 20 cells that were used to discretize the axial dimension for the safety calculations. Highest operating surface heat fluxes were observed to occur in axial cells 10 through 15.

To show some representative results, the operating surface heat flux and the calculated limits for Case 4 are shown in Figs. 5-3 through 5-5 for all of the flow channels at axial level 11. Channels 1 and 5 are the rectangular flow channels nearest the decoupler side of the plate while channel 8 is the first annular flow channel on that side. This side of the plate absorbs the largest fraction of the deposited power but has a larger fraction of the coolant flow. Channels 4 and 7 are the rectangular flow channels nearest the cavity side of the plate where deposited power and coolant flow are lowest.

Results from other axial locations on the plate surface are similar demonstrating a substantial margin between the surface heat flux and the potentially limiting values. The closest approach of the operating heat flux to the limiting values typically occurs in flow channels 1 or 8 between 0 and 2 seconds into the transients. Near the top of the plate, the surface heat flux can even reverse as energy flows from the heated water back into the cooler metal. This condition was observed to occur in the annular flow channels and in some of the low power rectangular channels.

Figure 5-1 Maximum aluminum temperature for LOCA Case 4.

Figure 5-2 Blanket axial power shape.

Figure 5-3 Surface heat fluxes for LOCA Case 4, axial level 11, channels 1-4.

Figure 5-4 Surface heat fluxes for LOCA Case 4, axial level 11, channels 5-8.

Figure 5-5 Surface heat fluxes for LOCA Case 4, axial level 11, channels 9-12.

6 Conclusions

Simulations performed using the TRAC system model and the FLOWTRAN-TF detailed bin model show that the APT blanket modules maintain a coolable geometry during the LOCA Case 4 scenario.

6.1 Comparison to Thermal/Hydraulic Design Criteria

The thermal/hydraulic (T/H) design criteria, along with the basis for their development, is discussed in Refs. [8, 14]. For LOCA the T/H onset criteria are based on meeting very strict phenomenological limits with a high degree of confidence, as follows:

- for local heated surfaces within the module components, the onset-of-significant-voids [OSV]) at a three sigma confidence level; and
- for the remaining unheated piping sections of the blanket system, the onset-of-bulk-boiling [OBB]) at a three sigma confidence level.

Additional (steady-state derived) material design criteria are imposed on the maximum lead and aluminum (Series 6061 - Type T6) metal temperatures acceptable for the module components. The limiting values for these parameters are 327.5 C and 115 C for lead and aluminum, respectively. These material design criteria ensure that a coolable geometry can be maintained throughout the expected lifetime of each module unit.

On a module-by-module basis, the above steady-state material and thermal onset criteria for LOCA are compared to the FLOWTRAN-TF detailed bin model results. The bin model results for the reference 1 plate-type module are tabulated in Table 6.1-1 (note that only module 1 results are currently available since the design specifications for modules 2 through 6 do not presently exist). However, module 1 should be close to the most limiting module. Additional thermal onset criteria, which are typically considered, are also provided in Table 6.1-1. Note that these are generally more stringent than the imposed design criteria chosen.

The definitions of the criteria ratios in Table 6.1-1 are listed below, as follows:

$$R_{SUB} = \max\left(\frac{T_f - T_{in}}{T_{sat} - T_{in}}\right), \text{ liquid subcooling}$$

$$R_{SUP} = \max\left(\frac{T_w - T_{in}}{T_{sat} - T_{in}}\right), \text{ wall superheating}$$

$$R_{ONB} = \max\left(\frac{q''_{OHF}}{q''_{ONB}}\right), \text{ ONB heat flux}$$

$$R_{OSV} = \max\left(\frac{q''_{OHF}}{q''_{OSV}}\right), \text{ OSV heat flux}$$

$$R_{CHF} = \max\left(\frac{q''_{OHF}}{q''_{CHF}}\right), \text{ CHF heat flux}$$

where:

- q''_{OHF} operating heat flux
- q''_{ONB} heat flux at onset of subcooled nucleate boiling
- q''_{OSV} heat flux at onset of significant void formation
- q''_{CHF} critical heat flux
- T_f fluid temperature
- T_{in} fluid temperature at inlet to flow channels, (53.05 C)
- T_{sat} local fluid saturation temperature
- T_w wall temperature

To evaluate these criteria, the maximum value corresponds to its limit spatially, as well as over the time period of the event sequence. The ratio of OHF-to-CHF is sometimes referred to as the departure from nucleate boiling ratio [DNBR]. Predicted thermal onset ratios should not exceed unity.

Confidence bounds are required to establish the acceptable level of probability of exceeding these criteria. The results presented in Table 6.1-1 represent primarily best estimate values (however, some parameters were set to their estimated upper bounds, such as power density). Quantification of overall uncertainties and then their corresponding confidence levels (i.e., operating and modeling uncertainties) have not yet been performed. Future efforts to perform a response surface analysis are planned. At that time quantification of safety margins will be determined.

The peak blanket metal temperature occurs in module #1, and it is 112.8 C, as predicted by the FLOWTRAN-TF model. This occurs in the lead plate, and it is well below the lead melting point, 327.5 C. The peak aluminum temperature also occurs in module #1, and it is 100 C, below the long term temperature limit of 115 C. Since the power decay is steeper than the flow decay the reported maximum metal temperatures are essentially the pre-incident values. Actually, maximum temperatures are reached 1 second after the start of the accident when the beam trips. However, the thermal inertia of the solid is such that this brief time delay is negligible.

6.2 Design Issues

The TRAC system model predicts a peak lead temperature in module #1 of 152 C and the detailed FLOWTRAN-TF bin model predicts a peak lead temperature of 112.8 C. The cruciform design was used in the TRAC system model, and the plate design was used in the FLOWTRAN-TF model. This points out the need for consistency between the two models. The TRAC model will be upgraded in order to provide this consistency.

6.3 Predicted Impact

Blanket conditions during LOCA Case 4 fall within all specified thermal/hydraulic design criteria. No off-site impact to people or the environment would occur as a result of LOCA Case 4. The only on-site consequence would result from the release of contaminated cooling water.

Table 6.1-1 FLOWTRAN-TF model results under LOCA Case 4 conditions.

Module #	Max Pb Temp (C)	Max Al Temp (C)	Max Subcooling Ratio	Max Superheat Ratio	Max ONB Ratio	Max OSV Ratio	Max CHR Ratio
1	112.8	100.0	0.304	0.507	0.296	0.074	0.308
2	TBD	TBD	TBD	TBD	TBD	TBD	TBD
3	TBD	TBD	TBD	TBD	TBD	TBD	TBD
4	TBD	TBD	TBD	TBD	TBD	TBD	TBD
5	TBD	TBD	TBD	TBD	TBD	TBD	TBD
6	TBD	TBD	TBD	TBD	TBD	TBD	TBD

7 References

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Appendix A: TRAC Model Component Nomenclature

Table A-1 Blanket System Component Descriptions in TRAC Model.

System	Component Type	Comp #	No of Cells	Descriptions
HR	Fixed Header (FH)	380	1	coolant Supply FH
		340	1	coolant Return FH
	Pressurizer (Pzr)	760	1	Pzr surge line 1 connected to Supply FH 380
		761	2	Pzr surge line 2
		762	1	Pzr surge line 3
		763	1	Pzr surge line 4
		764	1	Pzr surge line 5
		765	13	Pzr surge line 6
		766	9	primary Pzr
	Hot Leg Loop	20	1	pipe connected to Return FH340
		21	1	plenum for potential break loc.
		22	7	pipe connection to external loop
		23	1	pipe connect. for potential break
		24	13	connection pipe
		25	1	connection pipe
		26	2	pipe connected to two pumps
		27	1	plenum for two pump connection
		28	2	pump#1 suction pipe
		29	7	pump#2 suction pipe
		30	2	pump located at cell face 2
		31	2	pump located at cell face 2
		32	3	check valve located at pump#1 discharge
		33	3	check valve located at pump#2 discharge
		34	1	pump outlet plenum
	HX	36	1	connect. pipe between pump and pipe
		37	1	HX connect. pipe for potential break
		38	1	pipe connect. to two HX's inlet plenum
		40	1	plenum
		48	3	HX #1 inlet pipe
		50	4	HX #1 1 st pass
		52	3	HX #1 middle header
		54	4	HX #1 2 nd pass
		49	3	HX #2 inlet pipe
		51	4	HX #2 1 st pass
		53	3	HX #2 middle header
		55	4	HX #2 2 nd pass
		710	1	HX #1 secondary side fill
		711	4	HX #1 2 nd pass secondary side
		712	3	HX #1 middle header secondary side
		713	4	HX #1 1 st pass secondary side
		714	1	HX #1 secondary side break BC
		730	1	HX #2 secondary side fill BC

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Table A-1 Blanket System Component Descriptions in TRAC Model (continued).

System	Component Type	Comp #	No of Cells	Descriptions
		731	4	HX #2 2 nd pass secondary side
		732	3	HX #2 middle header secondary side
		733	4	HX #2 1 st pass secondary side
		734	1	HX #2 secondary side break BC
HR	Cold Leg Loop	56	3	HX #1 outlet pipe
		57	6	HX #2 outlet pipe
		60	3	HX outlet plenum merged after two HX's
		62	1	cold leg pipe
		63	1	cold leg pipe
		64	13	cold leg pipe located outside cavity wall
		65	1	pipe for cold leg pipe break
		66	1	horizontal cold leg pipe penetration
		67	1	plenum for internal break on HR loop
		854	2	HR isolation valve for internal break
		69	1	plenum for internal LOCA simulation
		68	5	pipe connect. to FH 340 inside cavity
Cavity Vessel	Cold Leg Loop	850	2	valve located bet. cavity vessel and HR
		852	2	valve located bet. cavity vessel and HR
			1	plenum for cavity vessel connection
		828	3	cavity vent valve
		802	1	break component for cavity vent pressure BC
		823	11	pipe for cavity lower section simulation
		824	1	plenum for cavity connection
		840	2	valve to connect cavity line to Module 1
		825	4	pipe for cavity middle section simulation
Cavity Pool	Cavity Flood Line	820	13	pipe for cavity pool connection to cavity vessel
		821	2	cavity flood line valve
		822	1	flood line pipe inside cavity vessel
	Cavity Flood Pool	801	1	break component for cavity pool BC
		810	10	pipe for top cavity pool section
		811	1	plenum for middle cavity pool section
		812	7	pipe for lower cavity pool section
		813	1	plenum for cavity pool bottom
RHR	RHR Loop	621	1	pipe located to return FH
		623	10	pipe located inside the cavity vessel
		624	1	pipe located outside the cavity vessel
		625	18	pipe bet. RHR pump and pipe comp. #624
		630	2	RHR pump located at face 2
		640	3	check valve located at pump discharge
		652	4	HX tubes
		660	16	pipe at the cold leg side
		661	1	pipe located before cavity vessel
		662	8	cold leg pipe inside cavity vessel

Table A-1 Blanket System Component Descriptions in TRAC Model (continued).

System	Component Type	Comp #	No of Cells	Descriptions
		663	1	cold leg pipe connected to supply FH
		672	1	fill for HX secondary side BC
		671	4	HX secondary shell side
		673	1	break comp. for HX secondary side BC
Module	Module 1 Flow	454	7	pipe connected to supply FH
		80	1	plenum for potential internal break simulation at Module 1
		375	5	pipe connection bet. Supply FH and Module 1 upper plenum
		370	1	upper plenum for Module 1 downcomer
		360	5	Module 1 downflow region
		350	1	middle plenum bet. Module 1 downflow and upflow regions
		300	5	Module 1 upflow region
		330	1	upper plenum for module 1 upflow region
		335	5	connection pipe after Module 1 upper plenum
		429	4	pipe connected to return FH
	Module 2 Flow	173	7	pipe connected to supply FH
		81	1	plenum for potential internal break simulation at Module 2
		82	3	pipe connection
		172	1	upper plenum for Module 2 downcomer
		158	6	Module 2 downflow region
		147	1	middle plenum bet. Module 2 downflow and upflow regions
		102	6	Module 2 upflow region
		133	1	upper plenum for module 2 upflow region
		136	7	pipe connected to return FH
	Module 3 Flow	415	7	pipe connected to supply FH
		85	1	plenum for potential internal break simulation at Module 3
		86	3	pipe connection
		479	1	upper plenum for Module 3 downcomer
		478	5	Module 3 downflow region
		418	1	middle plenum bet. Module 3 downflow and upflow regions
		409	5	Module 3 upflow region
		423	1	upper plenum for module 3 upflow region
		417	7	pipe connected to return FH
	Module 4 Flow	485	7	pipe connected to supply FH
		87	1	plenum for potential internal break simulation at Module 4
		88	3	pipe connection
		489	1	upper plenum for Module 4 downcomer

Table A-1 Blanket System Component Descriptions in TRAC Model (continued).

System	Component Type	Comp #	No of Cells	Descriptions
		480	6	Module 4 downflow region
		419	1	middle plenum bet. Module 4 downflow and upflow regions
		412	6	Module 4 upflow region
		483	1	upper plenum for module 4 upflow region
		484	7	pipe connected to return FH
Module	Module 5 Flow	513	7	pipe connected to supply FH
		89	1	plenum for potential internal break simulation at Module 5
		90	3	pipe connection
		510	1	upper plenum for Module 5 downcomer
		507	6	Module 5 downflow region
		503	1	middle plenum bet. Module 4 downflow and upflow regions
		500	6	Module 5 upflow region
		508	1	upper plenum for Module 5 upflow region
		511	7	pipe connected to return FH
	Module 6 Flow	541	7	pipe connected to supply FH
		83	1	plenum for potential internal break simulation at Module 6
		84	1	pipe connection
		538	1	upper plenum for Module 6 decoupler
		535	5	Module 6 downcomer region
		531	1	middle plenum bet. Module 6 decoupler and main heated regions
		528	5	Module 6 main heated region
		536	1	upper plenum for module 6 main heated region
		539	12	pipe connected to return FH
	Module 1 Heater Structure	901	5	Al tube structure in Row 1
		951	5	Lead zone with Al cladding in Row 1
		984	5	Al tube structure in decoupler
	Module 2 Heater Structure	905	6	Al tube structure in Row 2
		955	6	Lead zone with Al cladding in Row 2
		916	6	Al tube structure in Row 3
		966	6	Lead zone with Al cladding in Row 3
	Module 3 Heater Structure	911	5	Al tube structure in Row 1
		961	5	Lead zone with Al cladding in Row 1
		988	5	Al tube structure in decoupler
	Module 4 Heater Structure	912	6	Al tube structure in Row 1
		962	6	Lead zone with Al cladding in Row 1
		931	6	Al tube structure in Row 2

Table A-1 Blanket System Component Descriptions in TRAC Model (continued).

System	Component Type	Comp #	No of Cells	Descriptions
		978	6	Lead zone with Al cladding in Row 2
	Module 5 Heater Structure	913	6	Al tube structure in Row 2
		963	6	Lead zone with Al cladding in Row 2
		932	6	Al tube structure in Row 2
		979	6	Lead zone with Al cladding in Row 2
	Module 6 Heater Structure	915	5	Al tube structure in Row 2
		965	5	Lead zone with Al cladding in Row 2

Table A-2 Steady State Conditions.

Parameter	Units	Calculated Values
Total power deposited in blanket modules	MW	56.5
Total flow rate	kg/sec gpm	1569 25252
Pressure in cold-leg fixed header	MPa psia	0.7325 106.24
Pressure in hot-leg fixed header	MPa psia	0.4563 66.180
Pressurizer (cell #1) pressure	MPa psia	0.7311 106.03
Pump #1 suction pressure	MPa psia	0.2751 39.90
Pump #1 discharge pressure	MPa psia	1.0356 150.20
Pump #2 suction pressure	MPa psia	0.2958 42.91
Pump #2 discharge pressure	MPa psia	1.0409 150.97
Temperature in cold-leg fixed header	C F	49.43 121.0
Temperature in hot-leg fixed header	C F	58.03 136.5
Max. fluid temperature of the hottest module	C F	71.95 161.5

Figure A-1 6 blanket module layout for safety analysis.

Figure A-2 TRAC component layout for the cavity vessel and blanket module heat structures.

Figure A-3 TRAC component layout for the cavity vessel and cavity flood system.

Figure A-4 TRAC component layout for blanket primary HR coolant loop.

Figure A-5 TRAC component layout for blanket primary RHR coolant loop.

Figure A-6 TRAC component layout for blanket primary pressurizer and surge line.

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Appendix B: LOCA (Case 4) TRAC Results

Appendix B1 LOCA (Case 4) TRAC Plenum Component Figures

The following figures are from a TRAC simulation for Case 4 of a LOCA (external pressurizer surge line break near inlet header):

Figure B-1a Fixed header fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-1b. Fixed header fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-1c. Fixed header fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-1d Fixed header void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-2a Module 1 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-2b Module 1 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-2c Module 1 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-2d Module 1 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-3a Module 2 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-3b Module 2 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-3c Module 2 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

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Figure B-3d Module 2 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-4a Module 3 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-4b Module 3 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-4c Module 3 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-4d Module 3 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-5a Module 4 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-5b Module 4 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-5c Module 4 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-5d Module 4 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-6a Module 5 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-6b Module 5 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-6c Module 5 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-6d Module 5 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-7a Module 6 plenum fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-7b Module 6 plenum fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-7c Module 6 plenum fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-7d Module 6 plenum void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Appendix B2 LOCA (Case 4) TRAC Pipe, Pump, and Valve Component Figures

The following figures are from a TRAC simulation for Case 4 of a LOCA (external pressurizer surge line break near inlet header):

Figure B-8a Primary HR hot-leg piping fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-8b Primary HR hot-leg piping fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-8c Primary HR hot-leg piping fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-8d Primary HR hot-leg piping liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-8e Primary HR hot-leg piping void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-9a Primary HR pump 1 fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-9b Primary HR pump 1 fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-9c Primary HR pump 1 fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-9d Primary HR pump 1 liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-9e Primary HR pump 1 void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-10a Primary HR pump 2 fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-10b Primary HR pump 2 fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-10c Primary HR pump 2 fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-10d Primary HR pump 2 liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-10e Primary HR pump 2 void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-11a Primary HR pump discharge piping fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-11b Primary HR pump discharge piping fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-11c Primary HR pump discharge piping fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-11d Primary HR pump discharge piping liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-11e Primary HR pump discharge piping void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-12a Primary HR heat exchanger inlet piping fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-12b Primary HR heat exchanger inlet piping fluid temperatures for a LOCA
(Case 4: external Pressurizer break near inlet header).

Figure B-12c Primary HR heat exchanger inlet piping fluid subcoolings for a LOCA
(Case 4: external Pressurizer break near inlet header).

Figure B-12d Primary HR heat exchanger inlet piping liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-12e Primary HR heat exchanger inlet piping void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-13a Primary HR heat exchanger outlet piping fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-13b Primary HR heat exchanger outlet piping fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-13c Primary HR heat exchanger outlet piping fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-13d Primary HR heat exchanger outlet piping liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-13e Primary HR heat exchanger outlet piping void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-14a Primary HR cold-leg piping fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-14b Primary HR cold-leg piping fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-14c Primary HR cold-leg piping fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-14d Primary HR cold-leg piping liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-14e Primary HR cold-leg piping void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-15a Primary HR pressurizer and surge line fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-15b Primary HR pressurizer and surge line fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-15c Primary HR pressurizer and surge line fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-15d Primary HR pressurizer and surge line liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-15e Primary HR pressurizer and surge line void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-16a Primary RHR pump fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-16b Primary RHR pump fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-16c Primary RHR pump fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-16d Primary RHR pump liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-16e Primary RHR pump void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-17a Primary RHR heat exchanger fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-17b Primary RHR heat exchanger fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-17c Primary RHR heat exchanger fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-17d Primary RHR heat exchanger liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-17e Primary RHR heat exchanger void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-18a Module 1 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-18b Module 1 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-18c Module 1 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-18d Module 1 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-8e Module 1 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-19a Module 2 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-19b Module 2 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-19c Module 2 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-19d Module 2 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-19e Module 2 channel Module 2 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-20a Module 3 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-20b Module 3 channel Module 3 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-20c Module 3 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-20d Module 3 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-20e Module 3 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-21a Module 4 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-21b Module 4 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-21c Module 4 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-21d Module 4 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-21e Module 4 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-22a Module 5 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-22b Module 5 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-22c Module 5 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-22d Module 5 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-22e Module 5 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-23a Module 6 channel fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-23b Module 6 channel fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-23c Module 6 channel fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-23d Module 6 channel liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-23e Module 6 channel void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-24a Mid-plane module fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-24b Mid-plane module fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-24c Mid-plane module fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-24d Mid-plane module liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-24e Mid-plane module void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-25a Module inlet fluid pressures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-25b Module inlet fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-25c Module inlet fluid subcoolings for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-25d Module inlet liquid mass flowrates for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-25e Module inlet void fractions for a LOCA (Case 4: external Pressurizer break near inlet header).

Appendix B3 LOCA (Case 4) TRAC Heat Structure Component Figures

The following figures are from a TRAC simulation for Case 4 of a LOCA (external pressurizer surge line break near inlet header):

Figure B-26 Module 1 upflow section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-27 Module 2 upflow section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-28 Module 3 upflow section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-29 Module 4 upflow section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-30 Module 5 upflow section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-31 Module 6 down-stream section bottom and top maximum lead metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-32 Module 1 upflow section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-33 Module 2 upflow section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-34 Module 3 upflow section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-35 Module 4 upflow section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-36 Module 5 upflow section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-37 Module 6 down-stream section bottom and top maximum aluminum metal temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-38 Module 1 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-39 Module 2 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-40 Module 3 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-41 Module 4 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-42 Module 5 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

Figure B-43 Module 6 upflow section top-plane surface and fluid temperatures for a LOCA (Case 4: external Pressurizer break near inlet header).

WESTINGHOUSE SAVANNAH RIVER COMPANY

BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

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Appendix C: TRAC Standard Input File for LOCA Case 4 (with Beam Shutdown and Active RHR)

The file listed below represents the TRAC code "tracin" file that corresponds to the LOCA Case 4 (with beam shutdown and active RHR) for the blanket system. This input deck assumes that a TRAC restart file ("trcrst") exists based on normal operation (NO).

Input file tracin:

```

free format
*
*****
* main data *
*****
*
*          numtcr          ieos          inopt          nmat          id2o
*          38              0              1              2              0
* APT Lumped Blanket Model-** LOCA Simulation for Comp 764 Break**
*          ** HR pump trip **
6 Module Lumped Model with Primary Coolant Loop and RHR Loop
6 Modules - Lateral(R1/Dec) Module, R2/R3 Module,
            3 Backstop Modules, Low Power Module (12/18/1997)
Hydraulic RHR Loop added as of 12/22/1997
- This is based on check valve with flow reversal control logic.
Number of material = 2 (Al and Pb)
- This is single combined mod model without He comp (12/12/1997)
- Aluminum, lead material table got from Ref. (3/5, 1997)
- This is 1 module loop model without primary coolant and RHR loops
- adding two upper modules (L14B-back / L14F-front) as of 7/18/1997.
- Row2/3 power updated (4/23/1997).
- R2/R3 axial power distribution has been updated
  as of 4/25/1997.
- Al and lead material properties updated already.
- Unit cell cal. should be checked.
- K-loss values for each comp and elevation levels need be checked.
- Control signal variable was added (4/25/1997).
- Module 5 6 7 8 connection to fixed header was updated (5/28/97).
- Blanket primary loop pipe size (14 inch) was updated (5/28/1997).
- Lower modules(module 15 16 17 18) were added/updated (5/29/1997).
- Backstop 1st module was updated (5/29/1997).
- Backstop 2nd and 3rd modules were updated (5/30/1997).
- R2/R3 lateral modules were updated from 9 to 11 bins (6/3/1997).
- Lateral module 1 to 4 decay powers were updated (6/23/1997).
- Power for each module was updated from the 6/9/97 e-mail except
  for snout and top modules (6/26/97).
- Decay power fraction for each module was updated from the 6/9/97
  e-mail except for snout and top modules (6/26/97).
- Power for each module was updated from the 6/9/97 e-mail
  for snout module (7/8/97).
- Decay power fraction for each module was updated from the 6/9/97
  e-mail for snout module (7/8/97).
- Single loop to connect two front lateral modules was updated
  (7/16/97).
- Single loop to connect two back lateral modules was updated
  (7/16/97).
*
*
*
*
*****

```

BLANKET SAFETY ANALYSES FOR LOCA

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```

* namelist data *
*****
*
&inopts nrslv=1, nhtstr=25, iconht=0, iadded=10, ielv=1, ipowr=-1,
      tpowr=10, igas=1, noair=0, nlt=12, ikfac=1, ithd=1, nsend=120000 &
*
*          dstep          timet
*          -1             0.0000e+00
*          stdyst          transi          ncomp          njun          ipak
*          0               1             141           120           1
*          epso            epss
*          2.0000e-04      1.0000e-04
*          oitmax          sitmax          isolut          ncontr          nccfl
*          50              50             0              2              0
*          ntsv            ntcb            ntcf            ntrp            ntcp
*          7               0              0              7              1
*
*****
* component-number data *
*****
*
* iorder*
*
760 s * pipe          pressurizer surge line1
761 s * pipe          pressurizer surge line2
762 s * pipe          pressurizer surge line3
763 s * pipe          pressurizer surge line4
* Component 764 is broken
515 s * break         HX-1 sec. break
516 s * break         HX-1 sec. break
*
765 s * pipe          pressurizer surge line6
766 s * pipe          primary pressurizer
767 s * break         pressurizer boundary
*
* HR hot leg
20 s * pipe          HR pump suction pipe
21 s * plenum        HR pump suction pipe (bk)
22 s * pipe          HR pump suction pipe
23 s * pipe          HR pump suction pipe (bk)
24 s * pipe          HR pump suction pipe
25 s * pipe          HR pump suction pipe (bk)
26 s * pipe          HR pump suction pipe
* HR pumps
27 s * plenum        HR pump suction plenum
28 s * pipe          HR pump #1 inlet pipe
30 s * pump          HR pump #1
32 s * pipe          HR pump #1 outlet pipe
29 s * pipe          HR pump #2 inlet pipe
31 s * pump          HR pump #2
33 s * pipe          HR pump #2 outlet pipe
34 s * plenum        HR pump discharge plenum
* HR pump-to-hx piping
36 s * pipe          HR pump discharge pipe
37 s * pipe          HR pump discharge pipe (bk)
38 s * pipe          HR pump discharge pipe
* HR hx's
40 s * plenum        HR hx inlet plenum
48 s * pipe          HR hx 1 inlet pipe
50 s * pipe          HR hx 1 tubes 1st pass
52 s * pipe          HR hx 1 mid-header
54 s * pipe          HR hx 1 tubes 2nd pass

```

BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

56	s	* pipe	HR hx 1 outlet pipe
49	s	* pipe	HR hx 2 inlet pipe
51	s	* pipe	HR hx 2 tubes 1st pass
53	s	* pipe	HR hx 2 mid-header
55	s	* pipe	HR hx 2 tubes 2nd pass
57	s	* pipe	HR hx 2 outlet pipe
60	s	* plenum	HR hx outlet plenum
* HR cold leg			
62	s	* pipe	HR hx discharge pipe
63	s	* pipe	HR hx discharge pipe (bk)
64	s	* pipe	HR hx discharge pipe
*			
65	s	* pipe	HR hx discharge pipe
66	s	* pipe	HR hx discharge pipe
67	s	* plenum	HR hx discharge pipe (bk)
68	s	* pipe	HR hx discharge pipe
* HR hx Secondary Side			
710	s	* fill	HR hx Secondary Side-1
711	s	* pipe	HR hx Secondary Side-1
712	s	* pipe	HR hx Secondary Side-1
713	s	* pipe	HR hx Secondary Side-1
714	s	* break	HR hx Secondary Side-1
730	s	* fill	HR hx Secondary Side-2
731	s	* pipe	HR hx Secondary Side-2
732	s	* pipe	HR hx Secondary Side-2
733	s	* pipe	HR hx Secondary Side-2
734	s	* break	HR hx Secondary Side-2
*			
621	s	* pipe	RHR hot leg sect 1 (bk)
623	s	* pipe	RHR hot leg sect 2
624	s	* pipe	RHR hot leg sect 3 (bk)
625	s	* pipe	RHR hot leg sect 4
630	s	* pump	RHR primary pump
640	s	* valve	RHR pump discharge valve
652	s	* pipe	RHR primary heat exchanger tubes
660	s	* pipe	RHR cold leg sect 1
661	s	* pipe	RHR cold leg sect 2 (bk)
662	s	* pipe	RHR cold leg sect 3
663	s	* pipe	RHR cold leg sect 4 (bk)
* RHR hx Secondary Side			
672	s	* fill	RHR hx Secondary Side
671	s	* pipe	RHR hx Secondary Side
673	s	* break	RHR hx Secondary Side
*			
300	s	* pipe	L1 Blanket Row1
330	s	* plenum	L1 Blanket Row1 Plenum
335	s	* pipe	L1 pipe conn. 330 - 340
340	s	* plenum	L1 outlet header
350	s	* plenum	L1 lower plenum
360	s	* pipe	L1 decoupler
370	s	* plenum	L1 decoupler upper plenum
375	s	* pipe	L1 pipe conn. 370 - 380
380	s	* plenum	L1 inlet header
429	s	* pipe	L1 connect hot header-tee
454	s	* pipe	L1 connect cold header-tee
*			
173	s	* pipe	L1 Blanket Row1
172	s	* plenum	L1 Blanket Row1 Plenum
158	s	* pipe	L1 pipe conn. 330 - 340
147	s	* plenum	L1 outlet header
102	s	* pipe	L1 lower plenum
133	s	* plenum	L1 decoupler

BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

*	136	s * pipe	L1 decoupler upper plenum
	541	s * pipe	L1 Blanket Row1
	538	s * plenum	L1 Blanket Row1 Plenum
	535	s * pipe	L1 pipe conn. 330 - 340
	531	s * plenum	L1 outlet header
	528	s * pipe	L1 lower plenum
	536	s * plenum	L1 decoupler
	539	s * pipe	L1 decoupler upper plenum
*	415	s * pipe	L1 Blanket Row1
	479	s * plenum	L1 Blanket Row1 Plenum
	478	s * pipe	L1 pipe conn. 330 - 340
	418	s * plenum	L1 outlet header
	409	s * pipe	L1 lower plenum
	423	s * plenum	L1 decoupler
	417	s * pipe	L1 decoupler upper plenum
*	485	s * pipe	2nd DNS Blanket Row1
	489	s * plenum	2nd DNS Blanket Row1 Plenum
	480	s * pipe	2nd DNS pipe conn. 330 - 340
	419	s * plenum	2nd DNS outlet header
	412	s * pipe	2nd DNS lower plenum
	483	s * plenum	2nd DNS decoupler
	484	s * pipe	2nd DNS dec upper plenum
*	513	s * pipe	Third DNS Blanket Row1
	510	s * plenum	Third DNS Row1 Plenum
	507	s * pipe	Third DNS pipe conn. 330-340
	503	s * plenum	Third DNS outlet header
	500	s * pipe	Third DNS lower plenum
	508	s * plenum	Third DNS decoupler
	511	s * pipe	Third DNS dec upper plenum
*	901	s * rod	annular aluminum rod
	951	s * rod	cylindrical lead rod
	984	s * rod	cylindrical lead rod
*	905	s * rod	annular aluminum rod
	955	s * rod	cylindrical lead rod
	916	s * rod	cylindrical lead rod
	966	s * rod	cylindrical lead rod
*	915	s * rod	annular aluminum rod
	965	s * rod	cylindrical lead rod
*	911	s * rod	annular aluminum rod
	961	s * rod	cylindrical lead rod
	988	s * rod	cylindrical lead rod
*	912	s * rod	annular aluminum rod
	962	s * rod	cylindrical lead rod
	931	s * rod	cylindrical lead rod
	978	s * rod	cylindrical lead rod
*	913	s * rod	annular aluminum rod
	963	s * rod	cylindrical lead rod
	932	s * rod	cylindrical lead rod
	979	s * rod	cylindrical lead rod
*	919	s * rod	annular ss rod
	920	s * rod	annular ss rod

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```

921  s  * rod          annular ss rod
922  s  * rod          annular ss rod
971  e  * rod          annular ss rod

*
*****
* material-properties data *
*****
*
*
* matb  *              51          52e
* ptbln *              2          6e
*
* lead material
*
*   prptb(1,i)  prptb(2,i)  prptb(3,i)  prptb(4,i)  prptb(5,i)
*   2.7300e+02  1.1374e+04  1.2970e+02  3.4592e+01  2.8000e-01
*   1.0000e+10  1.1374e+04  8.9538e+02  3.3382e+01  2.8000e-01
e
*
* aluminum material
*
*   prptb(1,i)  prptb(2,i)  prptb(3,i)  prptb(4,i)  prptb(5,i)
*   2.7300e+02  2.6990e+03  8.6985e+02  2.1046e+02  5.0000e-02
*   3.0000e+02  2.6990e+03  8.9000e+02  2.1046e+02  5.0000e-02
*   3.7300e+02  2.6990e+03  9.4140e+02  2.1046e+02  5.0000e-02
*   4.7300e+02  2.6990e+03  9.9538e+02  2.2175e+02  5.0000e-02
*   6.7300e+02  2.6990e+03  1.0900e+03  2.2845e+02  5.0000e-02
*   1.0000e+10  2.6990e+03  1.2000e+03  2.3000e+02  5.0000e-02
e
*
*****
*
* CSS data
*
*****
*
*****
* control-parameter data *
*****
*
*****
* signal variables
*****
*
* time
*   idsv      isvn      ilcn      icn1      icn2
*       1         0         0         0         0
*
* pressure difference across RHR check valve
*   idsv      isvn      ilcn      icn1      icn2
*       2      -21      640         1         2
*
* Elapse time since RHR pump activated
*   idsv      isvn      ilcn      icn1      icn2
*       3         0         0         0         0
*
* Elapse time since HR pumps activated
*   idsv      isvn      ilcn      icn1      icn2
*       4         0         0         0         0
*
* pressure difference across HR check valve
*   idsv      isvn      ilcn      icn1      icn2

```

BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

	5	-21	32	1	2
--	---	-----	----	---	---

*
 * pressure difference across HR check valve
 * idsv isvn ilcn icn1 icn2
 6 -21 33 1 2
 * pressure, cold leg at plenum, component 761
 * idsv isvn ilcn icn1 icn2
 7 21 761 1 1
 *

 * control-block data *

 *

 * trips

 * trips from off to on at time given by setp(2), fill BC
 * ntse ntct ntsf ntddp ntsd
 1 0 0 0 0
 * idtp isrt iset itst idsg
 101 2 0 1 1
 * setp(1) setp(2)
 0.0000e+00 1.0000e-04
 * dtsp(1) dtsp(2)
 0.0000e+00 0.0000e+00
 * ifsp(1) ifsp(2)
 0 0
 *
 * trips from on to off at time given by setp(2)
 * idtp isrt iset itst idsg
 102 1 1 1 1
 * setp(1) setp(2)
 0.0000e+00 1.0000e+04
 * dtsp(1) dtsp(2)
 0.0000e+00 0.0000e+00
 * ifsp(1) ifsp(2)
 0 0
 *
 * trips from off to on at time given by setp(2), trips RHR check valve
 * idtp isrt iset itst idsg
 103 2 0 1 1
 * setp(1) setp(2)
 0.0000e+00 1.0000e-04
 * dtsp(1) dtsp(2)
 0.0000e+00 0.0000e+00
 * ifsp(1) ifsp(2)
 0 0
 *
 * trips from off to on when the cold leg 1 press. drops below setp(1)
 * trips power in bundles, heat structures
 * idtp isrt iset itst idsg
 104 1 0 1 7
 * setp(1) setp(2)
 6.8745e+05 6.8745e+05
 * dtsp(1) dtsp(2)
 2.0000e-01 2.0000e-01
 * ifsp(1) ifsp(2)
 0 0
 *
 * trips from off to on at setp(2), starts RHR pump.
 * idtp isrt iset itst idsg
 105 1 0 1 7
 * setp(1) setp(2)

BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

```

6.8745e+05  6.8745e+05
*   dtsp(1)   dtsp(2)
0.0000e+00  0.0000e+00
*   ifsp(1)   ifsp(2)
      0       0
*
* trips from off to on at time given by setp(2), trips Primary HR pumps
*   idtp      isrt      iset      itst      idsg
      106      1        0        1        7
*   setp(1)   setp(2)
6.8745e+05  6.8745e+05
*   dtsp(1)   dtsp(2)
2.0000e-01  2.0000e-01
*   ifsp(1)   ifsp(2)
      0       0
*
* trips from off to on at time given by setp(2), trips HR check valves
*   idtp      isrt      iset      itst      idsg
      107      2        0        1        1
*   setp(1)   setp(2)
0.0000e+00  1.0000e-06
*   dtsp(1)   dtsp(2)
0.0000e+00  0.0000e+00
*   ifsp(1)   ifsp(2)
      0       0
*
*****
* component data *
*****
*****
***** type          num          id          ctitle
break          515          515 $515$ break cold leg 1
*   jun1          ibty          isat          ioff
      764          1            0            0
*   ibtr          ibsv          nbtr          nbsv          nbrf
      101          1            -3            0            0
*   dxin          volin          alpin          tin          pin
1.0000e+00  1.7936e-01  1.0000e+00  3.0000e+02  6.3543e+05
*   pain          concin          rbmx          poff          belv
6.3543e+05  0.0000e+00  1.0000e+10  0.0000e+00  5.0227e+00
*   pscl          tclscl          tvscl          pascl          conscl
1.0000e+00  1.0000e+00  1.0000e+00  1.0000e+00  1.0000e+00
*
* ptb * 0.0000e+00  6.35430e+05s
* ptb * 1.0000e-01  1.01325e+05s
* ptb * 1.0000e+04  1.01325e+05e
*
*****
***** type          num          id          ctitle
break          516          516 $516$ break cold leg 2
*   jun1          ibty          isat          ioff
      765          1            0            0
*   ibtr          ibsv          nbtr          nbsv          nbrf
      101          1            -3            0            0
*   dxin          volin          alpin          tin          pin
1.0000e+00  1.7936e-01  1.0000e+00  3.0000e+02  6.3543e+05
*   pain          concin          rbmx          poff          belv
6.3543e+05  0.0000e+00  1.0000e+10  0.0000e+00  5.5560e+00
*   pscl          tclscl          tvscl          pascl          conscl
1.0000e+00  1.0000e+00  1.0000e+00  1.0000e+00  1.0000e+00
*

```


BLANKET SAFETY ANALYSES FOR LOCA

(CASE 4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

```

* ptb *    0.0000e+00    6.35430e+05s
* ptb *    1.0000e-01    1.01325e+05s
* ptb *    1.0000e+04    1.01325e+05e
*
*****
*****      type          num          id          cttitle
fill          767          767 $767$ pressurizer boundary
*      jun1          ifty          ioff
*      767          2          0
*      twtold          rfmix          concin          felv
*      0.0000e+00    1.0000e+20    0.0000e+00    1.1100e+01
*      dxin          volin          alpin          vlin          tlin
*      1.0000e+00    1.8639e-02    1.0000e+00    0.0000e+00    3.1315e+02
*      pin          pain          flowin          vvin          tvin
*      6.6679e+05    6.6679e+05    0.0000e+00    0.0000e+00    3.1315e+02
*
*****
*
end
*
*****
* time-step data *
*****
*
*      dtmin          dtmax          tend          rtwfp
*      1.0000e-07    1.0000e-03    2.0000e-02    1.0000e+01
*      edint          gfint          dmpint          sedint
*      1.0000e-01    5.0000e+00    1.0000e+06    1.0000e+06
*
*      dtmin          dtmax          tend          rtwfp
*      1.0000e-07    5.0000e-03    1.0000e+01    1.0000e+01
*      edint          gfint          dmpint          sedint
*      1.0000e-01    5.0000e+00    1.0000e+06    1.0000e+06
*
*      dtmin          dtmax          tend          rtwfp
*      1.0000e-07    1.0000e-02    5.0000e+01    1.0000e+01
*      edint          gfint          dmpint          sedint
*      1.0000e+00    5.0000e+00    1.0000e+06    1.0000e+06
*
*      dtmin          dtmax          tend          rtwfp
*      1.0000e-07    1.0000e-02    2.0000e+02    1.0000e+01
*      edint          gfint          dmpint          sedint
*      1.0000e+01    5.0000e+00    1.0000e+06    1.0000e+06
*
*      dtmin          dtmax          tend          rtwfp
*      1.0000e-07    1.0000e-02    6.0000e+02    1.0000e+01
*      edint          gfint          dmpint          sedint
*      2.0000e+01    5.0000e+00    1.0000e+06    1.0000e+06
*
*      endflag
*      -1.0000e+00

```

Appendix D: TRAC Graphics Input File for LOCA Case 4 (with Beam Shutdown and Active RHR)

The file listed below represents the TRAC code "graphin" file that corresponds to the LOCA Case 4 (with beam shutdown and active RHR) for the blanket system. This input deck contains the various graphics points selected for output to the "tecsum.grf" file.

Input file graphin:

```

/ npoints /
96
/ component      cell      ictype      itee/
340              1         1         1      Fixed outlet header
380              1         1         1      Fixed inlet header

454              2         0         1      Module 1 pipe
173              2         0         1      Module 2 pipe
415              2         0         1      Module 3 pipe
485              2         0         1      Module 4 pipe
513              2         0         1      Module 5 pipe
541              2         0         1      Module 6 pipe

300              1         0         1      Module 1 Row1
102              1         0         1      Module 2 Row2
409              1         0         1      Module 3 Row1
412              1         0         1      Module 4 Row1
500              1         0         1      Module 5 Row2
528              1         0         1      Module 6 Low Power

300              3         0         1      Module 1 Row1
102              3         0         1      Module 2 Row2
409              3         0         1      Module 3 Row1
412              3         0         1      Module 4 Row1
500              3         0         1      Module 5 Row2
528              3         0         1      Module 6 Low Power

300              5         0         1      Module 1 Row1
102              6         0         1      Module 2 Row2
409              5         0         1      Module 3 Row1
412              6         0         1      Module 4 Row1
500              6         0         1      Module 5 Row2
528              5         0         1      Module 6 Low Power

370              1         1         1      Module 1 Inlet Plenum
350              1         1         1      Module 1 Middle Plenum
330              1         1         1      Module 1 Outlet Plenum
172              1         1         1      Module 2 Inlet Plenum
147              1         1         1      Module 2 middle Plenum
133              1         1         1      Module 2 Outlet Plenum
479              1         1         1      Module 3 Inlet Plenum
418              1         1         1      Module 3 Middle Plenum
423              1         1         1      Module 3 Outlet Plenum
489              1         1         1      Module 4 Inlet Plenum
419              1         1         1      Module 4 Middle Plenum
483              1         1         1      Module 4 Outlet Plenum
510              1         1         1      Module 5 Inlet Plenum
503              1         1         1      Module 5 Middle Plenum
508              1         1         1      Module 5 Outlet Plenum
538              1         1         1      Module 6 Inlet Plenum
531              1         1         1      Module 6 Middle Plenum

```

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536	1	1	1	Module 6 Outlet Plenum
21	1	1	1	Plenum after hot leg FH
22	1	0	1	Pipe 22 near hot leg FH
22	7	0	1	Pipe 22 near hot leg FH
26	1	0	1	Hot leg pump suction line
28	1	0	1	Hot leg pump suction line
28	2	0	1	Hot leg pump suction line
29	1	0	1	Hot leg pump suction line
29	7	0	1	Hot leg pump suction line
30	1	0	1	PCL Pump 1 Suction
30	2	0	1	PCL Pump 1 Discharge
31	1	0	1	PCL Pump 2 Suction
31	2	0	1	PCL Pump 2 Discharge
32	2	0	1	PCL Pump 1 check valve
33	2	0	1	PCL Pump 2 check valve
37	1	0	1	PCL Pump to HX
48	2	0	1	PCL Hx 1 inlet
56	2	0	1	PCL Hx 1 outlet
49	2	0	1	PCL Hx 2 inlet
57	2	0	1	PCL Hx 2 outlet
62	1	0	1	Cold leg Hx discharge line
66	1	0	1	Cold leg Hx discharge line
625	16	0	1	Pipe 16 before RHR Pump Suct
630	1	0	1	RHR Pump Suction
630	2	0	1	RHR Pump Discharge
640	3	0	1	RHR Hx inlet
660	1	0	1	RHR Hx outlet
761	1	0	1	Pzr Pressure Signal
766	1	0	1	Pzr Bottom Pressure
951	1	3	1	Hot Module (1) upflow inside
951	5	3	1	Hot Module (1) upflow inside
951	1	3	2	Hot Module (1) upflow outside
951	5	3	2	Hot Module (1) upflow outside
955	1	3	1	Hot Module (2) upflow inside
955	6	3	1	Hot Module (2) upflow inside
955	1	3	2	Hot Module (2) upflow outside
955	6	3	2	Hot Module (2) upflow outside
961	1	3	1	Hot Module (3) upflow inside
961	5	3	1	Hot Module (3) upflow inside
961	1	3	2	Hot Module (3) upflow outside
961	5	3	2	Hot Module (3) upflow outside
962	1	3	1	Hot Module (4) upflow inside
962	6	3	1	Hot Module (4) upflow inside
962	1	3	2	Hot Module (4) upflow outside
962	6	3	2	Hot Module (4) upflow outside
963	1	3	1	Hot Module (5) upflow inside
963	6	3	1	Hot Module (5) upflow inside
963	1	3	2	Hot Module (5) upflow outside
963	6	3	2	Hot Module (5) upflow outside
965	1	3	1	Hot Module (6) upflow inside
965	5	3	1	Hot Module (6) upflow inside

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965	1	3	2	Hot Module (6) upflow outside
965	5	3	2	Hot Module (6) upflow outside

INPUT NOTES:

npoints - number of locations (points) within TRAC model graphics requested
 component - component id number containing specified graph point
 cell - cell number with in component where graphics requested
 ictype - type of component:
 (0 for fill, pipe, pressurizer, pump, tee, turb, value)
 (1 for plenum)

OUTPUT NOTES:

tsec - Time into simulation (sec)
 Psia - Cell center pressure (psia)
 Qf - Liquid volumetric flowrate at cell face (gpm)
 tl - Liquid phase temperature (C)
 tsub - Liquid subcooling (C)
 tsat - Liquid saturation temperature (C)
 rol - Liquid phase density (kg/m³)
 vl - Liquid phasic velocity at cell face (m/s)
 Pa - Cell center pressure (Pa)
 qf - Liquid volumetric flowrate at cell face (m³/s)
 void - Gas void fraction (-)
 Qg - Gas volumetric flowrate at cell face (gpm)
 qg - Gas volumetric flowrate at cell face (m³/s)
 tv - Gas phase temperature (C)
 rov - Gas phase density (kg/m³)
 vv - Gas phasic velocity at cell face (m/s)
 pair - Partial pressure of non-condensable in gas phase (psia)

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Appendix E: FLOWTRAN-TF Input File for LOCA Case 4 (with Beam Shutdown and Active RHR)

Below is an abridged listing of the FLOWTRAN-TF input deck for LOCA Case 4. The finite element input of the solid geometric parameters used in the heat conduction calculations and the fluid geometry input are identical to the values given in Ref. [1] and have been edited from this listing to save space.

Input file apt.in:

```

/**** 12-channel APT input deck for flowtran-apt code ****/
!   Case 4 LOCA input deck
!
! Input Deck Description:
!
! General Comments:
!   *The solid input units are: [T] = C
!   *The fluid input units are determined by iunits as described below
!   *The working units in the fluid modules are: s, m, kg, K, Pa, J, W, ...
!   *The working units in the solid modules are: s, m, kg, C, Pa, J, W, ...
/RUN TIME, TIME STEP LIMITS, AND PRINT TIMES/
! total          minimum          maximum          minimum          maximum
! runtime fluid time step fluid time step solid time step solid time step
!-----
! runsec,      dtmin,      dtmax,      dtmin,      dtmax
! 600.0        1.0e-6        0.10        0.1         0.5         !>
!
!           printing intervals in seconds
! fluid      solid      power      plot      criteria
! dtpfld,    dtpsld,    dtppwr,    dtpplt,    dtpcrt
! 100.0      100.0      100.0      100.0      10.0         !>
!-----
!
/BOUNDARY CONDITION, UNITS, RESTART, AND PRINT FLAGS/
! ibond: 1 = P          (fluid and gas momentum balances at plenum)
!        2 = Qf          (prescribed Qf replaces fluid mom. bal. at plenum)
!        3 = Qg          (prescribed Qg replaces gas mom. bal. at plenum)
!        4 = Qf,Qg       (prescribed Qf, Qg replace both mom. bal. at plenum)
!       -2 = Qf          (prescribed Qf replaces fluid mom. bal. at tank bottom)
!       -3 = Qg          (prescribed Qg replaces gas mom. bal. at tank bottom)
!       -4 = Qf,Qg       (prescribed Qf, Qg replace both mom. bal. at tank bottom)
! iunits applies to the fluid input only
! iunits: 1 = SI (m, m^2, m^3, Pa, m^3/s, C)
!        2 = SRS (in, in^2, in^3, psia, gpm, C)
! istart: 0 = new
!        1 = restart (time = runsec)
!        2 = restart (time = zero)
!        3 = restart (time = tcrit0)
! isave: 0 = no restart file saved
!        1 = restart file saved and tsec set to runsec
!        2 = restart file saved and tsec set to zero
!        3 = restart file saved and tsec set to tcrit0
! iprint: 1 = short print
!        2 = long print
! icrit: 0 = no printing of criteria messages
!        1 = print criteria messages
! iscrn: 0 = no screen print
!        1 = long screen print
!        2 = short screen print

```

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```

! istdy: -1 = grid generation only
!          0 = transient from tsec to runsec
!          1 = steady state from tsec
!          2 = steady state at tsec
!          3 = steady state at tsec followed by a transient to runsec
! igpsk: 0 = no node renumbering
!          1 = optimum node renumbering using Gibbs-Poole-Stockmeyer-King
!          2 = optimum node renumbering using Gibbs-Poole-Stockmeyer-Cuthill-McKee
! inorm: 0 = use unnormalized axial power shapes
!          1 = normalize the axial power shape
!-----
! ibond,  iunits,  istart,  isave,  iprint
!   -2      1         2         2         1
!                                     !>
! icrit,  iscrn,   istdy,   ippu,   ibpu
!   0      2         0         0         0
!                                     !>
! igpsk   inorm
!   1      0
!                                     !>
!-----
!
! /REFERENCE PRESSURE, COMPRESSIBILITY FACTOR, .../
!   ilq: liquid identification, 1=H2O, 2=D2O
!   pref: reference pressure used in subroutine inner to compute
!         relative changes in the dp's
!   factor: multiplier to drho,fluid/dP to increase fluid compressibility
!   vminz: minimum absolute velocity for full donoring in z direction
!   tol: accchk parameter
!   tolss: steady state tolerance on dhmix/dt, (J/m^3-s)
!   tolts: relative tolerance on solid temperature
!   ttol: relative tolerance on solid time step change
!   dtsup: wall superheat reduction, C
!   htdamp: solid-fluid heat transfer damping factor
!   cidamp: interfacial drag damping factor
!   xa0: source/sink air mass fraction
!   dtf: perturbation to liquid temperature for derivative estimation
!   dtg: perturbation to gas temperature for derivative estimation
!   nstdy: maximum iterations for steady-state (istdy > 0)
!   nmat: maximum number of solid materials
!   delox: surface oxide layer thickness (m)
!   tkox: oxide thermal conductivity (W/m-K)
!-----
!   ilq,      pref,      factor,  vminz
!     1       5.0e+5     1.0       0.05
!                                     !>
!
!   tol,      tolss,     tolts,    ttol
!     1.0      10.0      0.1       0.1
!                                     !>
!
!   dtsup,    htdamp,    cidamp,    xa0
!     0.0      1.0      0.1       0.0
!                                     !>
!
!   dtf,      dtg,      nstdy,     nmat
!     1.0      1.0      9000       9
!                                     !>
!
!   delox,    tkox
!     5.08e-5  2.16
!                                     !>
!-----
!
! /BOILING CURVE AND INTERPHASE TRANSPORT OPTIONS/
!   iboil: 0 = use specified heat transfer coefficient
!           1 = forced convection (SRL)
!           2 = forced convection (Dittus-Boelter)
!           3 = forced convection (Sieder-Tate)

```

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```

!      4 = Mikic-Rohsenow interpolation
!      5 = Chen correlation
!   ichf: 1 = SRS correlation
!      2 = Biasi
! matgas: 1 = helium dissolved in water
!      2 =   air dissolved in water
! persat: percent of saturation (0-100)
!   igami: 0 = bulk interfacial mass transport off
!      1 = bulk interfacial mass transport on
!   igamw: 0 = wall interfacial mass transport off
!      1 = wall interfacial mass transport on
!-----
!   iboil,   ichf,   matgas,   persat,   igami,   igamw
!     4       3       2       0.0       1       1           !>
!-----
!
/SOLID PARAMETERS/
! isolid: 0 = no solid calculations
!      1 = solid calculations with matrix decomposition every time step
!      2 = solid calculations with matrix decomposition first time step
! tsolid: initial solid temperature
!   beta: implicitness parameter in solid calculations
!   iheat: 0 = no wall heat transfer calculation
!      1 = wall heat transfer calculations
!   qsurf: specified surface heat flux (used when iheat = 0)
!   hfix: specified heat transfer coefficient (used when iboil = 0)
! iaxcon: 0 = no axial conduction
!      1 = explicit axial conduction calculation
!-----
! isolid,   tsolid,   beta,   iheat,   qsurf,   hfix,   iaxcon
!     2       54.9     1.0     1       0.0     1.0e4     1           !>
!-----
!
/INNER ITERATION OPTIONS & NEWTON ITERATION PARAMETERS/
! irebal: 0 = no coarse mesh rebalance
!      1 = coarse mesh rebalance on first pass
!      2 = coarse mesh rebalance on each pass
!   ncmr: number of coarse mesh rebalances when irebal = 1 or 2
!   epsin: inner iteration convergence criterion for relative dp error
!   initmx: max. number of inner iterations allowed
!   epsp: newton iteration convergence criterion for absolute p error in Pa
!   epsalp: newton iteration convergence criterion for absolute alp error
!   epstg: newton iteration convergence criterion for absolute tg error in K
!   epstf: newton iteration convergence criterion for absolute tf error in K
!   epsxa: newton iteration convergence criterion for absolute xa error
!   nitmax: |nitmax| = max. number of newton iterations allowed
!           If nitmax is positive and |nitmax| iterations are reached, then
!           then computations continue using the mth iterate values from the
!           |nitmax| iteration.
!           If nitmax is negative and |nitmax| iterations are reached, then
!           a new time step with a time step reduction is requested.
!-----
!   irebal,   ncmr,   epsin,                               initmx
!     1       1       1.0e-5                               200           !>
!           epsy,   epsf,                               nitysi
!           1.0e-5   0.01                               50           !>
!           epsp,   epsalp,   epstg,   epstf,   epsxa,   nitmax
!           50.0     0.0005   0.05   0.05   0.005   -100           !>
!-----
!
/NUMBER OF SPLINE PROFILES AND DATA POINTS/
! ndata: number of data groups

```



```

! itime: number of time snapshots for axial power profiles
!-----
! ndata,  itime
! 10      2                                     !>
!-----
! npdat: number of data points per data set
! nset: number of data sets in data group
!-----
! npdat  nset
! 3       1                                     !>
! 29      1                                     !>
! 13      1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
! 173     1                                     !>
!-----
!
! /GEOMETRIC DIMENSIONS:/
! nchn: number of flow channels
! nzt: number of top section axial cells (>=2)
! nz: number of middle section axial cell layers (>=3)
! nzb: number of bottom section axial cells (>=2)
!-----
! nchn,  nzt,  nz,  nzb
! 12     2     20   2                                     !>
!-----
!
! /POWER ITERATION INPUT/
! power: initial power in kW
! maxpi: maximum number of power iterations
! tolpow: tolerance on power limit
! ncrit: number of criteria used to check for power limit
!-----
! power,    maxpi,  tolpow,  ncrit
! 61.5      1       0.005    8                                     !>
!-----
!
! SENSITIVITY VARIABLES INPUT SECTION
!
! /SENSITIVITY PARAMETERS/
! cizfac: axial interfacial drag multiplying factor
!-----
! xcofh,  xreh,  xcofl,  xrel,  xkmet,  xcvmet
! 1.0     1.0    1.0     1.0    1.0     1.0                                     !>
!
! xhfi,   xhgi,  xkgi,   xphi
! 1.0     1.0    1.0     1.0                                     !>
!
! cizfac  xfric,  plnht,  cipln,  formhs,  alphs
! 1.0     1.0    8.75    1.0     5.382    0.05                                     !>
!
! alb2,   als2,  ala2,   expbs,  expsa
! 0.25    0.52   0.75    4.0     4.0                                     !>
!-----
!
! INPUT FOR SOLID FINITE ELEMENT CALCULATIONS
!

```

.
 .
Solid mesh input for finite element regions, nodes and side boundary conditions is identical to that shown in reference [1]
 .
 .
 .
 !
 !-----!

! FLUID GEOMETRY AND MOMENTUM CLOSURE INPUT SECTION

.
 .
 .
 !
Fluid geometry input is identical to that shown in reference [1]
 .
 .
 .
 !
 !-----!

/BOUNDARY CONDITION INPUT SECTION/

/OUTLET PLENUM (TOP)/

! pp10: multiplier to P transient profile
 ! ippl: P transient identifier
 ! alpp10: multiplier to alpha transient profile
 ! ialpl: alpha transient identifier
 ! tfpl0: multiplier to Tf transient profile
 ! itfpl: Tf transient identifier
 ! tgpl0: multiplier to Tg transient profile
 ! itgpl: Tg transient identifier
 ! xapl0: multiplier to Xa transient profile
 ! ixapl: Xa transient identifier
 !-----!

! pp10, ippl
 584133.9 8 !>
 ! alpp10, ialpl
 1.0 10 !>
 ! tf010, itfpl
 59.85 9 !>
 ! tgpl0, itgpl
 59.85 9 !>
 ! xapl0, ixapl
 0.0 1 !>
 !-----!

/INLET PLENUM (BOTTOM)/

! ptb0: multiplier to P transient profile
 ! iptb: P transient identifier
 ! alptb0: multiplier to alpha transient profile
 ! ialtb: alpha transient identifier
 ! tftb0: multiplier to Tf transient profile
 ! itftb: Tf transient identifier
 ! tgtb0: multiplier to Tg transient profile
 ! itgtb: Tg transient identifier
 ! xatb0: multiplier to Xa transient profile
 ! ixatb: Xa transient identifier
 !-----!

! ptb0, iptb
 685997.0 5 !>
 ! alptb0, ialtb
 1.0 7 !>

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```

! tftb0,      itftb
53.05         6      !>
! tgtb0,      itgtb
53.05         6      !>
! xatb0,      ixatb
0.0           1      !>
!-----
!
/INLET FLOW DATA/
! The following inlet flow data is always used to initialize
! axial velocities and will also be used to define the
! appropriate prescribed flowrate for t > 0 if ibond = 2, 3, or 4.
! qfin0: multiplier to Qf transient profile
! iqfin: Qf transient identifier
! qgin0: multiplier to Qg transient profile
! iggin: Qg transient identifier
! qfin0 = Nominal APT total flow 12 half channels, transient
!-----
! qfin0,      iqfin
-1.508e-3     4      ! 1  >
! qgin0,      iggin
0.0           1      !      >
!-----
!
/INITIAL CONDITION INPUT SECTION/
! If iset0 > 0 then initial conditions are
! input for fluid parameters at each axial level
! iset0
0
!-----
!
/CRITERIA CHECKING FLAGS AND PEAKING FACTORS/
! checking flags for criteria #1 #2 #3 #4 #5 #6 #7 #8
0 0 0 0 0 0 0 0 !>
!peaking factors for criteria #1 #2 #3 #4 #5 #6 #7 #8
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 !>
/CRITERIA CHECKING TIME/
! time to begin criteria checking, sec
!-----
! tcrit0
0.0           !>
!-----
!
! POWER INPUT
!
/POWER PROFILE SPLINE POINTERS/
! DECAY HEAT TRANSIENT
3              !>
!
/AXIAL SPLINE POINTERS AND TIMES/
2 0.0         2 600.00
!
/TRANSIENT DATA SET INPUT SECTION/
!
/DATA SET NUMBER 1/
! enter data set label below
!-----
data set 1 - UNIFORM
!-----
! itype: 1 = linear spline
!         0 = cubic spline
! x, y: data pairs

```

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```
!-----
!           itype
!           1           !>
! x(ipt), y(ipt)  ipt=1,npts
!           0.0      1.0      !>
!           60.0     1.0      !>
!           600.0    1.0      !>
!-----
!
! /DATA SET NUMBER 2/
!-----
data set 2 - NON-UNIFORM AXIAL POWER PROFILE
!           itype
!           1           !>
! x(ipt), y(ipt)  ipt=1,npts
!           0.00     0.032    !>
!           0.10     0.043    !>
!           0.20     0.049    !>
!           0.30     0.074    !>
!           0.40     0.093    !>
!           0.50     0.124    !>
!           0.60     0.165    !>
!           0.70     0.217    !>
!           0.80     0.317    !>
!           0.90     0.508    !>
!           1.00     0.943    !>
!           1.10     1.446    !>
!           1.20     1.658    !>
!           1.30     1.754    !>
!           1.40     1.783    !>
!           1.50     1.827    !>
!           1.60     1.870    !>
!           1.70     1.881    !>
!           1.80     1.915    !>
!           1.90     1.915    !>
!           2.00     1.887    !>
!           2.10     1.864    !>
!           2.20     1.790    !>
!           2.30     1.660    !>
!           2.40     1.423    !>
!           2.50     0.932    !>
!           2.60     0.506    !>
!           2.70     0.313    !>
!           2.80     0.229    !>
!-----
!
! /DATA SET NUMBER 3/
!-----
data set 3 - DECAY POWER CURVE (+1 second time delay)
!           itype
!           1           !>
! x(ipt), y(ipt)  ipt=1,npts
!           0.00     1.000000000E+00
!           1.00     1.000000000E+00
!           1.01     1.298500039E-02
!           2.00     9.929999709E-03
!           3.00     8.652999997E-03
!           6.00     7.736000232E-03
!           11.00    7.573999930E-03
!           21.00    7.437000051E-03
!           61.00    7.073000073E-03
!           121.00   6.672000047E-03
```

BLANKET SAFETY ANALYSES FOR LOCA

Date: 07/14/98

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

Page: 8 of 28

301.00 5.936999805E-03
 601.00 5.392999854E-03
 1201.00 4.968000110E-03

!-----
 !
 /DATA SET NUMBER 4/
 !-----

data set 4 - COOLANT FLOW TRANSIENT

! itype
 1
 ! x(ipt), y(ipt) ipt=1,npts
 0.00 1.00000E+00
 0.12 9.79332E-01
 0.22 9.64634E-01
 0.33 9.45688E-01
 0.43 9.18738E-01
 0.53 8.76990E-01
 0.63 8.26369E-01
 0.73 7.83209E-01
 0.83 7.51345E-01
 0.93 7.32232E-01
 1.03 7.23843E-01
 1.13 7.27035E-01
 1.23 7.29626E-01
 1.33 7.30029E-01
 1.43 7.22505E-01
 1.53 7.07188E-01
 1.63 6.86410E-01
 1.73 6.64462E-01
 1.83 6.43644E-01
 1.93 6.26095E-01
 2.03 6.11615E-01
 2.13 6.00571E-01
 2.23 5.93251E-01
 2.33 5.88485E-01
 2.43 5.84838E-01
 2.53 5.80998E-01
 2.63 5.75747E-01
 2.73 5.68558E-01
 2.83 5.59561E-01
 2.93 5.49453E-01
 3.03 5.39015E-01
 3.13 5.28577E-01
 3.23 5.18703E-01
 3.33 5.09565E-01
 3.43 5.01389E-01
 3.53 4.94235E-01
 3.63 4.88096E-01
 3.73 4.82829E-01
 3.83 4.78242E-01
 3.93 4.74090E-01
 4.03 4.70131E-01
 4.13 4.66150E-01
 4.23 4.62000E-01
 4.33 4.57604E-01
 4.43 4.53257E-01
 4.54 4.48715E-01
 4.64 4.44362E-01
 4.74 4.40156E-01
 4.84 4.36358E-01
 4.94 4.32954E-01
 5.04 4.29931E-01

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

5.14	4.27219E-01
5.24	4.24819E-01
5.34	4.22623E-01
5.44	4.20596E-01
5.54	4.18701E-01
5.64	4.16852E-01
5.74	4.14977E-01
5.84	4.12997E-01
5.94	4.10884E-01
6.04	4.08602E-01
6.14	4.06092E-01
6.24	4.03282E-01
6.34	4.00213E-01
6.44	3.97125E-01
6.54	3.92629E-01
6.64	3.86310E-01
6.74	3.79202E-01
6.84	3.72056E-01
6.94	3.64976E-01
7.04	3.58268E-01
7.14	3.51172E-01
7.24	3.43999E-01
7.34	3.37251E-01
7.44	3.30337E-01
7.54	3.24997E-01
7.64	3.19884E-01
7.74	3.14406E-01
7.84	3.09719E-01
7.94	3.05890E-01
8.04	3.02834E-01
8.14	3.00364E-01
8.24	2.98338E-01
8.34	2.96731E-01
8.44	2.95574E-01
8.54	2.94825E-01
8.65	2.94346E-01
8.75	2.94048E-01
8.85	2.93818E-01
8.95	2.93612E-01
9.05	2.93427E-01
9.15	2.93316E-01
9.25	2.93164E-01
9.35	2.92996E-01
9.45	2.92881E-01
9.55	2.92859E-01
9.65	2.93083E-01
9.75	2.93532E-01
9.85	2.93517E-01
9.95	2.92079E-01
11.00	3.31893E-01
12.00	3.39543E-01
13.00	3.35506E-01
14.00	3.45688E-01
15.00	3.53209E-01
16.00	3.53058E-01
17.00	3.49543E-01
18.00	3.35760E-01
19.00	3.49190E-01
20.00	3.53019E-01
21.01	3.51372E-01
22.01	3.57285E-01
23.01	3.54160E-01

24.01	3.45726E-01
25.01	3.46000E-01
26.01	3.43483E-01
27.01	3.41160E-01
28.02	3.35086E-01
29.03	3.27440E-01
30.03	3.15009E-01
31.03	3.10938E-01
32.03	3.09022E-01
33.03	2.99464E-01
34.03	2.95055E-01
35.03	2.89748E-01
36.03	2.75732E-01
37.03	2.68810E-01
38.03	2.64330E-01
39.03	2.48232E-01
40.03	2.40088E-01
41.03	2.30916E-01
42.03	2.21376E-01
43.03	2.12069E-01
44.03	2.03478E-01
45.03	1.94964E-01
46.03	1.87100E-01
47.03	1.79569E-01
48.03	1.73309E-01
49.03	1.66604E-01
60.00	1.12663E-01
70.01	7.76216E-02
80.01	4.71272E-02
90.01	4.41765E-02
100.01	4.16358E-02
110.01	4.26561E-02
120.01	4.64400E-02
130.01	4.80770E-02
140.01	4.96390E-02
150.01	4.60243E-02
160.01	4.30953E-02
170.01	4.49240E-02
180.01	4.32585E-02
190.01	4.36635E-02
220.00	3.91442E-02
240.00	3.89445E-02
260.00	3.97614E-02
280.00	4.08983E-02
300.00	4.27781E-02
320.00	3.92918E-02
340.00	4.02924E-02
360.00	4.21664E-02
380.00	4.40452E-02
400.00	4.27897E-02
420.00	4.03309E-02
440.00	4.13226E-02
460.00	4.22458E-02
480.00	4.37557E-02
500.00	4.17746E-02
520.00	3.98676E-02
540.00	4.12165E-02
560.00	4.20904E-02
580.00	4.33208E-02
600.00	4.07419E-02

!-----
!

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

/DATA SET NUMBER 5/

!-----

data set 5 - INLET PRESSURE TRANSIENT

! itype

!	x(ipt),	y(ipt)	ipt=1,npts
	0.00	1.00000E+00	
	0.12	7.44220E-01	
	0.22	3.84343E-01	
	0.33	4.89121E-01	
	0.43	3.68114E-01	
	0.53	3.50529E-01	
	0.63	2.97278E-01	
	0.73	3.14176E-01	
	0.83	3.25557E-01	
	0.93	3.40278E-01	
	1.03	3.68301E-01	
	1.13	3.83884E-01	
	1.23	3.79440E-01	
	1.33	3.69779E-01	
	1.43	3.45146E-01	
	1.53	3.20884E-01	
	1.63	3.05001E-01	
	1.73	2.93214E-01	
	1.83	2.93071E-01	
	1.93	2.92022E-01	
	2.03	2.94706E-01	
	2.13	2.97920E-01	
	2.23	3.04556E-01	
	2.33	3.05918E-01	
	2.43	3.06574E-01	
	2.53	3.02785E-01	
	2.63	2.96902E-01	
	2.73	2.89534E-01	
	2.83	2.82571E-01	
	2.93	2.77765E-01	
	3.03	2.73219E-01	
	3.13	2.70795E-01	
	3.23	2.68735E-01	
	3.33	2.67901E-01	
	3.43	2.67478E-01	
	3.53	2.67702E-01	
	3.63	2.67970E-01	
	3.73	2.68213E-01	
	3.83	2.68116E-01	
	3.93	2.67614E-01	
	4.03	2.66603E-01	
	4.13	2.65177E-01	
	4.23	2.63424E-01	
	4.33	2.61513E-01	
	4.43	2.60732E-01	
	4.54	2.59143E-01	
	4.64	2.58099E-01	
	4.74	2.57581E-01	
	4.84	2.57464E-01	
	4.94	2.57428E-01	
	5.04	2.57374E-01	
	5.14	2.57312E-01	
	5.24	2.57308E-01	
	5.34	2.57067E-01	
	5.44	2.56976E-01	
	5.54	2.56613E-01	

5.64	2.56202E-01
5.74	2.55545E-01
5.84	2.54747E-01
5.94	2.53845E-01
6.04	2.52658E-01
6.14	2.51332E-01
6.24	2.49748E-01
6.34	2.48546E-01
6.44	2.48311E-01
6.54	2.47561E-01
6.64	2.46284E-01
6.74	2.45910E-01
6.84	2.45829E-01
6.94	2.45933E-01
7.04	2.46362E-01
7.14	2.46967E-01
7.24	2.46994E-01
7.34	2.47168E-01
7.44	2.47158E-01
7.54	2.46926E-01
7.64	2.47113E-01
7.74	2.47227E-01
7.84	2.46912E-01
7.94	2.46702E-01
8.04	2.46544E-01
8.14	2.46450E-01
8.24	2.46260E-01
8.34	2.46038E-01
8.44	2.45776E-01
8.54	2.45475E-01
8.65	2.45169E-01
8.75	2.44869E-01
8.85	2.44559E-01
8.95	2.44239E-01
9.05	2.43910E-01
9.15	2.43569E-01
9.25	2.43218E-01
9.35	2.42864E-01
9.45	2.42510E-01
9.55	2.42129E-01
9.65	2.41755E-01
9.75	2.41375E-01
9.85	2.40981E-01
9.95	2.40587E-01
11.00	2.37824E-01
12.00	2.36991E-01
13.00	2.42012E-01
14.00	2.41253E-01
15.00	2.42450E-01
16.00	2.41866E-01
17.00	2.42214E-01
18.00	2.45586E-01
19.00	2.43594E-01
20.00	2.39347E-01
21.01	2.41918E-01
22.01	2.41743E-01
23.01	2.41055E-01
24.01	2.42072E-01
25.01	2.43186E-01
26.01	2.40290E-01
27.01	2.44046E-01
28.02	2.46006E-01

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

29.03	2.48030E-01
30.03	2.48081E-01
31.03	2.51427E-01
32.03	2.58488E-01
33.03	2.61303E-01
34.03	2.61963E-01
35.03	2.67724E-01
36.03	2.70217E-01
37.03	2.72600E-01
38.03	2.78307E-01
39.03	2.81537E-01
40.03	2.85485E-01
41.03	2.86149E-01
42.03	2.87260E-01
43.03	2.87301E-01
44.03	2.87375E-01
45.03	2.87059E-01
46.03	2.86454E-01
47.03	2.85738E-01
48.03	2.84835E-01
49.03	2.84527E-01
60.00	2.79509E-01
70.01	2.80237E-01
80.01	2.82495E-01
90.01	2.81331E-01
100.01	2.82332E-01
110.01	2.82793E-01
120.01	2.83488E-01
130.01	2.82774E-01
140.01	2.82913E-01
150.01	2.87547E-01
160.01	2.81547E-01
170.01	2.82911E-01
180.01	2.81613E-01
190.01	2.80608E-01
220.00	2.77853E-01
240.00	2.78241E-01
260.00	2.79038E-01
280.00	2.79071E-01
300.00	2.78185E-01
320.00	2.77806E-01
340.00	2.78906E-01
360.00	2.79311E-01
380.00	2.79030E-01
400.00	2.78680E-01
420.00	2.78351E-01
440.00	2.79120E-01
460.00	2.79256E-01
480.00	2.78934E-01
500.00	2.78619E-01
520.00	2.78538E-01
540.00	2.79107E-01
560.00	2.78778E-01
580.00	2.78340E-01
600.00	2.77759E-01

!-----

!

/DATA SET NUMBER 6/

!-----

data set 6 - INLET TEMPERATURE TRANSIENT

! itype

1

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

!	x(ipt),	y(ipt)	ipt=1,npts
	0.00	1.00000E+00	
	0.12	1.00000E+00	
	0.22	1.00000E+00	
	0.33	1.00000E+00	
	0.43	1.00000E+00	
	0.53	9.99811E-01	
	0.63	9.99434E-01	
	0.73	9.98869E-01	
	0.83	9.98115E-01	
	0.93	9.97172E-01	
	1.03	9.96229E-01	
	1.13	9.94721E-01	
	1.23	9.93213E-01	
	1.33	9.91516E-01	
	1.43	9.89630E-01	
	1.53	9.87557E-01	
	1.63	9.85483E-01	
	1.73	9.83597E-01	
	1.83	9.81523E-01	
	1.93	9.79449E-01	
	2.03	9.77564E-01	
	2.13	9.75679E-01	
	2.23	9.73793E-01	
	2.33	9.71908E-01	
	2.43	9.70211E-01	
	2.53	9.68514E-01	
	2.63	9.66817E-01	
	2.73	9.65121E-01	
	2.83	9.63612E-01	
	2.93	9.62104E-01	
	3.03	9.60596E-01	
	3.13	9.59276E-01	
	3.23	9.58145E-01	
	3.33	9.56825E-01	
	3.43	9.55694E-01	
	3.53	9.54751E-01	
	3.63	9.53620E-01	
	3.73	9.52677E-01	
	3.83	9.51735E-01	
	3.93	9.50980E-01	
	4.03	9.50038E-01	
	4.13	9.49284E-01	
	4.23	9.48529E-01	
	4.33	9.47964E-01	
	4.43	9.47210E-01	
	4.54	9.46644E-01	
	4.64	9.45890E-01	
	4.74	9.45324E-01	
	4.84	9.44759E-01	
	4.94	9.44382E-01	
	5.04	9.43816E-01	
	5.14	9.43439E-01	
	5.24	9.42873E-01	
	5.34	9.42496E-01	
	5.44	9.42119E-01	
	5.54	9.41742E-01	
	5.64	9.41365E-01	
	5.74	9.40988E-01	
	5.84	9.40611E-01	
	5.94	9.40422E-01	
	6.04	9.40045E-01	

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

6.14	9.39668E-01
6.24	9.39480E-01
6.34	9.39291E-01
6.44	9.38914E-01
6.54	9.38725E-01
6.64	9.38537E-01
6.74	9.38348E-01
6.84	9.38160E-01
6.94	9.37971E-01
7.04	9.37783E-01
7.14	9.37594E-01
7.24	9.37406E-01
7.34	9.37217E-01
7.44	9.37029E-01
7.54	9.37029E-01
7.64	9.36840E-01
7.74	9.36652E-01
7.84	9.36463E-01
7.94	9.36463E-01
8.04	9.36274E-01
8.14	9.36274E-01
8.24	9.36086E-01
8.34	9.36086E-01
8.44	9.35897E-01
8.54	9.35897E-01
8.65	9.35709E-01
8.75	9.35709E-01
8.85	9.35520E-01
8.95	9.35520E-01
9.05	9.35332E-01
9.15	9.35332E-01
9.25	9.35332E-01
9.35	9.35143E-01
9.45	9.35143E-01
9.55	9.35143E-01
9.65	9.35143E-01
9.75	9.34955E-01
9.85	9.34955E-01
9.95	9.34955E-01
11.00	9.34578E-01
12.00	9.34201E-01
13.00	9.34201E-01
14.00	9.34012E-01
15.00	9.34012E-01
16.00	9.33823E-01
17.00	9.33823E-01
18.00	9.33823E-01
19.00	9.33635E-01
20.00	9.33446E-01
21.01	9.33258E-01
22.01	9.32504E-01
23.01	9.31561E-01
24.01	9.29864E-01
25.01	9.27790E-01
26.01	9.25528E-01
27.01	9.22888E-01
28.02	9.20437E-01
29.03	9.17986E-01
30.03	9.15347E-01
31.03	9.13084E-01
32.03	9.10633E-01
33.03	9.08560E-01

34.03	9.06486E-01
35.03	9.04412E-01
36.03	9.02338E-01
37.03	9.00452E-01
38.03	8.98567E-01
39.03	8.96682E-01
40.03	8.94985E-01
41.03	8.93099E-01
42.03	8.91591E-01
43.03	8.90083E-01
44.03	8.88575E-01
45.03	8.87255E-01
46.03	8.85935E-01
47.03	8.84804E-01
48.03	8.83861E-01
49.03	8.82919E-01
60.00	8.80845E-01
70.01	8.85747E-01
80.01	8.90460E-01
90.01	8.94042E-01
100.01	8.97813E-01
110.01	9.01395E-01
120.01	9.04412E-01
130.01	9.06863E-01
140.01	9.08748E-01
150.01	9.09691E-01
160.01	9.09502E-01
170.01	9.08560E-01
180.01	9.07051E-01
190.01	9.05543E-01
220.00	9.01772E-01
240.00	9.00075E-01
260.00	8.99887E-01
280.00	9.00641E-01
300.00	9.02149E-01
320.00	9.03846E-01
340.00	9.05354E-01
360.00	9.06674E-01
380.00	9.07805E-01
400.00	9.08182E-01
420.00	9.08182E-01
440.00	9.07805E-01
460.00	9.07428E-01
480.00	9.07051E-01
500.00	9.06863E-01
520.00	9.06863E-01
540.00	9.07051E-01
560.00	9.07051E-01
580.00	9.07428E-01
600.00	9.07617E-01

!-----

!

/DATA SET NUMBER 7/

!-----

data set 7 - INLET VOID TRANSIENT

!

itype

1

!

x(ipt), y(ipt) ipt=1,npts

0.00 0.00000E+00

0.12 0.00000E+00

0.22 0.00000E+00

0.33 0.00000E+00

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

0.43	0.00000E+00
0.53	0.00000E+00
0.63	0.00000E+00
0.73	0.00000E+00
0.83	0.00000E+00
0.93	0.00000E+00
1.03	0.00000E+00
1.13	0.00000E+00
1.23	0.00000E+00
1.33	0.00000E+00
1.43	0.00000E+00
1.53	0.00000E+00
1.63	0.00000E+00
1.73	0.00000E+00
1.83	0.00000E+00
1.93	0.00000E+00
2.03	0.00000E+00
2.13	0.00000E+00
2.23	0.00000E+00
2.33	0.00000E+00
2.43	0.00000E+00
2.53	0.00000E+00
2.63	0.00000E+00
2.73	0.00000E+00
2.83	0.00000E+00
2.93	0.00000E+00
3.03	0.00000E+00
3.13	0.00000E+00
3.23	0.00000E+00
3.33	0.00000E+00
3.43	0.00000E+00
3.53	0.00000E+00
3.63	0.00000E+00
3.73	0.00000E+00
3.83	0.00000E+00
3.93	0.00000E+00
4.03	0.00000E+00
4.13	0.00000E+00
4.23	0.00000E+00
4.33	0.00000E+00
4.43	0.00000E+00
4.54	0.00000E+00
4.64	0.00000E+00
4.74	0.00000E+00
4.84	0.00000E+00
4.94	0.00000E+00
5.04	0.00000E+00
5.14	0.00000E+00
5.24	0.00000E+00
5.34	0.00000E+00
5.44	0.00000E+00
5.54	0.00000E+00
5.64	0.00000E+00
5.74	0.00000E+00
5.84	0.00000E+00
5.94	0.00000E+00
6.04	0.00000E+00
6.14	0.00000E+00
6.24	0.00000E+00
6.34	0.00000E+00
6.44	0.00000E+00
6.54	0.00000E+00

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

6.64	0.00000E+00
6.74	0.00000E+00
6.84	0.00000E+00
6.94	0.00000E+00
7.04	0.00000E+00
7.14	0.00000E+00
7.24	0.00000E+00
7.34	0.00000E+00
7.44	0.00000E+00
7.54	0.00000E+00
7.64	0.00000E+00
7.74	0.00000E+00
7.84	0.00000E+00
7.94	0.00000E+00
8.04	0.00000E+00
8.14	0.00000E+00
8.24	0.00000E+00
8.34	0.00000E+00
8.44	0.00000E+00
8.54	0.00000E+00
8.65	0.00000E+00
8.75	0.00000E+00
8.85	0.00000E+00
8.95	0.00000E+00
9.05	0.00000E+00
9.15	0.00000E+00
9.25	0.00000E+00
9.35	0.00000E+00
9.45	0.00000E+00
9.55	0.00000E+00
9.65	0.00000E+00
9.75	0.00000E+00
9.85	0.00000E+00
9.95	0.00000E+00
11.00	0.00000E+00
12.00	0.00000E+00
13.00	0.00000E+00
14.00	0.00000E+00
15.00	0.00000E+00
16.00	0.00000E+00
17.00	0.00000E+00
18.00	0.00000E+00
19.00	0.00000E+00
20.00	0.00000E+00
21.01	0.00000E+00
22.01	0.00000E+00
23.01	0.00000E+00
24.01	0.00000E+00
25.01	0.00000E+00
26.01	2.90000E-03
27.01	9.20000E-03
28.02	4.34000E-02
29.03	5.28000E-02
30.03	4.58000E-02
31.03	3.47000E-02
32.03	2.48000E-02
33.03	1.79000E-02
34.03	1.31000E-02
35.03	9.10000E-03
36.03	4.80000E-03
37.03	2.50000E-03
38.03	1.30000E-03

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

39.03	7.00000E-04
40.03	4.00000E-04
41.03	2.00000E-04
42.03	1.00000E-04
43.03	1.00000E-04
44.03	0.00000E+00
45.03	0.00000E+00
46.03	0.00000E+00
47.03	0.00000E+00
48.03	0.00000E+00
49.03	0.00000E+00
60.00	0.00000E+00
70.01	0.00000E+00
80.01	0.00000E+00
90.01	0.00000E+00
100.01	0.00000E+00
110.01	0.00000E+00
120.01	0.00000E+00
130.01	0.00000E+00
140.01	0.00000E+00
150.01	0.00000E+00
160.01	0.00000E+00
170.01	0.00000E+00
180.01	0.00000E+00
190.01	0.00000E+00
220.00	0.00000E+00
240.00	0.00000E+00
260.00	0.00000E+00
280.00	0.00000E+00
300.00	0.00000E+00
320.00	0.00000E+00
340.00	0.00000E+00
360.00	0.00000E+00
380.00	0.00000E+00
400.00	0.00000E+00
420.00	0.00000E+00
440.00	0.00000E+00
460.00	0.00000E+00
480.00	0.00000E+00
500.00	0.00000E+00
520.00	0.00000E+00
540.00	0.00000E+00
560.00	0.00000E+00
580.00	0.00000E+00
600.00	0.00000E+00

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/DATA SET NUMBER 8/

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data set 8 - OUTLET PRESSURE TRANSIENT

! itype

1

! x(ipt), y(ipt) ipt=1,npts

0.00 1.00000E+00

0.12 7.05737E-01

0.22 2.90684E-01

0.33 4.13414E-01

0.43 2.82641E-01

0.53 2.71077E-01

0.63 2.20337E-01

0.73 2.46463E-01

0.83 2.64253E-01

0.93	2.83495E-01
1.03	3.16110E-01
1.13	3.32913E-01
1.23	3.27558E-01
1.33	3.16642E-01
1.43	2.90249E-01
1.53	2.65444E-01
1.63	2.50744E-01
1.73	2.40653E-01
1.83	2.43403E-01
1.93	2.44534E-01
2.03	2.49429E-01
2.13	2.54405E-01
2.23	2.62739E-01
2.33	2.64819E-01
2.43	2.65995E-01
2.53	2.62216E-01
2.63	2.56282E-01
2.73	2.48924E-01
2.83	2.42231E-01
2.93	2.38068E-01
3.03	2.34201E-01
3.13	2.32701E-01
3.23	2.31507E-01
3.33	2.31593E-01
3.43	2.32009E-01
3.53	2.33029E-01
3.63	2.33978E-01
3.73	2.34801E-01
3.83	2.35167E-01
3.93	2.35031E-01
4.03	2.34306E-01
4.13	2.33117E-01
4.23	2.31579E-01
4.33	2.29886E-01
4.43	2.29447E-01
4.54	2.28123E-01
4.64	2.27381E-01
4.74	2.27215E-01
4.84	2.27446E-01
4.94	2.27732E-01
5.04	2.27957E-01
5.14	2.28141E-01
5.24	2.28360E-01
5.34	2.28294E-01
5.44	2.28381E-01
5.54	2.28148E-01
5.64	2.27860E-01
5.74	2.27299E-01
5.84	2.26589E-01
5.94	2.25773E-01
6.04	2.24651E-01
6.14	2.23394E-01
6.24	2.21877E-01
6.34	2.20813E-01
6.44	2.20810E-01
6.54	2.20233E-01
6.64	2.19071E-01
6.74	2.18920E-01
6.84	2.19069E-01
6.94	2.19395E-01
7.04	2.20051E-01

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

7.14	2.20866E-01
7.24	2.21013E-01
7.34	2.21338E-01
7.44	2.21421E-01
7.54	2.21311E-01
7.64	2.21572E-01
7.74	2.21848E-01
7.84	2.21506E-01
7.94	2.21341E-01
8.04	2.21235E-01
8.14	2.21193E-01
8.24	2.21056E-01
8.34	2.20869E-01
8.44	2.20641E-01
8.54	2.20367E-01
8.65	2.20096E-01
8.75	2.19829E-01
8.85	2.19553E-01
8.95	2.19267E-01
9.05	2.18972E-01
9.15	2.18666E-01
9.25	2.18350E-01
9.35	2.18034E-01
9.45	2.17720E-01
9.55	2.17383E-01
9.65	2.17051E-01
9.75	2.16713E-01
9.85	2.16362E-01
9.95	2.16013E-01
11.00	2.14536E-01
12.00	2.13566E-01
13.00	2.18300E-01
14.00	2.16652E-01
15.00	2.17505E-01
16.00	2.16550E-01
17.00	2.16782E-01
18.00	2.21115E-01
19.00	2.19006E-01
20.00	2.14371E-01
21.01	2.17302E-01
22.01	2.17065E-01
23.01	2.16146E-01
24.01	2.17331E-01
25.01	2.18856E-01
26.01	2.16017E-01
27.01	2.21009E-01
28.02	2.25200E-01
29.03	2.29563E-01
30.03	2.30883E-01
31.03	2.35815E-01
32.03	2.44567E-01
33.03	2.47719E-01
34.03	2.48003E-01
35.03	2.54618E-01
36.03	2.58228E-01
37.03	2.61163E-01
38.03	2.68004E-01
39.03	2.72869E-01
40.03	2.77819E-01
41.03	2.79371E-01
42.03	2.81190E-01
43.03	2.81843E-01

BLANKET SAFETY ANALYSES FOR LOCA

Date: 07/14/98

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

Page: 22 of 28

44.03	2.82429E-01
45.03	2.82557E-01
46.03	2.82282E-01
47.03	2.81849E-01
48.03	2.81163E-01
49.03	2.81132E-01
60.00	2.77918E-01
70.01	2.80095E-01
80.01	2.83064E-01
90.01	2.81853E-01
100.01	2.82903E-01
110.01	2.83516E-01
120.01	2.84308E-01
130.01	2.83503E-01
140.01	2.83555E-01
150.01	2.88682E-01
160.01	2.82123E-01
170.01	2.83492E-01
180.01	2.82047E-01
190.01	2.80959E-01
220.00	2.77762E-01
240.00	2.78254E-01
260.00	2.79151E-01
280.00	2.79186E-01
300.00	2.78136E-01
320.00	2.77717E-01
340.00	2.78995E-01
360.00	2.79452E-01
380.00	2.79091E-01
400.00	2.78634E-01
420.00	2.78332E-01
440.00	2.79225E-01
460.00	2.79390E-01
480.00	2.78986E-01
500.00	2.78578E-01
520.00	2.78554E-01
540.00	2.79229E-01
560.00	2.78875E-01
580.00	2.78300E-01
600.00	2.77658E-01

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/DATA SET NUMBER 9/

!-----

data set 9 - OUTLET TEMPERATURE TRANSIENT

! itype

1

! x(ipt), y(ipt) ipt=1,npts

0.00	1.00000E+00
0.12	1.00000E+00
0.22	1.00000E+00
0.33	1.00000E+00
0.43	9.99833E-01
0.53	9.99833E-01
0.63	9.99499E-01
0.73	9.99332E-01
0.83	9.98830E-01
0.93	9.98162E-01
1.03	9.97494E-01
1.13	9.96491E-01
1.23	9.95489E-01
1.33	9.94152E-01

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

1.43	9.92815E-01
1.53	9.91145E-01
1.63	9.89641E-01
1.73	9.87803E-01
1.83	9.86132E-01
1.93	9.84294E-01
2.03	9.82289E-01
2.13	9.80451E-01
2.23	9.78446E-01
2.33	9.76441E-01
2.43	9.74436E-01
2.53	9.72264E-01
2.63	9.70092E-01
2.73	9.67920E-01
2.83	9.65748E-01
2.93	9.63576E-01
3.03	9.61236E-01
3.13	9.59064E-01
3.23	9.56892E-01
3.33	9.54720E-01
3.43	9.52715E-01
3.53	9.50543E-01
3.63	9.48371E-01
3.73	9.46199E-01
3.83	9.44194E-01
3.93	9.42022E-01
4.03	9.40017E-01
4.13	9.38012E-01
4.23	9.35840E-01
4.33	9.33835E-01
4.43	9.31830E-01
4.54	9.29825E-01
4.64	9.27820E-01
4.74	9.25982E-01
4.84	9.23977E-01
4.94	9.22139E-01
5.04	9.20301E-01
5.14	9.18463E-01
5.24	9.16625E-01
5.34	9.14787E-01
5.44	9.12949E-01
5.54	9.11278E-01
5.64	9.09607E-01
5.74	9.07770E-01
5.84	9.06099E-01
5.94	9.04428E-01
6.04	9.02924E-01
6.14	9.01253E-01
6.24	8.99749E-01
6.34	8.98079E-01
6.44	8.96575E-01
6.54	8.95238E-01
6.64	8.93734E-01
6.74	8.92231E-01
6.84	8.90894E-01
6.94	8.89557E-01
7.04	8.88221E-01
7.14	8.86884E-01
7.24	8.85547E-01
7.34	8.84378E-01
7.44	8.83041E-01
7.54	8.81871E-01

7.64	8.80702E-01
7.74	8.79532E-01
7.84	8.78363E-01
7.94	8.77193E-01
8.04	8.76023E-01
8.14	8.75021E-01
8.24	8.74018E-01
8.34	8.73016E-01
8.44	8.71846E-01
8.54	8.70844E-01
8.65	8.69841E-01
8.75	8.69006E-01
8.85	8.68003E-01
8.95	8.67168E-01
9.05	8.66165E-01
9.15	8.65330E-01
9.25	8.64495E-01
9.35	8.63659E-01
9.45	8.62824E-01
9.55	8.61988E-01
9.65	8.61320E-01
9.75	8.60485E-01
9.85	8.59816E-01
9.95	8.58981E-01
11.00	8.52632E-01
12.00	8.47786E-01
13.00	8.43943E-01
14.00	8.40769E-01
15.00	8.38429E-01
16.00	8.36591E-01
17.00	8.35088E-01
18.00	8.33918E-01
19.00	8.33083E-01
20.00	8.32414E-01
21.01	8.31913E-01
22.01	8.31579E-01
23.01	8.31245E-01
24.01	8.30911E-01
25.01	8.30576E-01
26.01	8.30075E-01
27.01	8.29407E-01
28.02	8.28571E-01
29.03	8.27402E-01
30.03	8.26232E-01
31.03	8.24896E-01
32.03	8.23392E-01
33.03	8.21888E-01
34.03	8.20217E-01
35.03	8.18546E-01
36.03	8.16709E-01
37.03	8.15205E-01
38.03	8.13534E-01
39.03	8.11863E-01
40.03	8.10526E-01
41.03	8.09023E-01
42.03	8.07686E-01
43.03	8.06349E-01
44.03	8.05180E-01
45.03	8.04010E-01
46.03	8.02840E-01
47.03	8.01671E-01
48.03	8.00668E-01

49.03	7.99666E-01
60.00	7.92314E-01
70.01	7.90309E-01
80.01	7.91145E-01
90.01	7.93150E-01
100.01	7.96157E-01
110.01	8.00334E-01
120.01	8.04845E-01
130.01	8.09357E-01
140.01	8.13367E-01
150.01	8.16541E-01
160.01	8.18880E-01
170.01	8.20886E-01
180.01	8.22222E-01
190.01	8.23058E-01
220.00	8.22891E-01
240.00	8.21554E-01
260.00	8.19716E-01
280.00	8.18212E-01
300.00	8.17210E-01
320.00	8.16876E-01
340.00	8.17043E-01
360.00	8.17711E-01
380.00	8.18546E-01
400.00	8.19215E-01
420.00	8.19883E-01
440.00	8.20217E-01
460.00	8.20050E-01
480.00	8.19883E-01
500.00	8.19549E-01
520.00	8.19048E-01
540.00	8.18880E-01
560.00	8.18546E-01
580.00	8.18379E-01
600.00	8.18379E-01

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!

/DATA SET NUMBER 10/

!-----

data set 10 - OUTLET VOID TRANSIENT

! . itype

1

x(ipt),	y(ipt)	ipt=1,npts
0.00	0.00000E+00	
0.12	0.00000E+00	
0.22	0.00000E+00	
0.33	0.00000E+00	
0.43	0.00000E+00	
0.53	0.00000E+00	
0.63	0.00000E+00	
0.73	0.00000E+00	
0.83	0.00000E+00	
0.93	0.00000E+00	
1.03	0.00000E+00	
1.13	0.00000E+00	
1.23	0.00000E+00	
1.33	0.00000E+00	
1.43	0.00000E+00	
1.53	0.00000E+00	
1.63	0.00000E+00	
1.73	0.00000E+00	
1.83	0.00000E+00	

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

1.93	0.00000E+00
2.03	0.00000E+00
2.13	0.00000E+00
2.23	0.00000E+00
2.33	0.00000E+00
2.43	0.00000E+00
2.53	0.00000E+00
2.63	0.00000E+00
2.73	0.00000E+00
2.83	0.00000E+00
2.93	0.00000E+00
3.03	0.00000E+00
3.13	0.00000E+00
3.23	0.00000E+00
3.33	0.00000E+00
3.43	0.00000E+00
3.53	0.00000E+00
3.63	0.00000E+00
3.73	0.00000E+00
3.83	0.00000E+00
3.93	0.00000E+00
4.03	0.00000E+00
4.13	0.00000E+00
4.23	0.00000E+00
4.33	0.00000E+00
4.43	0.00000E+00
4.54	0.00000E+00
4.64	0.00000E+00
4.74	0.00000E+00
4.84	0.00000E+00
4.94	0.00000E+00
5.04	0.00000E+00
5.14	0.00000E+00
5.24	0.00000E+00
5.34	0.00000E+00
5.44	0.00000E+00
5.54	0.00000E+00
5.64	0.00000E+00
5.74	0.00000E+00
5.84	0.00000E+00
5.94	0.00000E+00
6.04	0.00000E+00
6.14	0.00000E+00
6.24	0.00000E+00
6.34	0.00000E+00
6.44	0.00000E+00
6.54	0.00000E+00
6.64	0.00000E+00
6.74	0.00000E+00
6.84	0.00000E+00
6.94	0.00000E+00
7.04	0.00000E+00
7.14	0.00000E+00
7.24	0.00000E+00
7.34	0.00000E+00
7.44	0.00000E+00
7.54	0.00000E+00
7.64	0.00000E+00
7.74	0.00000E+00
7.84	0.00000E+00
7.94	0.00000E+00
8.04	0.00000E+00

BLANKET SAFETY ANALYSES FOR LOCA

(CASE4: EXTERNAL PRESSURIZER SURGE LINE BREAK)

8.14	0.00000E+00
8.24	0.00000E+00
8.34	0.00000E+00
8.44	0.00000E+00
8.54	0.00000E+00
8.65	0.00000E+00
8.75	0.00000E+00
8.85	0.00000E+00
8.95	0.00000E+00
9.05	0.00000E+00
9.15	0.00000E+00
9.25	0.00000E+00
9.35	0.00000E+00
9.45	0.00000E+00
9.55	0.00000E+00
9.65	0.00000E+00
9.75	0.00000E+00
9.85	0.00000E+00
9.95	0.00000E+00
11.00	0.00000E+00
12.00	0.00000E+00
13.00	0.00000E+00
14.00	0.00000E+00
15.00	0.00000E+00
16.00	0.00000E+00
17.00	0.00000E+00
18.00	0.00000E+00
19.00	0.00000E+00
20.00	0.00000E+00
21.01	0.00000E+00
22.01	0.00000E+00
23.01	0.00000E+00
24.01	0.00000E+00
25.01	0.00000E+00
26.01	0.00000E+00
27.01	0.00000E+00
28.02	0.00000E+00
29.03	0.00000E+00
30.03	0.00000E+00
31.03	2.63000E-02
32.03	4.33000E-02
33.03	5.08000E-02
34.03	5.12000E-02
35.03	4.58000E-02
36.03	3.94000E-02
37.03	3.28000E-02
38.03	2.57000E-02
39.03	1.92000E-02
40.03	1.43000E-02
41.03	1.06000E-02
42.03	8.00000E-03
43.03	6.00000E-03
44.03	4.60000E-03
45.03	3.60000E-03
46.03	2.80000E-03
47.03	2.30000E-03
48.03	1.80000E-03
49.03	1.50000E-03
60.00	2.00000E-04
70.01	1.00000E-04
80.01	0.00000E+00
90.01	0.00000E+00

100.01	0.00000E+00
110.01	0.00000E+00
120.01	0.00000E+00
130.01	0.00000E+00
140.01	0.00000E+00
150.01	0.00000E+00
160.01	0.00000E+00
170.01	0.00000E+00
180.01	0.00000E+00
190.01	0.00000E+00
220.00	0.00000E+00
240.00	0.00000E+00
260.00	0.00000E+00
280.00	0.00000E+00
300.00	0.00000E+00
320.00	0.00000E+00
340.00	0.00000E+00
360.00	0.00000E+00
380.00	0.00000E+00
400.00	0.00000E+00
420.00	0.00000E+00
440.00	0.00000E+00
460.00	0.00000E+00
480.00	0.00000E+00
500.00	0.00000E+00
520.00	0.00000E+00
540.00	0.00000E+00
560.00	0.00000E+00
580.00	0.00000E+00
600.00	0.00000E+00

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/END OF INPUT FILE/