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Digital Feedwater Control Algorithms—Real Time Simulation Using RELAP5

TP-112229

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TP-112229

Technical Progress, March 1999

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This document was prepared by

Touch Base Computing
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This document describes research sponsored by EPRI.

The publication is a corporate document that should be cited in the literature in the following manner:

Digital Feedwater Control Algorithms – Real-Time Simulation Using RELAP5, EPRI, Palo Alto, CA: 1999. TP-112229.

ABSTRACT

A model developed to test and tune a digital feedwater control system for a boiling water reactor was expanded to include the feedwater heater system and a variable-speed drive recirculation pump option. The model consists of a RELAP5 thermal-hydraulic simulation coupled to a 'LabVIEW' control system simulation that can operate either interactively with a Foxboro IA control system or in a stand-alone plant simulation mode. This report describes in detail the changes that were made in the RELAP model and the 'LabVIEW ' control interface.

Stand-alone plant transient test cases were run using the new feedwater system model, and results compared favorably to plant data. Parametric studies were performed to investigate the sensitivity of the feedwater heater control system to selected single failures and variations in response times of selected components. This project successfully demonstrated the utility of an inexpensive human-machine-interface for plant simulation, and the capability of modeling complex balance of plant control systems in RELAP5. It also demonstrated a tool for investigation of potential control scheme weaknesses. Finally, it developed a recirculation pump model with variable speed drive characteristics for use in future simulations.

ACKNOWLEDGEMENTS

This work was funded jointly by EPRI and the Tennessee Valley Authority as a tailored collaboration project. The authors and EPRI would like to thank TVA for their support in supplying plant data and reviews in support of this project and to specifically acknowledge the following individuals at the Browns Ferry Nuclear Plant:

Gaylon Hicks

D. Tony Langley

S. Raymond Journey

CONTENTS

**Note: Appendices are quite long (200 pages each) and can be downloaded from EPRIWeb.*

1

INTRODUCTION

The main purpose of this project was to develop a stand-alone model that could be used to simulate both reactor feedwater control (pressure vessel level control) and feedwater heater control (heater level control). The approach was to expand a previously developed set of computer models used in the development of a feedwater control system to include the feedwater heater systems. This adds significant complexity to the model because of the intricacies of modeling condensing heat exchangers, but offers the added capability to investigate heater and integrated heater/feedwater control strategies. A submodel for a recirculation pump speed control variable speed drive was also developed (Section 6), but was not used in the model checkout tests reported here.

1.1 Background

Recently, digital feedwater control system testing and tuning has been performed by coupling a thermal-hydraulic plant simulation model with a control system simulator or the real control equipment, and an operator interface with data acquisition technology. This study is based on a project that applied such an approach to a new distributed digital Reactor Feedwater Control System (RFWCS) for the Browns Ferry Nuclear Plant (Units 2 and 3). The replacement RFWCS made use of the Foxboro Company's Intelligent Automation (I/A) System, consisting of fault tolerant UNIX based distributed digital hardware designed for process controls.

The model and interface modified in this project were originally developed to support real-time testing of the RFWCS. In order to fully test the functionality of the digital RFWCS, the interface was designed to allow initiation of multiple transients including signal failures, as well as display and recording of plant data. A PC was used to house National Instruments data acquisition cards and the operator interface, which was written in “LabVIEW,” a National Instruments graphical data handling program for Windows. A RELAP5/MOD3.1 thermal-hydraulic model simulated the reactor system in real time code. The RELAP5 model could also operate in a stand-alone mode without the LabVIEW operator interface. Minor alterations were made to the RELAP5 source code to allow acceptance of external control signals and communication of calculated parameters over the interface. The test model and interface have been described previously.[1]

Prior to the current project, the work was performed in phases. First, the trips and control systems were modeled, including the previously existing analog feedwater control system, feedwater pump speed governor and feedpump turbine. The original trips and control systems were used to benchmark the model against plant data from various transients.

Next, the control systems in the model were altered to allow real time coupling and testing of the Foxboro digital RFWCS. An interface allowed display of important test parameters, initiation of all test transients from the "control panel" of the virtual display, control of plant power level and other operator selected parameters, automatic capture of test data, and communication of parameters between the digital control system, the display and the RELAP5 model. The interface also introduced noise into the signal to simulate an actual signal and allowed for on and off scale signal failures to test the new control system.

The third phase duplicated the control algorithms from the RFWCS within the LabVIEW interface and RELAP5 model to produce a stand-alone simulation of the plant and RFWCS. The new stand-alone model and interface were benchmarked against transients run during testing of the digital RFWCS. The LabVIEW interface, RELAP5 source code and TCP/IP communications program, were altered to accommodate communications between the stand alone model and interface.[2]

1.2 Current Project

In the current project, Foxboro feedwater heater level controls were duplicated in the model and interface. The entire model was updated to RELAP5/MOD 3.1.1. The hydrodynamic components were expanded to include the shell sides of the feedwater heaters and associated piping, steam supplies and condensers. The interface was expanded to handle additional communications and operator actions. The simulated feedwater heater level controls were tuned and benchmarked. Benchmarking was performed against steady state data at various power levels from both the previous test phase models and heat balance data from the plant (Section 3).

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[1] J. A. Mowrey, S. I. Abdel-Khalik, and K. W. Ross, "Use of a Real-Time RELAP5 Model to Dynamically Test a Digital Feedwater Control System for a Boiling Water Reactor," *Nucl. Technol.*, **111**, 283 (1995).

[2] Mowrey, J. A., Abdel-Khalik, S. I. and Boylan, P. R., "Dynamic Testing and Simulation of Digital Control Systems for Boiling Water Reactors," Proceedings of Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies, Vol. 1, pg. 97-104, May 1996.

After the model was benchmarked at the various power levels, the heater level controls were tuned for 100% power operation and a set of partial power steady-state initialization transients was run using step changes down to 75%, 50% and 30% power (Section 4). Power changes were made from the operator interface by controlling recirculation pump speeds and rod reactivity. RELAP5 restart plot files were saved for each power level simulation. Results of the power level simulations were compared with plant data for steady state operation. This ensured that the restart plot files were accurate starting points for partial power transient runs.

The purpose was to test possible failure modes of the heater level controls and their effects on the plant. This was done to identify potential weaknesses in the feedwater heater level controls, including software and instrumentation (Section 5).

Another purpose of this project was to change the reactor recirculation pump controls from the fluid coupled drive in the existing model to a variable speed drive, to enable the model to investigate this option as a possible plant upgrade. To accomplish this, the recirculation pump controls internal to the RELAP5 model were replaced in the 100% model (Section 6).

1.3 RELAP5 Code

The RELAP5 computer code is an advanced, best-estimate thermal-hydraulic code, developed at Idaho National Engineering Laboratory (INEL) under the sponsorship of the US Nuclear Regulatory Commission. The RELAP5/MOD2 version was based on the non-equilibrium, two-fluid modeling of two-phase flow, and included extensive flow-regime-dependent interphase and fluid-wall transfer models. The code has generic models which can be used in simulating various system configurations. The version of the code used here, RELAP5/MOD3.1.1, is capable of simulating all postulated accidents in reactor coolant systems except those requiring multi-dimensional core neutronics calculations.[1]

RELAP5 has been extensively applied in the past for various simulation, validation, experimental data analysis, and plant/system analysis purposes. Recently, attention has been paid to accurate modeling of control systems and circuitry, as well as mathematical modeling of the performance of physical components in balance-of-plant systems.

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[1] K. E. Carlson et al., *RELAP5/MOD3 Code Manual Volume I: Code Structure, System Models, and Solution Methods*, NUREG/CR-5535, EGG-2596, EG&G Idaho, Idaho National Engineering Laboratory, June 1990.

Appendix A contains the RELAP5 input deck for the base model with the new feedwater heater components. Appendix B contains the input deck for the base model with the new heaters plus the variable recirculation speed parameters.

1.4 Results Summary

This project successfully demonstrated the capability of providing an inexpensive MMI for plant simulation, and the capability of modeling complex balance of plant control systems in RELAP5. It also demonstrated a tool for examination of control schemes for potential weak spots. Finally, it allowed creation of a model of future plant modifications, such as variable speed drives for the recirculation pumps.

2

STAND ALONE MODEL WITH FEEDWATER HEATER LEVEL CONTROLS

Changes were made to the RELAP5 model previously developed, to a program called "term" which communicated between the operator interface and RELAP5 model, and to the LabVIEW operator interface to incorporate feedwater level control algorithms, including upgrading the RELAP5 model and executable to MOD3.1.1. It was necessary to upgrade to MOD3.1.1 in order to run the expanded RELAP5 model. The changes to the RELAP5 source code and "term" program were similar to the changes made for the RFWCS stand alone version, developed previously.

Nodalization diagrams of the RELAP5 model are shown in Figures 2-1, 2-2, and 2-3.

Changes to RELAP5 Model

Changes made to the RELAP5 model included changes to the model nodalization as well as changes to the control variables. All additions were made to the RFWCS stand alone version. The following subsections describe the changes made to the model.

Appendix A contains the complete RELAP5 input deck for the model. Alterations for the addition of the feedwater heater shell sides and the level controls are highlighted in bold type.

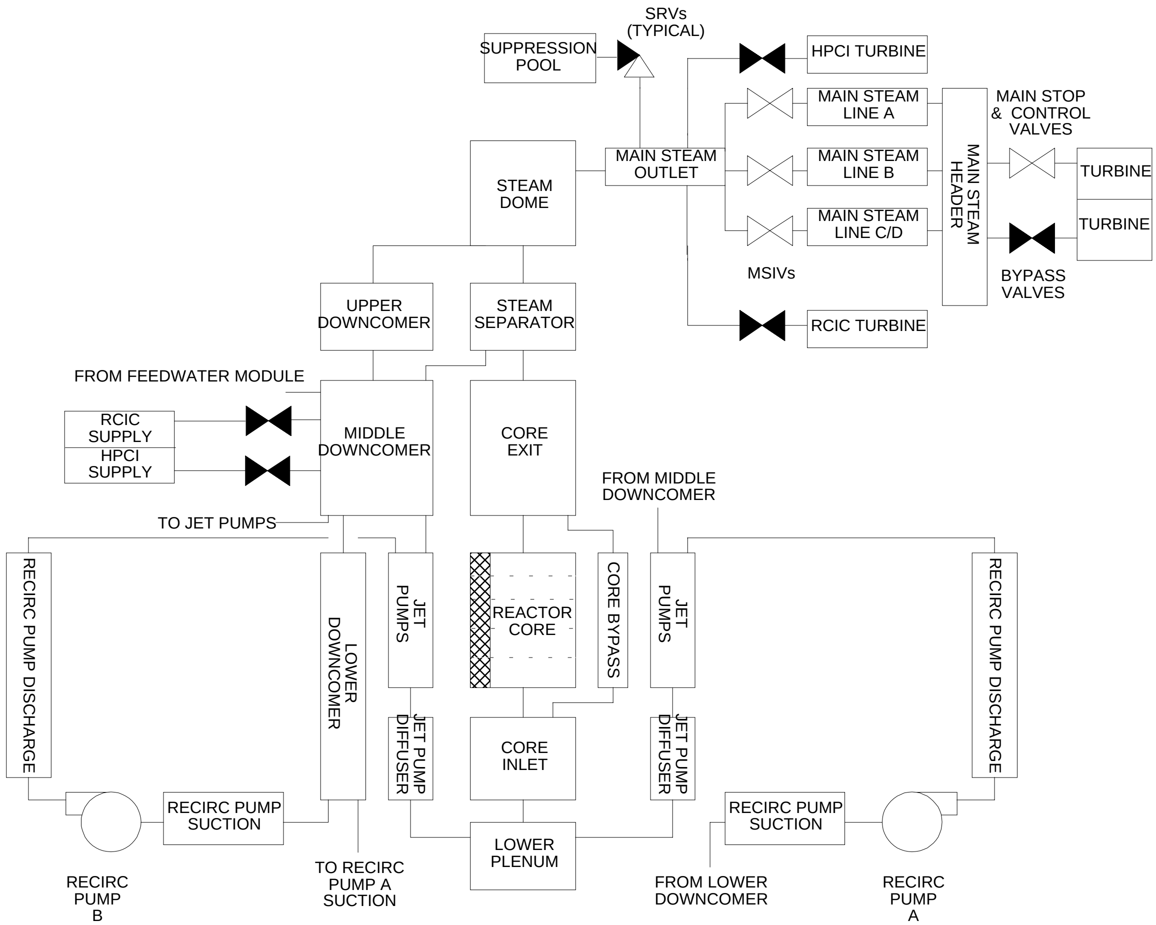

Figure 2-1 RELAP5 Reactor Coolant System Nodalization

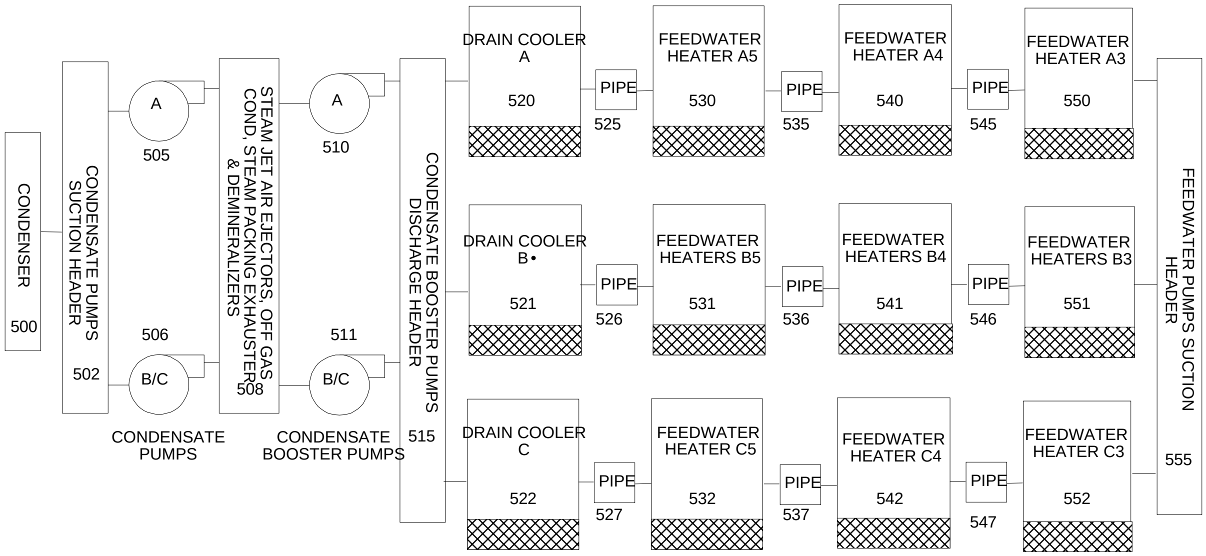

Figure 2-2 RELAP5 Low Pressure FW Heater Nodalization

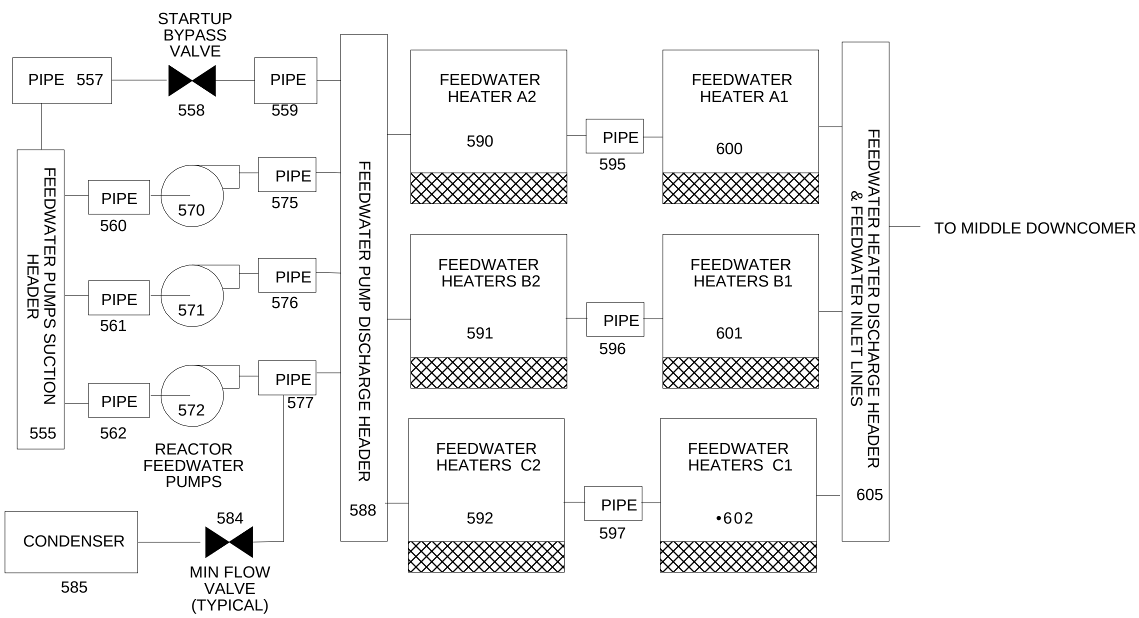

Figure 2-3 RELAP5 High Pressure FW Heater Nodalization

Changes to Hydrodynamic Volumes

In order to add the shell sides of the feedwater heaters, it was necessary to renumber several hydrodynamic volumes in the feed train. This also necessitated renumbering the volumes in trips and control variables where the renumbered volumes were referenced. The heat structures associated with the volumes were also renumbered; 1580 became 1520. The following table shows which volumes were renumbered.

Table 2-1
Changed Volume and Junction Numbers

Original Number	**Revised Number**
510	502
520	505
530	506
540	508
550	510
560	511
580	520
600	525
640	535
680	545
721	560
722	561
723	562
730	570
740	571
750	572

Table 2-1
Changed Volume and Junction Numbers

Original Number	Revised Number
735	575
745	576
755	577
790	595
736	580
737	581
746	582
747	583
756	584
757	585
840	557
850	558
860	559

The B and C train feedwater heaters' tube sides and piping were split into two single trains in this version. The prior models used a set of single and double heaters with single and double piping volumes on the tube side. This was done to minimize the number of volumes and junctions in the previous models to allow them to run in real time. Also, there was no need for heater controls in previous models. The following table shows which double (B/C) volumes and junctions were replace with both a B and C train volume or junction.

Table 2-2
Double Volumes and Junctions Replaced with Single Volumes and Junctions

Original Volume	Replacement Volume	Description
590	521, 522	Drain Coolers
610	526, 527	Pipe DC to Htr 5
630	531, 532	Htr B, C5 Tube Sides
650	536, 537	Pipe B, C5 to B, C4
670	541, 542	Htr B, C4 Tube Sides
690	546, 547	Pipe B, C4 to B, C3
710	551, 552	Htr B, C3 Tube Sides
780	591, 592	Htr B, C2 Tube Sides
800	596, 597	Pipe B, C2 to B, C1
820	601, 602	Htr B, C1 Tube Sides

Flow areas in the volumes or junctions for the single items were one half that of the deleted double unit. Also note that the double heater tube side single volumes were replaced with single pipe components, with multiple junctions and volumes. Formerly, there was no need for multiple tube volumes since heat transfer into the tube side was controlled by control variables. In the current model, the tube side receives heat through the tube walls from the added shell sides. In order to simulate this more accurately, additional tube side volumes were needed. The affected components include numbers 531, 532, 541, 542, 551, 552, 591, 592, 601 and 602 listed above in Table 2-2.

In order to support the splitting of the double feed train components into single components representing trains B and C, it was also necessary to add junctions to the branch volumes serving as headers for the three feed trains. The resulting B and C train junctions had one half the flow area as the previous model's double junction. The component numbers for the affected branches are: 515, the branch volume from the condensate booster pumps to the drain coolers, formerly numbered as 570; 555, the branch volume connecting the number 3 heaters to the Reactor Feed Pump inlets, formerly numbered as 720; 588, the branch volume from the Reactor Feed Pump outlets to the number 2 heaters, formerly numbered as 760; and 605, the inlet branch for feed water into the reactor, formerly branch component 830 and single junction 715.

Note that the single heater tube side single volumes were also replaced with single pipe components, with multiple junctions and volumes. As with the double heaters in the previous model, there was no need for multiple tube volumes since heat transfer into the tube side was controlled by control variables. In the current model, the tube side receives heat through the tube walls from the added shell sides. In order to simulate this more accurately, additional tube side volumes were needed. The affected components include: RFW heater A5 tubes (now component 530, was formerly 620), RFW heater A4 tubes (now component 540, was formerly 660), RFW heater A3 tubes (now component 550, was formerly 700), RFW heater A2 tubes (now component 590, was formerly 770), and RFW heater A1 tubes (now component 600, was formerly 810).

In addition, junctions were added to component 610, representing miscellaneous junctions in the B and C feed trains. Formerly, the multiple junction component was numbered as 870, and contained sixteen miscellaneous junctions for the A and B/C double train. The new component contains twenty-four for the A, B and C trains.

The shell sides of the feedwater heaters were added as an independent hydrodynamic system by card 121. The following table shows the added hydrodynamic components and their descriptions. Figures 2-4 through 2-8 show this nodalization scheme.

Table 2-3
RFW Heater Shell Side Components

Component	Description
701	RFW HTR A1 Steam Supply
702	RFW HTR A2 Steam Supply
703	RFW HTR A3 Steam Supply
704	RFW HTR A4 Steam Supply #1
705	RFW HTR A4 Steam Supply #2
706	RFW HTR A5 Steam Supply #1
707	RFW HTR A5 Steam Supply #2
708	Moisture Separator

Table 2-3
RFW Heater Shell Side Components

Component	Description
709	Moisture Separator Drain to HTR A2
710	RFW HTR A1 Steam Supply Valve
711	RFW HTR A2 Steam Supply Valve
712	RFW HTR A3 Steam Supply Valve
713	RFW HTR A4 Steam Supply Valve
714	RFW HTR A4 Steam Supply Valve
715	RFW HTR A5 Steam Supply Valve
716	RFW HTR A5 Steam Supply Valve
720	RFW Heater A1 Steam Dome
721	RFW HTR A1 Shellside Middle Volumes
722	RFW HTR A1 Tubesheet Shellside
723	RFW Heater A1 Drain Piping
725	RFW HTR A1 Drain Valve
730	RFW Heater A2 Steam Dome
731	RFW HTR A2 Drain Junction Volume
732	RFW HTR A2 Shellside Middle Volumes
733	RFW Heater A2 Tubesheet Shellside
734	RFW Heater A2 Drain Piping
735	RFW HTR A2 Drain Valve
737	RFW HTR A2 Bypass Valve

Table 2-3
RFW Heater Shell Side Components

Component	Description
738	RFW Bank 2 Bypass Drain Piping to Condenser
740	RFW Heater A3 Steam Dome
741	RFW HTR A3 Drain Junction Volume
742	RFW HTR A3 Shellside Middle & Lower Volumes
743	RFW Heater A3 Subcooling Zone
744	RFW Heater A3 Drain Piping
745	RFW HTR A3 Drain Valve
747	RFW HTR A3 Multiple Junctions
750	RFW HTR A4 (top of shell nearest tubesheet)
751	RFW Heater A4 (top of shell furthest from tubesheet)
752	RFW Heater A4 (bottom of shell furthest from tubesheet)
753	RFW Heater A4 Subcooling Zone
754	RFW Heater A4 Drain Piping
755	RFW HTR A4 Drain Valve
757	RFW HTR A4 Bypass Valve
758	RFW Bank 4 Bypass Drain Piping to Condenser
760	RFW Heater A5 Flash Tank
761	RFW Heater A5 Drain Piping

Table 2-3
RFW Heater Shell Side Components

Component	Description
762	RFW HTR A5 (top of shell nearest tubesheet)
763	RFW Heater A5 (top of shell furthest from tubesheet)
764	RFW Heater A5 (bottom of shell furthest from tubesheet)
765	RFW Heater A5 (bottom of shell nearest tubesheet)
766	RFW Heater A5 Collector
767	RFW HTR A5 Drain Valve
768	RFW HTR A5 Bypass Valve
801	RFW HTR B1 Steam Supply
802	RFW HTR B2 Steam Supply
803	RFW HTR B3 Steam Supply
804	RFW HTR B4 Steam Supply #1
805	RFW HTR B4 Steam Supply #2
806	RFW HTR B5 Steam Supply #1
807	RFW HTR B5 Steam Supply #2
808	Moisture Separator
809	Moisture Separator Drain to HTR B2
810	RFW HTR B1 Steam Supply Valve
811	RFW HTR B2 Steam Supply Valve
812	RFW HTR B3 Steam Supply Valve
813	RFW HTR B4 Steam Supply Valve

Table 2-3 RFW Heater Shell Side Components	
Component	**Description**
814	RFW HTR B4 Steam Supply Valve
815	RFW HTR B5 Steam Supply Valve
816	RFW HTR B5 Steam Supply Valve
820	RFW Heater A1 Steam Dome
821	RFW HTR B1 Shellside Middle Volumes
822	RFW Heater B1 Tubesheet Shellside
823	RFW Heater B1 Drain Piping
825	RFW HTR B1 Drain Valve
830	RFW Heater A2 Steam Dome
831	RFW HTR B2 Drain Junction Volume
832	RFW HTR B2 Shellside Middle Volumes
833	RFW Heater B2 Tubesheet Shellside
834	RFW Heater B2 Drain Piping
835	RFW HTR B2 Drain Valve
837	RFW HTR B2 Bypass Valve
840	RFW Heater B3 Steam Dome
841	RFW HTR B3 Drain Junction Volume
842	RFW Heater B3 Shellside Middle & Lower Volumes
843	RFW Heater B3 Subcooling Zone
844	RFW Heater B3 Drain Piping

Table 2-3
RFW Heater Shell Side Components

Component	Description
845	RFW HTR B3 Drain Valve
847	RFW HTR B3 Multiple Junctions
850	RFW Heater B4 (top of shell nearest tubesheet)
851	RFW Heater B4 (top of shell furthest from tubesheet)
852	RFW Heater B4 (bottom of shell furthest from tubesheet)
853	RFW Heater B4 Subcooling Zone
854	RFW Heater B4 Drain Piping
855	RFW HTR B4 Drain Valve
857	RFW HTR B4 Bypass Valve
860	RFW Heater B5 Flash Tank
861	RFW Heater B5 Drain Piping
862	RFW Heater B5 (top of shell nearest tubesheet)
863	RFW Heater B5 (top of shell furthest from tubesheet)
864	RFW Heater B5 (bottom of shell furthest from tubesheet)
865	RFW Heater B5 (bottom of shell nearest tubesheet)
866	RFW Heater B5 Collector
867	RFW HTR B5 Drain Valve
868	RFW HTR B5 Bypass Valve

Table 2-3
RFW Heater Shell Side Components

Component	Description
901	RFW HTR C1 Steam Supply
902	RFW HTR C2 Steam Supply
903	RFW HTR C3 Steam Supply
904	RFW HTR C4 Steam Supply #1
905	RFW HTR C4 Steam Supply #2
906	RFW HTR C5 Steam Supply #1
907	RFW HTR C5 Steam Supply #2
908	Moisture Separator
909	Moisture Separator Drain to HTR C2
910	RFW Heater C1 Steam Supply Valve
911	RFW Heater C2 Steam Supply Valve
912	RFW Heater C3 Steam Supply Valve
913	RFW Heater C4 Steam Supply Valve
914	RFW Heater C4 Steam Supply Valve
915	RFW Heater C5 Steam Supply Valve
916	RFW Heater C5 Steam Supply Valve
920	RFW Heater C1 Steam Dome
921	RFW Heater C1 Shellside Middle Volumes
922	RFW Heater C1 Tubesheet Shellside
923	RFW Heater C1 Drain Piping
925	RFW HTR C1 Drain Valve

Table 2-3
RFW Heater Shell Side Components

Component	Description
930	RFW Heater C2 Steam Dome
931	RFW HTR C2 Drain Junction Volume
932	RFW Heater C2 Shellside Middle Volumes
933	RFW Heater C2 Tubesheet Shellside
934	RFW Heater C2 Drain Piping
935	RFW HTR C2 Drain Valve
937	RFW HTR C2 Bypass Valve
940	RFW Heater C3 Steam Dome
941	RFW HTR C3 Drain Junction Volume
942	RFW Heater C3 Shellside Middle & Lower Volumes
943	RFW Heater C3 Subcooling Zone
944	RFW Heater C3 Drain Piping
945	RFW HTR C3 Drain Valve
947	RFW HTR C3 Multiple Junctions
950	RFW Heater C4 (top of shell nearest tubesheet)
951	RFW Heater C4 (top of shell furthest from tubesheet)
952	RFW Heater C4 (bottom of shell furthest from tubesheet)
953	RFW Heater C4 Subcooling Zone
954	RFW Heater C4 Drain Piping

Table 2-3
RFW Heater Shell Side Components

Component	Description
955	RFW HTR C4 Drain Valve
957	RFW HTR C4 Bypass Valve
960	RFW Heater C5 Flash Tank
961	RFW Heater C5 Drain Piping
962	RFW Heater C5 (top of shell nearest tubesheet)
963	RFW Heater C5 (top of shell furthest from tubesheet)
964	RFW Heater C5 (bottom of shell furthest from tubesheet)
965	RFW Heater C5 (bottom of shell nearest tubesheet)
966	RFW Heater C5 Collector
967	RFW HTR C5 Drain Valve
968	RFW HTR C5 Bypass Valve
969	RFW Heater Sump Header
970	HTR Sump / Condenser
971	HTR Sump / Condenser

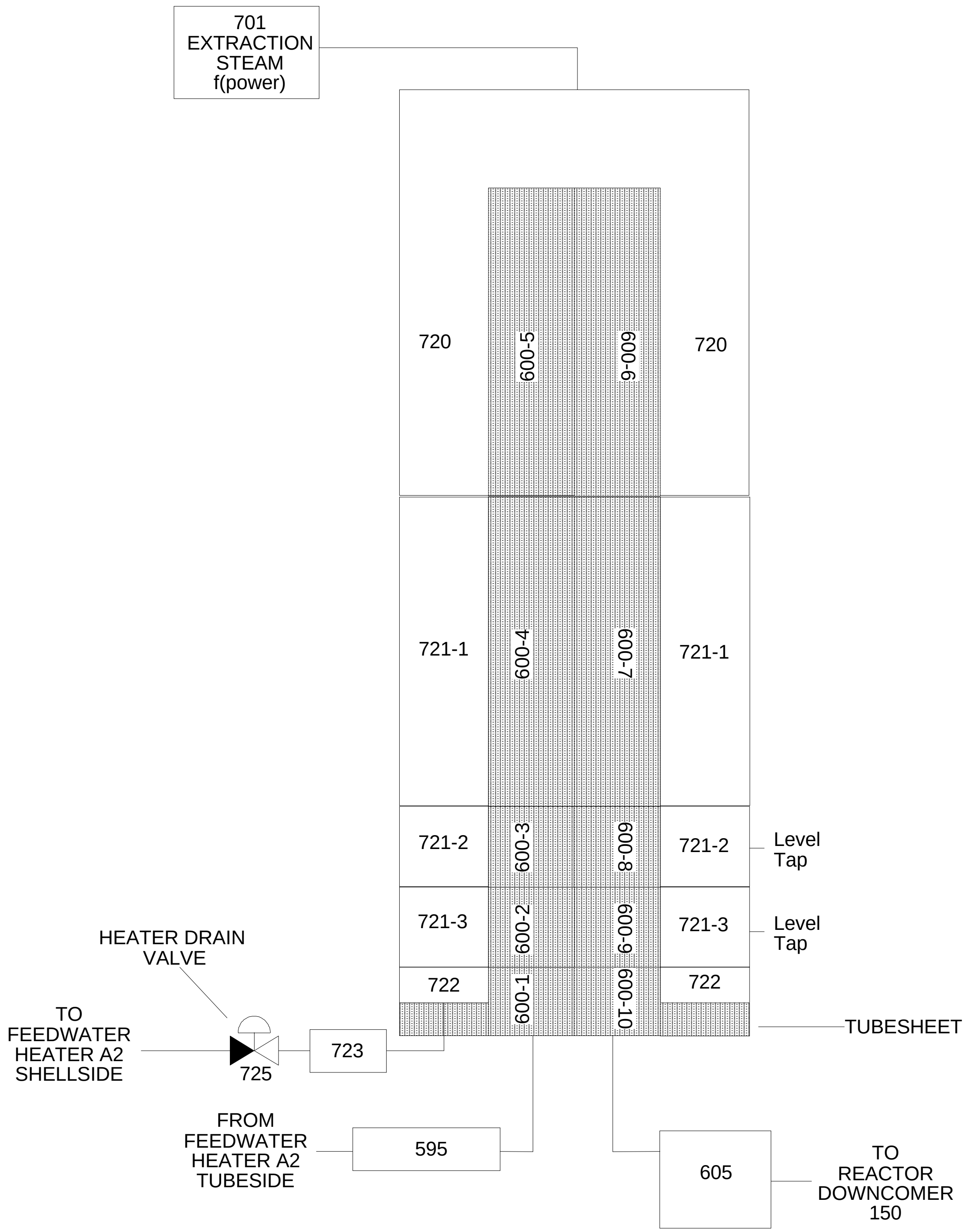

Figure 2-4 RELAP5 Nodalization for Feedwater Heater A1

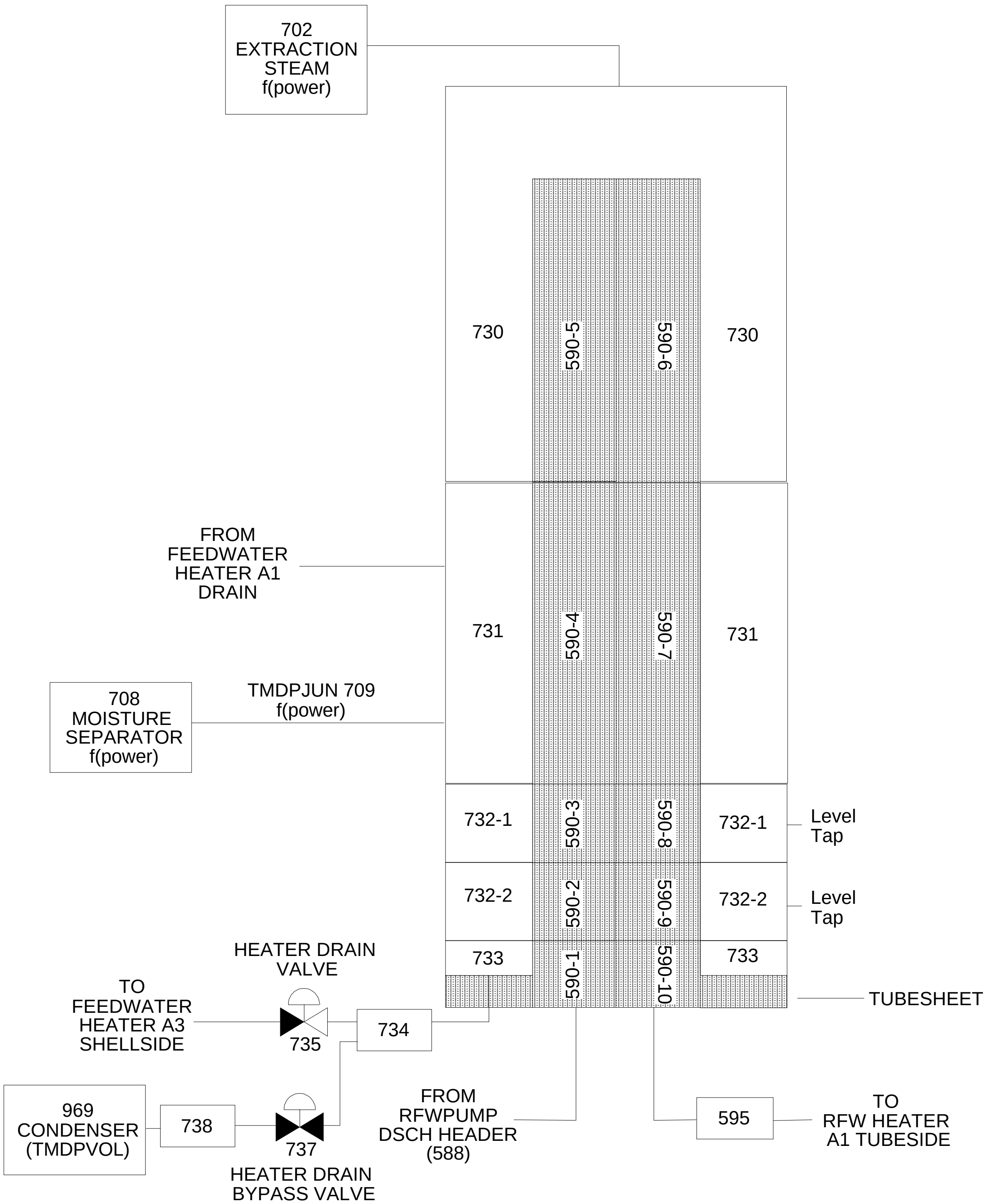

Figure 2-5 RELAP5 Nodalization for Feedwater Heater A2

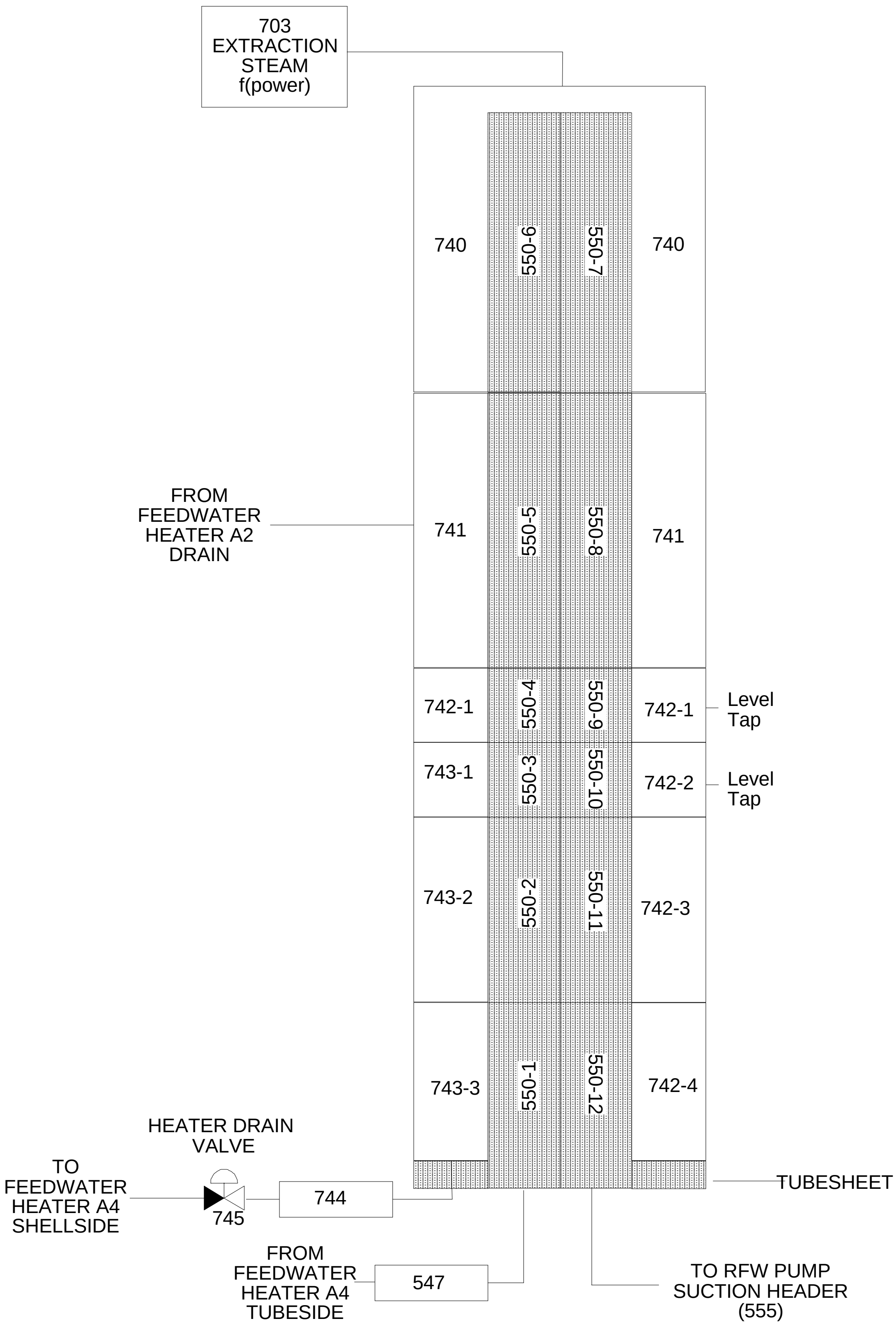

Figure 2-6 RELAP5 Nodalization for Feedwater Heater A3

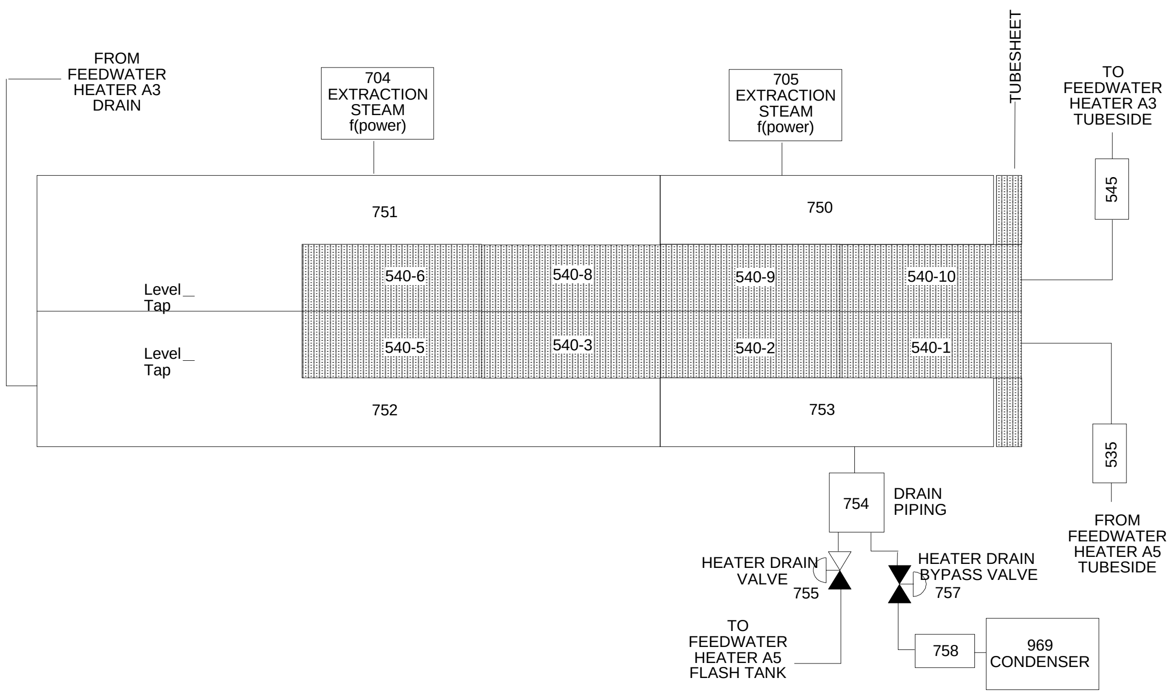

Figure 2-7 RELAP5 Nodalization for Feedwater Heater A4

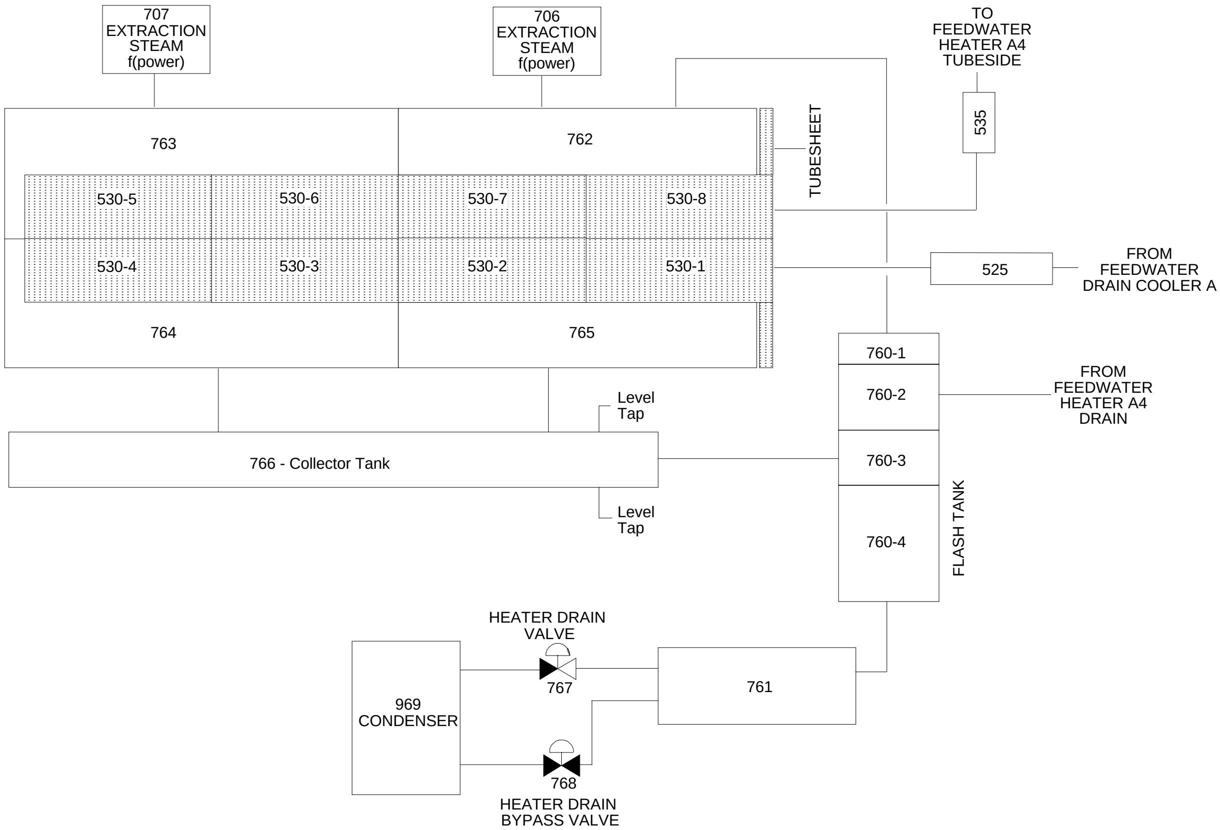

Figure 2-8 RELAP5 Nodalization for Feedwater Heater A5

Changes to Heat Structures

Formerly, feedwater heater tubes were modeled as cylindrical tubes with the inside surface in contact with the feed water, and the outside surface modeled as an adiabatic boundary. Heat was generated in the tube structure depending on the reactor power. Drain cooler heat transfer was also modeled in this way for both the A and combined B/C drain cooler. The drain coolers are still modeled in this way in the new RELAP5 input deck. The changes to the drain cooler A heat structures have already been discussed. The structures were renumbered using the same scheme as the hydrodynamic volumes. The drain cooler B/C tube heat structures were split into separate B and C structures. Also, the control variable which sets the source for the B and C drain coolers was changed to the same control variable as previously used for the A drain cooler.

For the feed water heaters themselves, the new heat structures were also renumbered exactly as the hydrodynamic components were. In addition, the number of axial elements in each heat structure were increased in the new input deck, and the adiabatic tube outer boundary was changed to a convective boundary connected to the shell side hydrodynamic volumes for all feed water heater tubes. The control variables which formerly set the source term were no longer used. The B/C double heat structures were split into B and C single heat structures. Finally, additional mesh points were added radially within the tube structures.

Changes to Trips

Most changes to trips were due to renumbering hydrodynamic components. Three trips, 632, 633 and 634 were added. These were the logical inversion of the feed pump trips. These trips were used to close the steam supply valves to the associated feed water heater shell sides when a feed pump was tripped. This is done solely to ease the RELAP5 calculations when a heater train is taken off line.

Changes to General Tables

Changes to general tables consisted of deletion of tables formerly used to determine the tube source term for feed water heaters. With the addition of shell side components, these tables were no longer needed.

Changes to Control Variables

Changes to the control variables included calculation of collapsed level within the shell side, lagging of the calculated value of level to simulate an actual level instrument which was written out to the LabVIEW interface, and "constant" control variables for heater drain and bypass valve positions. The "constant" control variables were then lagged to simulate actual normalized valve positions. The controllers were simulated within the LabVIEW interface; the controller outputs were then written to the “constant” valve positions. The following table lists these added control variables.

Table 2-4
Feed Water Heater Level Control Variables

Control Variable Number	Description
305	HTR A1 Collapsed Liquid Level
306	HTR A1 Level to LabVIEW
323	A1 Instant Drain Vlv Demand
324	A1 Drain Vlv Position
330	HTR A2 Collapsed Liquid Level
331	HTR A2 Level to LabVIEW
348	A2 Instant Drain Vlv Demand
349	A2 Drain Vlv Position
354	A2 Instant Bypass Vlv Demand
355	A2 Bypass Vlv Position
360	HTR A3 Collapsed Liquid Level
361	HTR A3 Level to LabVIEW
378	A3 Instant Drain Vlv Demand
379	A3 Drain Vlv Position
380	HTR A4 Collapsed Liquid Level
381	HTR A4 Level to LabVIEW
398	A4 Instant Drain Vlv Demand
399	A4 Drain Vlv Position
404	A4 Instant Bypass Vlv Demand
405	A4 Bypass Vlv Position
410	HTR A5 Collapsed Liquid Level
411	HTR A5 Level to LabVIEW

Table 2-4
Feed Water Heater Level Control Variables

Control Variable Number	Description
428	A5 Instant Drain Vlv Demand
429	A5 Drain Vlv Position
434	A5 Instant Bypass Vlv Demand
435	A5 Bypass Vlv Position
440	HTR B1 Collapsed Liquid Level
441	HTR B1 Level to LabVIEW
449	B1 Instant Drain Vlv Demand
450	B1 Drain Vlv Position
451	HTR B2 Collapsed Liquid Level
452	HTR B2 Level to LabVIEW
457	B2 Instant Drain Vlv Demand
458	B2 Drain Vlv Position
459	B2 Instant Bypass Vlv Demand
460	B2 Bypass Vlv Position
465	HTR B3 Collapsed Liquid Level
466	HTR B3 Level to LabVIEW
471	B3 Instant Drain Vlv Demand
472	B3 Drain Vlv Position
475	HTR B4 Collapsed Liquid Level
476	HTR B4 Level to LabVIEW
481	B4 Instant Drain Vlv Demand

Table 2-4
Feed Water Heater Level Control Variables

Control Variable Number	Description
482	B4 Drain Vlv Position
483	B4 Instant Bypass Vlv Demand
484	B4 Bypass Vlv Position
486	HTR B5 Collapsed Liquid Level
487	HTR B5 Level to LabVIEW
492	B5 Instant Drain Vlv Demand
493	B5 Drain Vlv Position
494	B5 Instant Bypass Vlv Demand
495	B5 Bypass Vlv Position
940	HTR C1 Collapsed Liquid Level
941	HTR C1 Level to LabVIEW
949	C1 Instant Drain Vlv Demand
950	C1 Drain Vlv Position
951	HTR C2 Collapsed Liquid Level
952	HTR C2 Level to LabVIEW
957	C2 Instant Drain Vlv Demand
958	C2 Drain Vlv Position
959	C2 Instant Bypass Vlv Demand
960	C2 Bypass Vlv Position
965	HTR C3 Collapsed Liquid Level
966	HTR C3 Level to LabVIEW
971	C3 Instant Drain Vlv Demand

Table 2-4
Feed Water Heater Level Control Variables

Control Variable Number	Description
972	C3 Drain Vlv Position
975	HTR C4 Collapsed Liquid Level
976	HTR C4 Level to LabVIEW
981	C4 Instant Drain Vlv Demand
982	C4 Drain Vlv Position
983	C4 Instant Bypass Vlv Demand
984	C4 Bypass Vlv Position
986	HTR C5 Collapsed Liquid Level
987	HTR C5 Level to LabVIEW
992	C5 Instant Drain Vlv Demand
993	C5 Drain Vlv Position
994	C5 Instant Bypass Vlv Demand
995	C5 Bypass Vlv Position

Many control variables were only changed by the renumbering of the components that they reference. These control variables are not discussed further.

Prior to the current model, heat transfer across the feedwater heater tubes was calculated in the control variables. The shell sides were not modeled. This scheme is still used for the drain coolers. The control variable used to calculate heat transfer in the "double line" drain cooler was number 826 in the previous model; this control variable was deleted in the current model.

For the feedwater heater power across the tubes, the control variables used to set the source term in the tube heat structures in the previous model were deleted (811 - 815, 821 - 825). Control variables were used to calculate the tube power for comparison with plant data; these variables did not set a source term, but only monitored tube power.

These variables include 811 - 815, and they are sums of the RELAP5 calculated heat fluxes in the heat structures.

The control variables simulating the Woodward governors were also altered. The error terms were moved to control variables 586, 587 and 588, and the error term multipliers were changed to 0.02. This value converts the speed input range (600 - 5600 RPM) to percent error. The error term was then lagged by 0.1 second in control variables 595, 596 and 597. This was done to more accurately simulate the Woodward 505 transfer function. Control variables 690, 691 and 692 were changed from error terms to differential terms in the governor transport equations. The integral time constants and proportional term gains were also changed to agree with the Woodward transport equation in control variables 696, 697, 698, 699, 700 and 701. Lagging of the outputs of the Woodward governor outputs was deleted in the new model; these control variables were 702, 703 and 704.

In the new model, changes were also made to the multipliers for control variables simulating the feedwater level controllers. It was discovered that errors were made in the original stand alone model simulating the proportional and integral terms for PID blocks within the Foxboro I/A System. Basically, the PID block automatically adds a gain or multiplicative factor representing the ratio between block output and input ranges to the proportional and integral terms. In this model, these errors were corrected in the multiplicative factors in control variables 654, 655, 661, 664, 668 and 671.

The control variables were also altered in the feedwater level control area to use returned level steam flow and feedwater flow from LabVIEW. This allowed the model to update feedwater level control variables each 0.2 second, and feedwater heater level control variables each 0.5 second. The variables returned from LabVIEW were only changes each 0.5 or 0.2 second.

Other changes to control variables included changing the feedwater controller output limits following a reactor scram from 58% to 63%.

Changes to “term” Program

Term is a program written to allow communications between the LabVIEW program on the PC and the workstation via a TCP/IP protocol. The only changes to this program and the source code of RELAP5 were based on the changes to the RELAP5 control variables which were passed between the operator interface and model. The changes to the control variables have been previously described.

Changes to the LabVIEW Interface

The front panel remained exactly the same for the feedwater heater level stand alone version as the previous stand alone version. The major changes to the LabVIEW interface involved changes to control the timing of signals to the RELAP5 model and the addition of PI controller simulations within LabVIEW for the feedwater heater level control valves and bypass valves.

Timing of control signals became critical when the feedwater heater level algorithms were added. The previous LabVIEW interface had passed level, steam flow, pressure and feedwater flow signals to the RELAP5 model every 200 msec to discretize control signals for the feedwater flow controllers. Since the model ran in real-time, the LabVIEW interface was constructed to update values every 200 msec. Once the feedwater heater level controls were added, the model no longer could run in real-time. Also, the feedwater heater level controls updated every 500 msec.

Two timing sub-virtual instruments were created. One passed new values for feedwater flow control variables for each 200 msec of problem time. The other passed a string containing feedwater heater levels directly to another sub-virtual instrument which contained the PI controllers every 500 msec of problem time. From there, the same timing sub-virtual instrument returned the new controller output string to the main virtual instrument for passing to the RELAP5 model's drain and bypass valves. Figure 2-9 shows the control diagram for the feedwater heater level timing sub-virtual instrument when updating the controller output. In between updates, the sub-virtual instrument did not pass the level string and returned the string from the last update to the main virtual instrument.

PI controllers were created for the drain and bypass valves within the LabVIEW interface. Figure 2-10 shows one of the PI controllers for the drain and bypass valve. The Foxboro I/A system used a single PI controller to control both valves. The drain valve was directly positioned by controller output, the bypass valve began to open when the controller output exceeded 75%, and was fully open at 100% controller output. Building the PI controllers within LabVIEW had several advantages. First, it made tuning of control loops and updating of control schemes easier for the stand alone version. Also, initialization of the controller on start up was made much easier by inserting the initial value and setting the "Initi" boolean. The controller output was set to the initial value, and when the "Initi" boolean was reset, the controller would bumplessly transition to automatic control. This same feature also allowed placing the controller in manual and setting its output.

Block Diagram

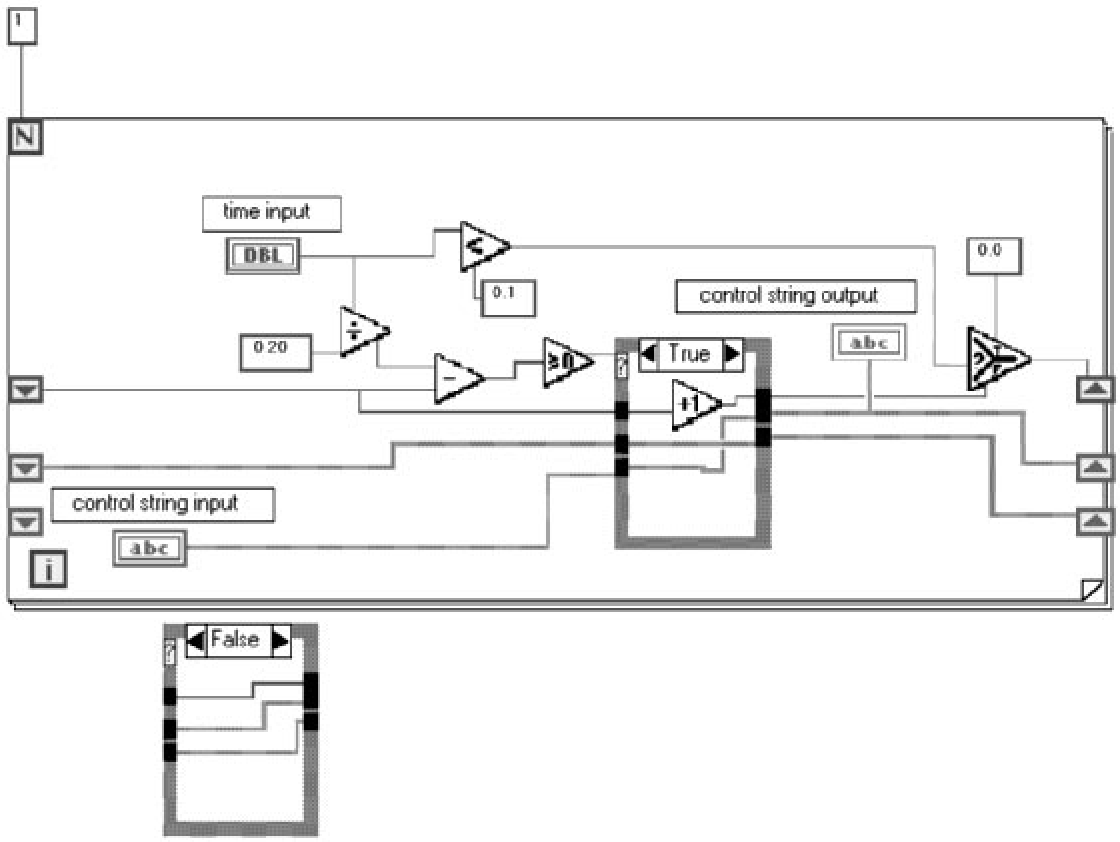

Figure 2-9 LabVIEW Feedwater Heater Level Timing Sub-Virtual Instrument

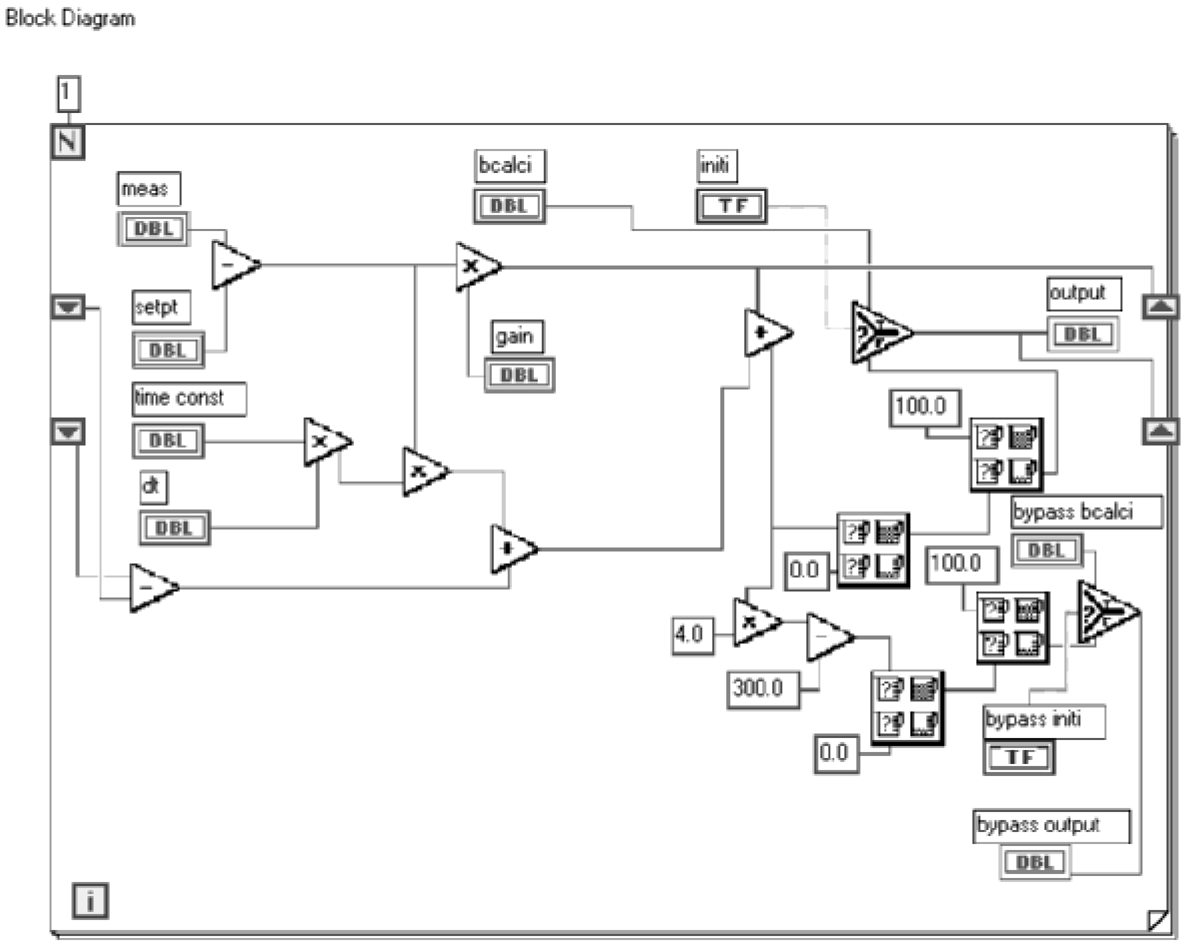

Figure 2-10 LabVIEW Controller Logic for the FW Heater Drain and Bypass Valves

3

BENCHMARKING RESULTS AT VARIOUS POWER LEVELS

This section displays the results of model initialization at various power levels compared with plant data and benchmarking runs. The model was initialized at four different power levels, and restart plot files were created at each steady-state power level.

100% Power Level

The results of the 100% steady state power model compared with plant data are compared in the table below.

Table 3-1
Steady State Comparisons at 100% Reactor Power

Parameter	RELAP5	PLANT DATA	% ERR.
REACTOR POWER	101.45	100.00	1.45
CORE MASS FLOW (Mlbm/hr)	99.532	98.500[1]	1.05
FEEDWATER MASS FLOW (Mlbm/hr)	13.538	13.37[2]	1.26

[1] Screen prints from Integrated Computer System taken on site at Browns Ferry, Unit 2 on December 21, 1993.

[2] Tennessee Valley Authority, Heat Balance Diagrams, 47K1110-001 through 47K1110-018, Revision 0.

Table 3-1
Steady State Comparisons at 100% Reactor Power

Parameter	RELAP5	PLANT DATA	% ERR.
STEAMLINE MASS FLOW (Mlbm/hr)	13.54	13.349[2]	1.43
STEAM DOME PRESSURE (psia)	1024.35	1020.0[1]	0.43
DOWNCOMER LIQUID LEVEL (in)	32.95	33.0[3]	-0.15
REACTOR FEEDPUMP SPEED (rpm)	4865.9	4848.5[1]	0.36
CONDENSATE PUMP INLET TEMP (^{O}F)	101.10	101.14[2]	-
DRAIN COOLER OUTLET TEMP (^{O}F)	130.34	130.20[2]	-
HEATER #5 OUTLET TEMP (^{O}F)	186.61	182.96[2]	-
HEATER #4 OUTLET TEMP (^{O}F)	244.23	239.37[2]	-
HEATER #3 OUTLET TEMP (^{O}F)	298.21	298.09[2]	-
HEATER #2 OUTLET TEMP (^{O}F)	330.81	330.63[2]	-
CONDENSATE BOOSTER PUMP OUTLET PRESSURE (psia)	298.66	305[2]	-2.08
INLET PRESS AT FEEDPUMPS (psia)	231.69	245[2]	-5.43
OUTLET PRESS AT FEEDPUMPS (psia)	1104.7	1102.3[2]	0.22
FEEDWATER TEMPERATURE (F)	377.00	376.97[2]	-
PRESSURE AT TCV (psia)	978.58	974.0[2]	0.47

[1] Tennessee Valley Authority, RETRAN model "BE2RPT" for CY6, Browns Ferry.

75% Reactor Power

The results of the 75% steady state power model compared with plant data are compared in the table below.

Table 3-2
Steady State Comparisons at 75% Reactor Power

PARAMETER	RELAP5	PLANT DATA	% ERR.
REACTOR POWER (%)	75.836	75.00	1.11
CORE MASS FLOW (Mlbm/hr)	62.845	61.5[1]	2.19
FEEDWATER MASS FLOW (Mlbm/hr)	9.9204	9.6962[2]	2.31
STEAMLINE MASS FLOW (Mlbm/hr)	9.8405	9.746[2]	0.97
STEAM DOME PRESSURE (psia)	996.602	993[3]	0.36
DOWNCOMER LIQUID LEVEL (in)	32.98	33.0[4]	-0.01
REACTOR FEEDPUMP SPEED (rpm)	4297.7	4242.0[2]	1.31
CONDENSATE PUMP INLET TEMP (^{O}F)	101.10	101.14[2]	-
DRAIN COOLER OUTLET TEMP (^{O}F)	126.38	126.45[2]	-
HEATER #5 OUTLET TEMP (^{O}**F)**	175.97	172.54[2]	-

[1] Mayfield, T., "Operating Instruction 2-OI-68, Reactor Recirculation System", Revision 33, Tennessee Valley Authority, Browns Ferry Nuclear Plant, July 26, 1993.

[2] Tennessee Valley Authority, Heat Balance Diagrams, 47K1110-001 through 47K1110-018, Revision 0.

[3] Screen prints from Integrated Computer System taken on site at Browns Ferry, Unit 2 on December 21, 1993.

[4] Tennessee Valley Authority, RETRAN model "BE2RPT" for CY6, Browns Ferry.

Table 3-2 Steady State Comparisons at 75% Reactor Power			
PARAMETER	**RELAP5**	**PLANT DATA**	**% ERR.**
HEATER #4 OUTLET TEMP (^{O}F)	229.64	225.41[2]	-
HEATER #3 OUTLET TEMP (^{O}F)	281.63	280.75[2]	-
HEATER #2 OUTLET TEMP (^{O}F)	311.64	310.88[2]	-
OUTLET PRESS AT FEEDPUMPS (psia)	1042.8	1049[3]	-0.59
FEEDWATER TEMPERATURE (F)	354.57	354.40[2]	-
PRESSURE AT TCV (psia)	970.70	967.0[3]	0.38

50% Reactor Power

The results of the 50% steady state power model compared with plant data are compared in the table below.

Table 3-3 Steady State Comparison at 50% Reactor Power			
PARAMETER	**RELAP5**	**PLANT DATA**	**% ERR.**
REACTOR POWER (%)	50.34	51.2[1]	-1.67
CORE MASS FLOW (Mlbm/hr)	56.687	56.3[1]	0.68
FEEDWATER MASS FLOW (Mlbm/hr)	6.3179	6.13[1]	3.06
STEAMLINE MASS FLOW (Mlbm/hr)	6.3158	6.2[1]	1.87

[1] Screen prints from Integrated Computer System taken on site at Browns Ferry, Unit 2 on December 21, 1993.

Table 3-3
Steady State Comparison at 50% Reactor Power

PARAMETER	RELAP5	PLANT DATA	% ERR.
STEAM DOME PRESSURE (psia)	974.20	977.1[1]	-0.30
DOWNCOMER LIQUID LEVEL (in)	32.94	33.0[1]	-0.18
REACTOR FEEDPUMP SPEED (rpm)	3871	3950[2]	-2.00
FEEDWATER TEMPERATURE (F)	329.76	317.5[1]	-
CONDENSATE PUMP INLET TEMP (^{O}F)	101.10	101.10[3]	-
DRAIN COOLER OUTLET TEMP (^{O}F)	117.84	119.2[4]	-
HEATER #5 OUTLET TEMP (^{O}F)	161.33	157.3[4]	-
HEATER #4 OUTLET TEMP (^{O}F)	210.79	207.0[4]	-
HEATER #3 OUTLET TEMP (^{O}F)	261.00	258.8[4]	-
HEATER #2 OUTLET TEMP (^{O}F)	289.03	286.8[4]	-
PRESSURE AT TCV (psia)	962.59	967[1]	-0.46
OUTLET PRESS AT FEEDPUMPS (psia)	991.45	1016[1]	-2.41

[1] Tennessee Valley Authority, RETRAN model "BE2RPT" for CY6, Browns Ferry.

[2] Screen prints from Integrated Computer System taken on site at Browns Ferry, Unit 2 on December 21, 1993. This value taken at 55.8% reactor power.

[3] Tennessee Valley Authority, Heat Balance Diagrams, 47K1110-001 through 47K1110-018, Revision 0.

30% Reactor Power

The results of the 30% steady state power model compared with plant data are compared in the table below.

Table 3-4
Steady State Comparison at 30% Reactor Power

PARAMETER	RELAP5	PLANT DATA	% ERR.
REACTOR POWER (%)	31.37	30.0	4.57
CORE MASS FLOW (Mlbm/hr)	38.30	37.9[1]	1.05
FEEDWATER MASS FLOW (Mlbm/hr)	3.692	3.494[2]	5.67
STEAMLINE MASS FLOW (Mlbm/hr)	3.701	3.544[2]	4.43
DOWNCOMER LIQUID LEVEL (in)	32.85	33.0[3]	-0.45
REACTOR FEEDPUMP SPEED (rpm)	3685.39	3830[2]	-3.78
CONDENSATE PUMP INLET TEMP (^{O}F)	101.10	101.10[2]	-
DRAIN COOLER OUTLET TEMP (^{O}F)	111.08	112.2[2]	-
HEATER #5 OUTLET TEMP (^{O}F)	144.86	132.4[2]	-
HEATER #4 OUTLET TEMP (^{O}F)	190.16	175.8[2]	-
HEATER #3 OUTLET TEMP (^{O}F)	195.17	221.3[2]	-

[1] Mayfield, T., "Operating Instruction 2-OI-68, Reactor Recirculation System", Revision 33, Tennessee Valley Authority, Browns Ferry Nuclear Plant, July 26, 1993.

[2] Tennessee Valley Authority, Heat Balance Diagrams, 47K1110-001 through 47K1110-018, Revision 0.

[3] Tennessee Valley Authority, RETRAN model "BE2RPT" for CY6, Browns Ferry.

Table 3-4 Steady State Comparison at 30% Reactor Power			
PARAMETER	**RELAP5**	**PLANT DATA**	**% ERR.**
HEATER #2 OUTLET TEMP (^{O}**F)**	249.87	245.7[2]	-
FEEDWATER TEMPERATURE (F)	262.45	280.90[2]	-
PRESSURE AT TCV (psia)	956.74	965.0[2]	-0.86

Some of the discrepancies at this power level can be accounted for due to the differences in power levels. Percentage differences at this level are more extreme due to the relatively large percentage effect of small changes at a lower power level. Also, the RELAP5 model does not include CRD flows into the vessel, therefore the feedwater system in the model maintains a higher flow than would actually be the case in the plant. This effect is negligible at high powers, but becomes more significant at lower power levels. The flow numbers are consistent with the higher 31.37% power level for the most part.

4

MODEL BENCHMARK TRANSIENTS

This section describes benchmark transients run on the new stand alone model. The results were then compared with the transients run during the Dynamic Factory Acceptance Test (FAT) for the Browns Ferry digital Reactor Feedwater Control System. The results are presented below.

Single Reactor Feedwater Pump Trip

The following figure shows the vessel level response to a trip of Reactor Feedwater Pump (RFP) C from 100% power. The data shown was taken from the dynamic FAT and the current stand alone (S.A.) model. The trips occur at 10 seconds.

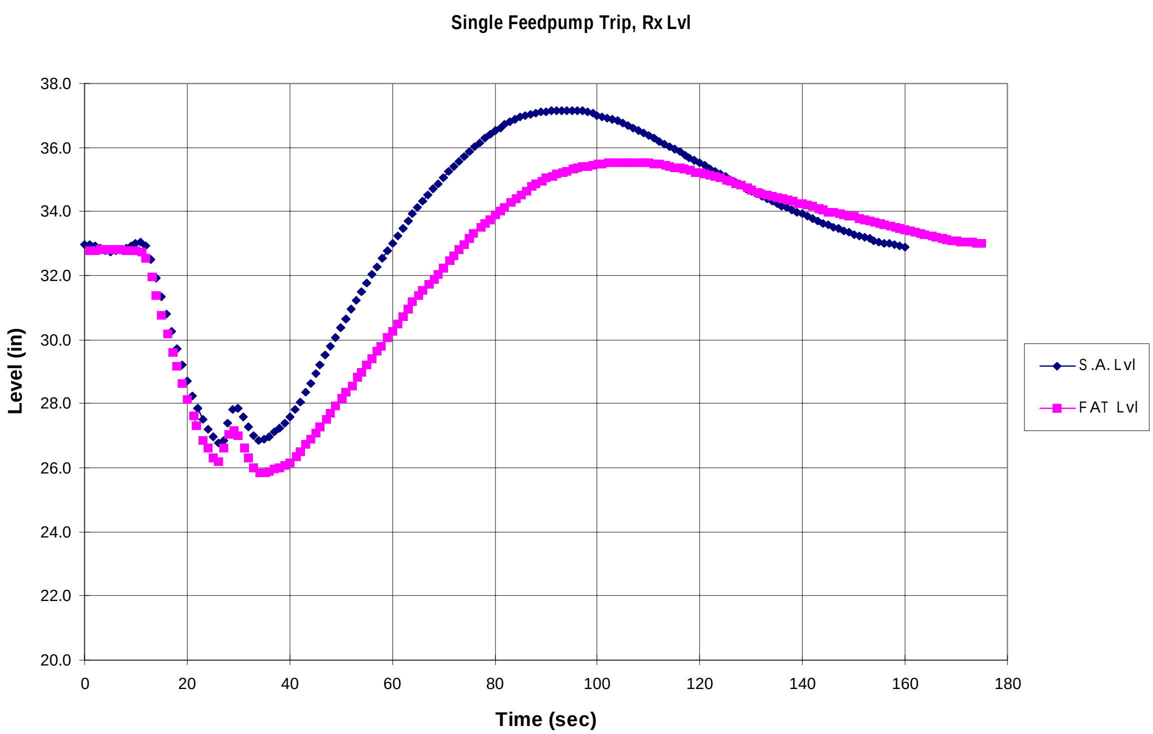

Figure 4-1 Single RFP Trip, Reactor Level

As can be seen in Figure 4-1, the FAT transient exhibited a slightly deeper drop in level and less overshoot past the setpoint of 33 inches. The reason for this response is best understood as a consequence of the output range for the feedpump speed controls within the Foxboro I/A System. Originally, the output of the three and single element controllers within I/A was within 600 and 5400 RPM. The idea was to limit the potential for feedpump runout due to a controls failure. When the FAT transient was run, these limits were in use. Later, a series of control blocks were written in I/A to prevent runout while allowing a larger controller range, from 600 to 5600 RPM. The tuning parameters were not adjusted.

Since the PID block within I/A sets output based on tuning parameters and automatically adjusts for the ratio between block output and input ranges, the effective proportional and integral terms were increased by a factor of 1.042 for the same magnitude error. Since the error is a function of time, this would tend to increase the responsiveness of the operable feedpumps. For this transient, this would increase overshoot and cause overshoot to occur slightly earlier in the transient. Since this represents the system as delivered (as opposed to as tested in this transient, and most others), the current output range was used for these transients.

Figures 4-2 to 4-4 show how the feedpump speed response varies. Note that in both cases, the speeds peak at just below the top of the output ranges for the I/A System's speed controller. For the FAT, this was 5400 RPM; it was 5600 after the FAT and in the stand alone model.

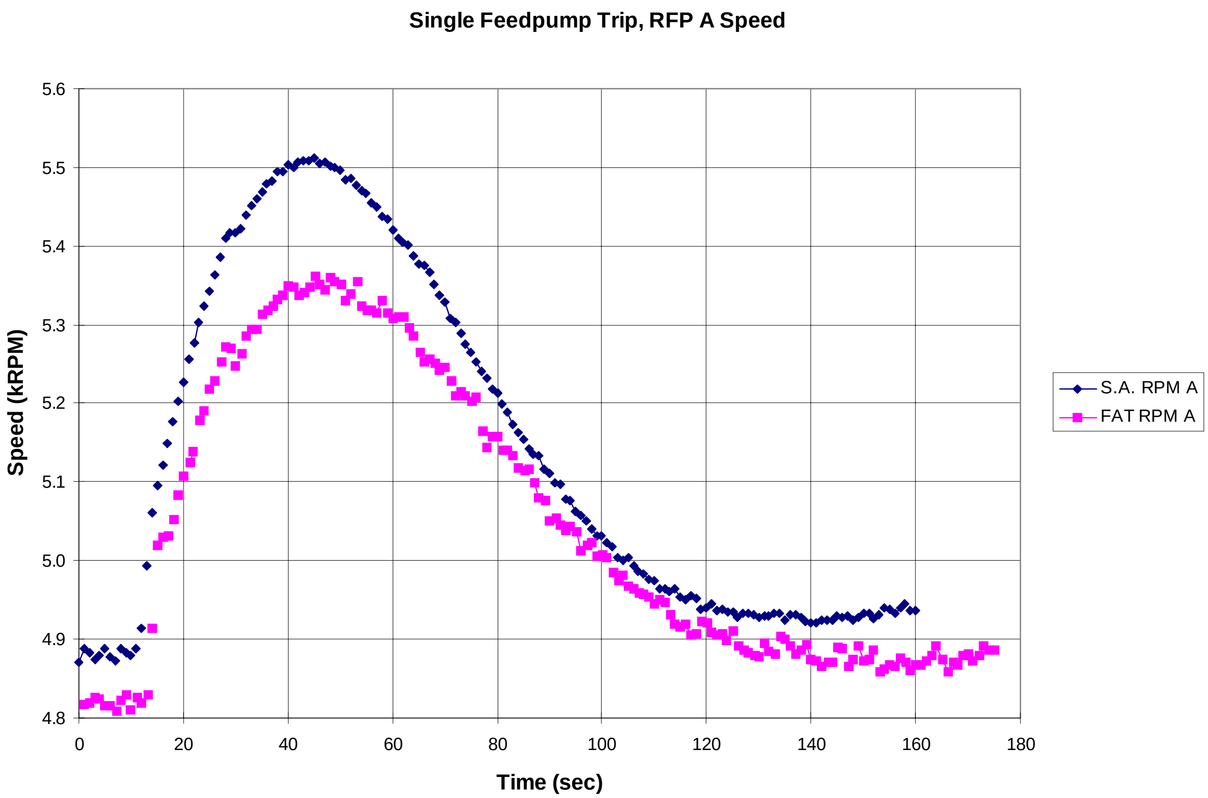

Figure 4-2 Single RFP Trip, RFP A Speed

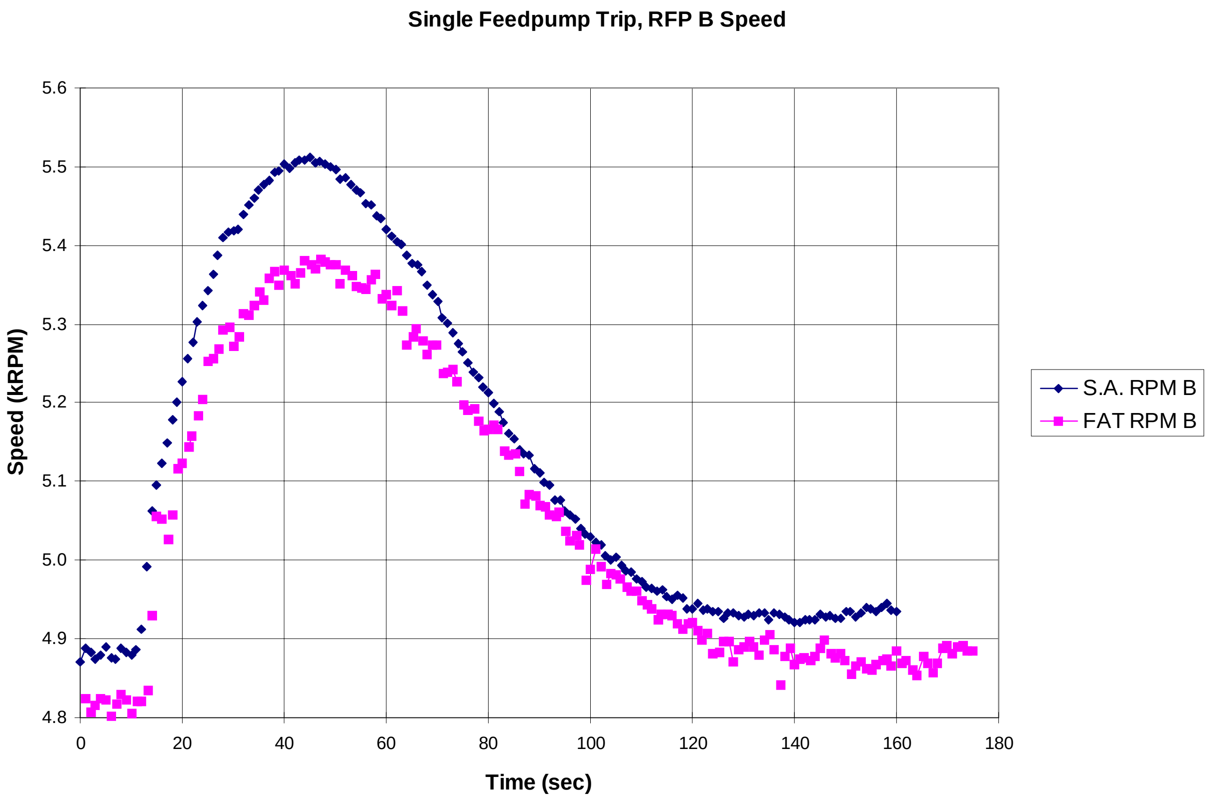

Figure 4-3 Single RFP Trip, RFP B Speed

Note also that the initial and final speeds for the pumps are slightly higher in the stand alone version, since it was initialized to a slightly higher power.

Figure 4-4 shows the coastdown of RFP C.

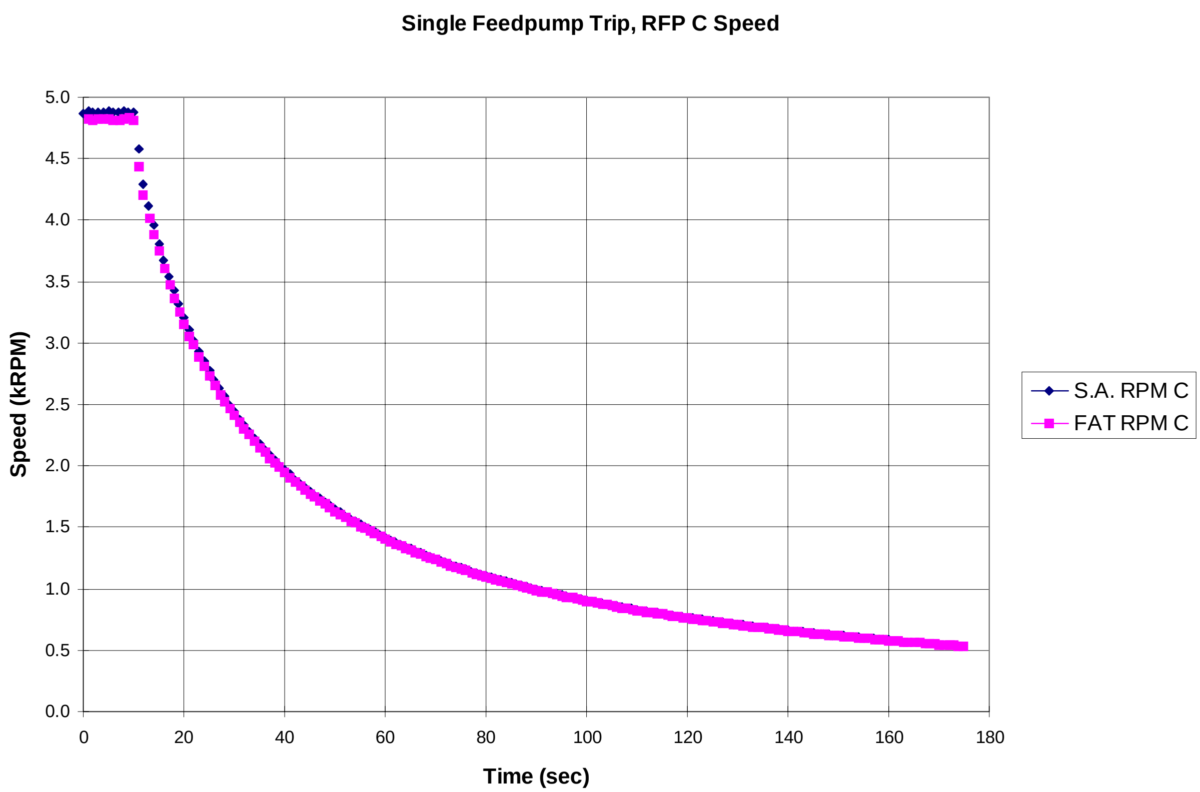

Figure 4-4 Single RFP Trip, RFP C Speed

Figure 4-5 shows the pressure transient following the RFP trip.

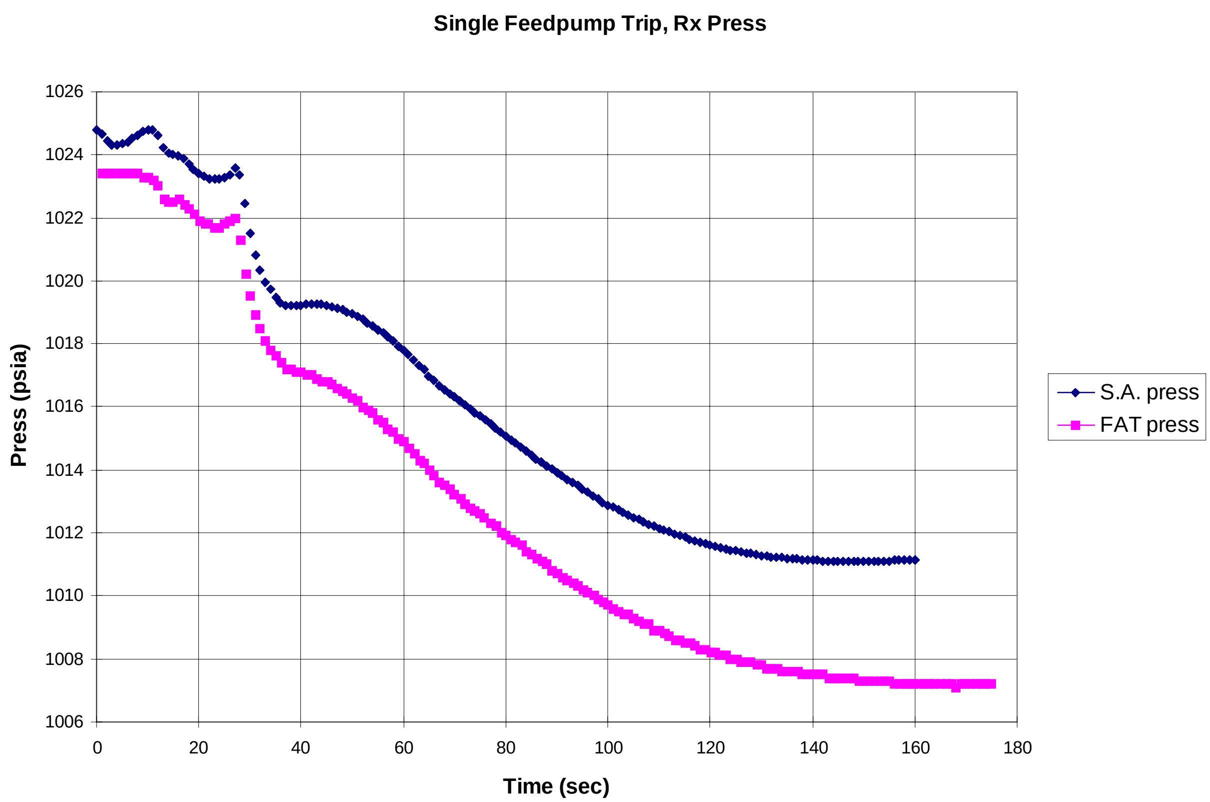

Figure 4-5 Single RFP Trip, Reactor Pressure

Figure 4-6 shows the total feed flow during the transients. As previously discussed, the higher operating feed pump speeds during the transient in the stand alone model result in higher feed flows.

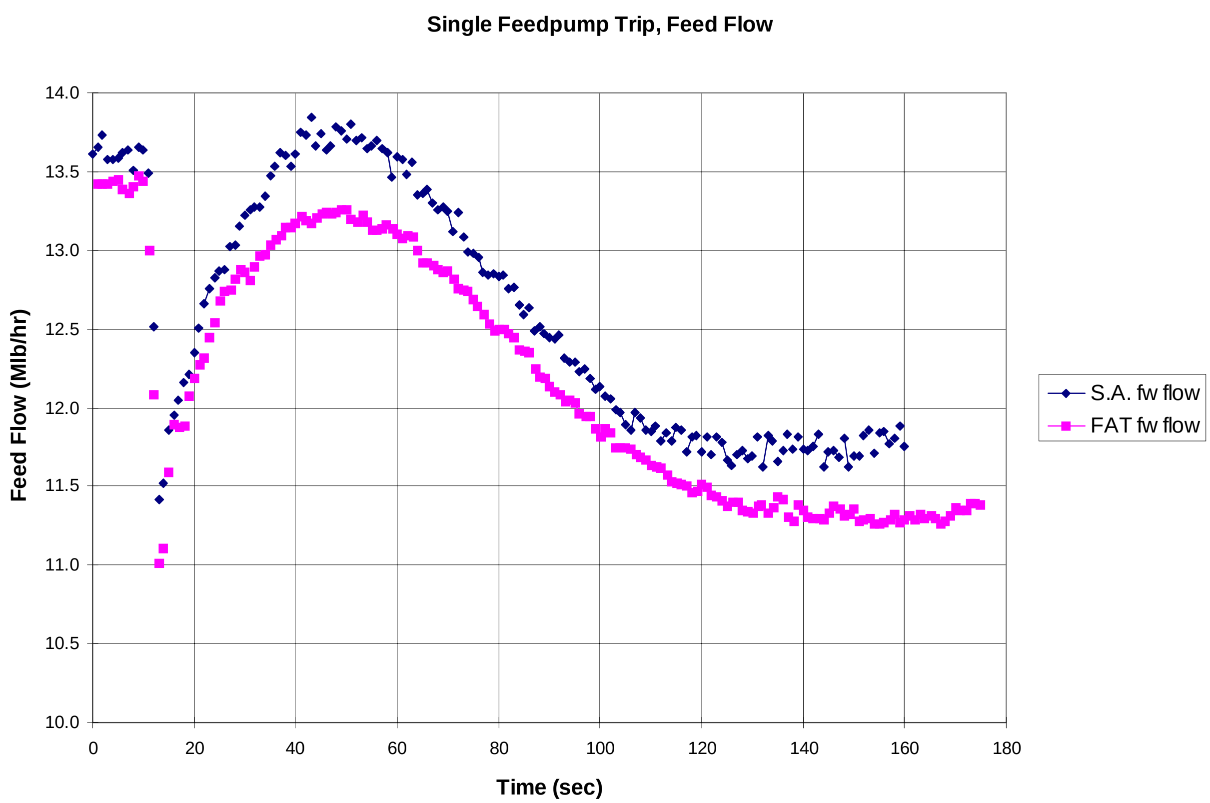

Figure 4-6 Single RFP Trip, Total Feedwater Flow

Figures 4-7 to 4-11 show the Feedwater Heater levels for the A train during the transient. There was no benchmark transients to compare this data to, so only the stand alone data is presented.

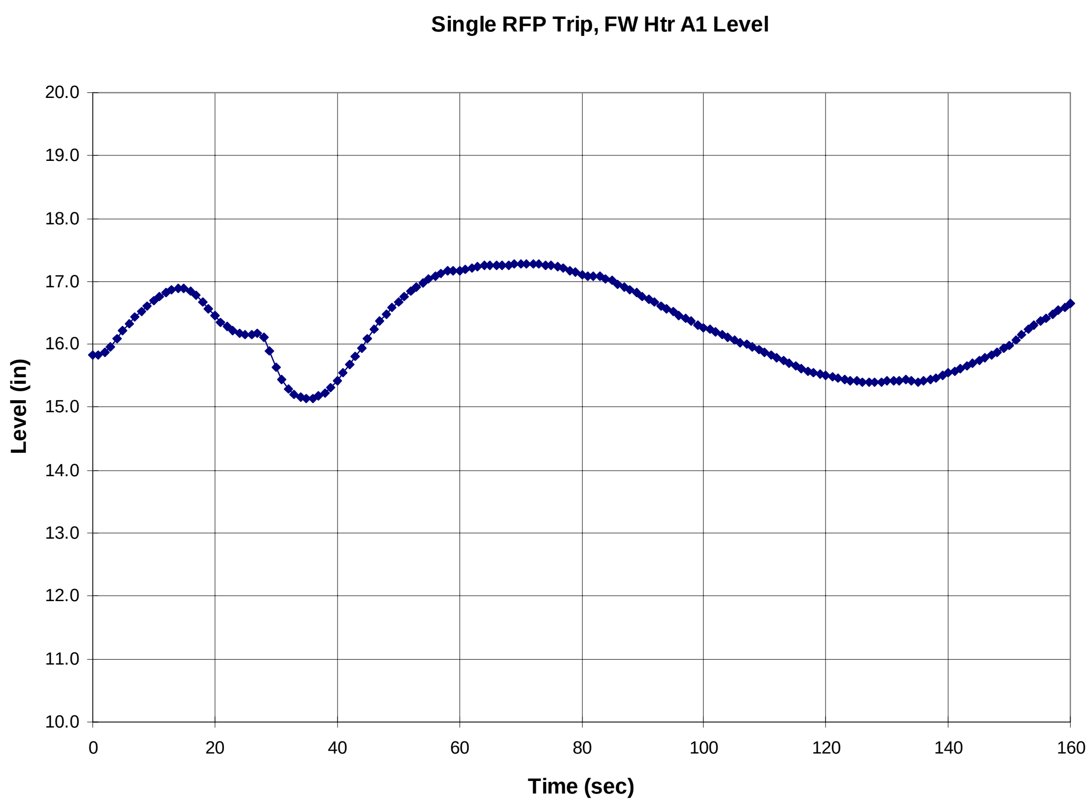

Figure 4-7 Single RFP Trip, Feed Heater A1

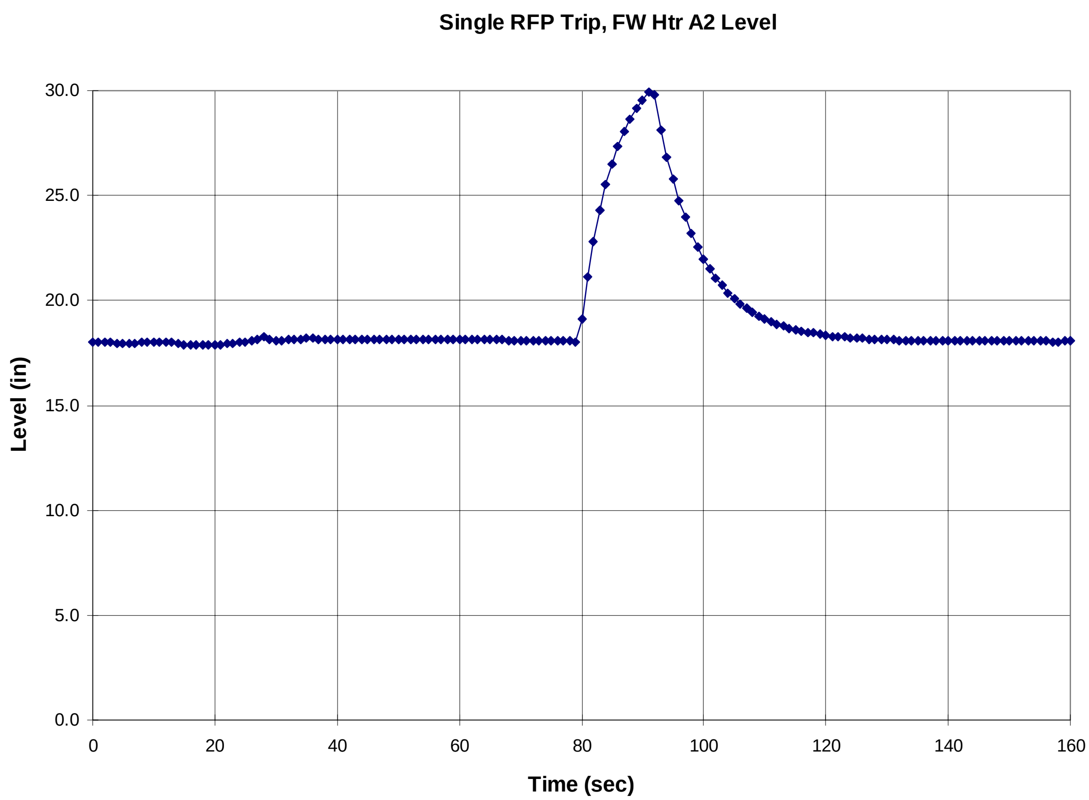

Figure 4-8 Single RFP Trip, Feed Heater A2

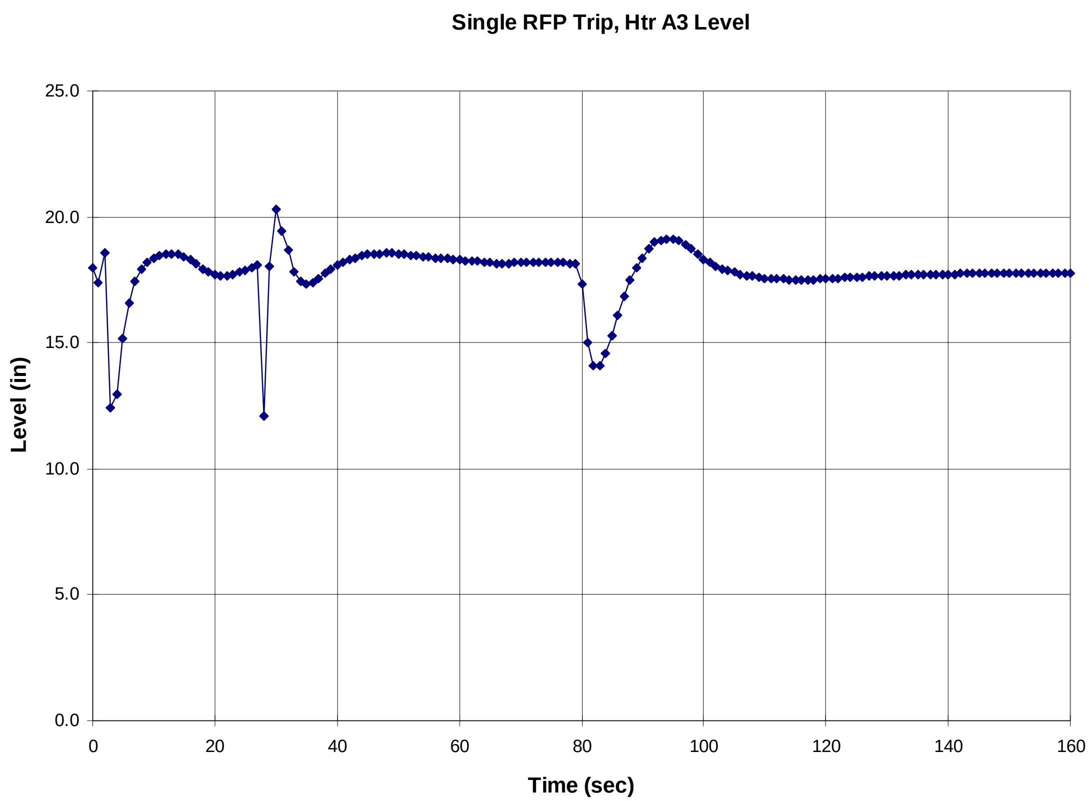

Figure 4-9 Single RFP Trip, Feed Heater A3

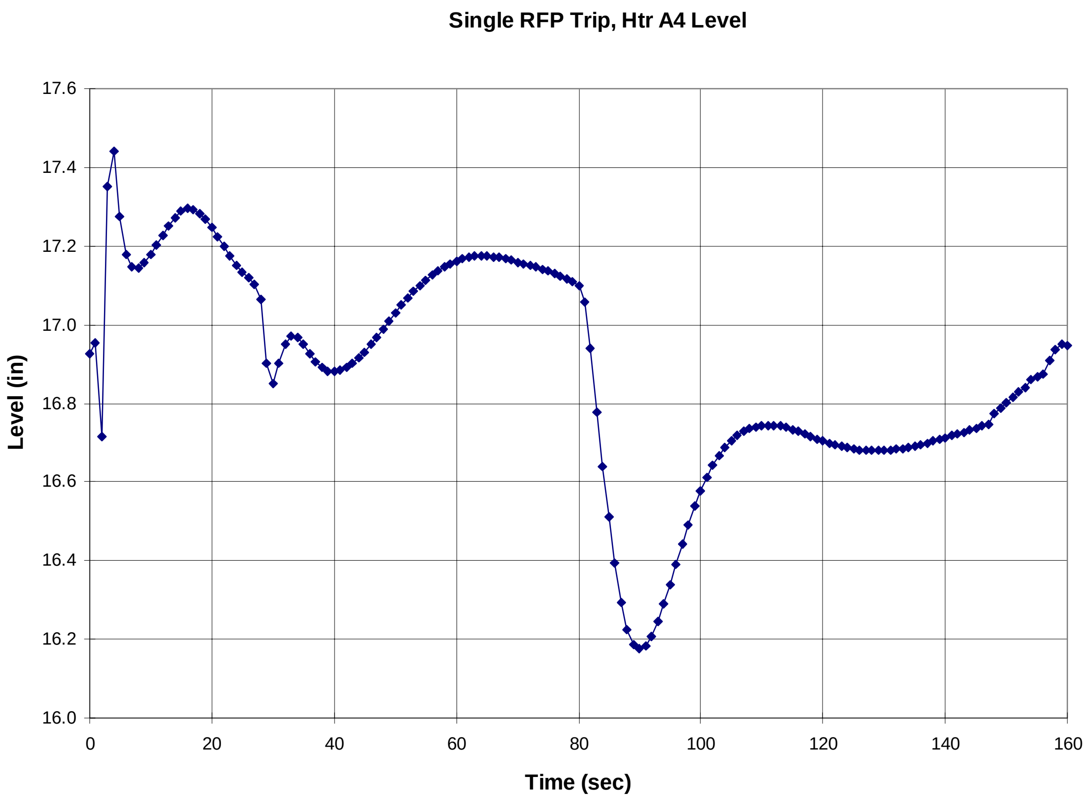

Figure 4-10 Single RFP Trip, Feed Heater A4

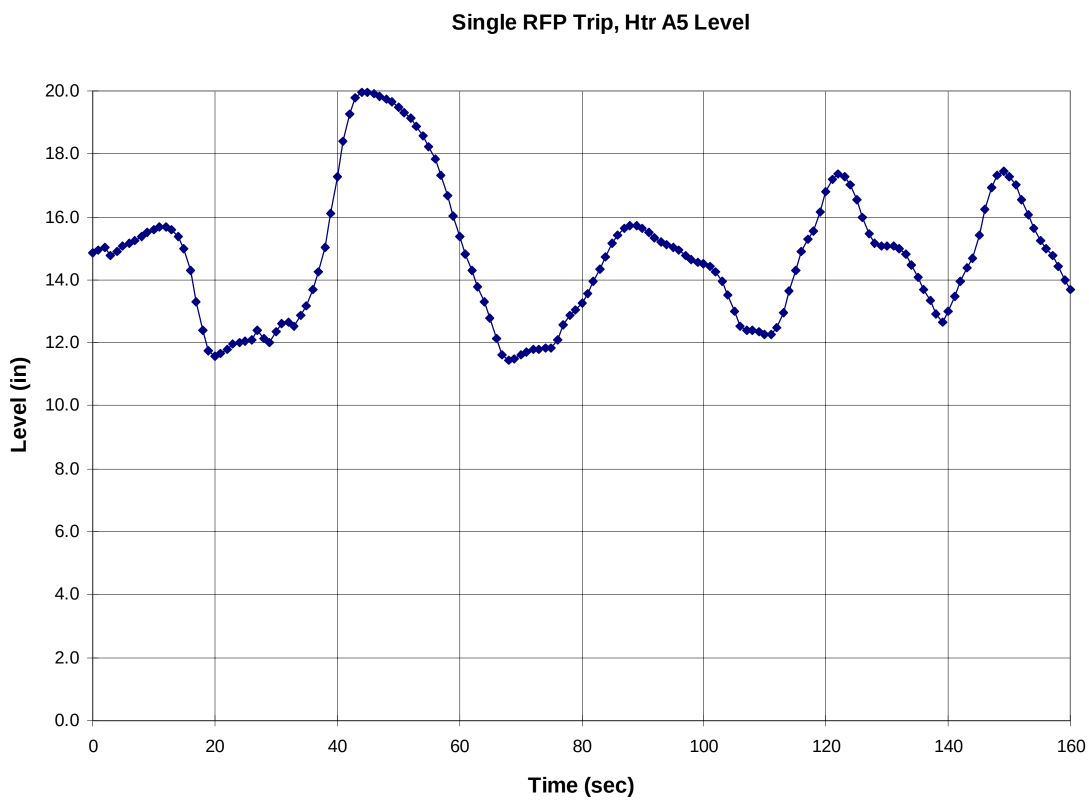

Figure 4-11 Single RFP Trip, Feed Heater A5 Level

The largest level transient is in the A3 heater (and B3 heater) due to the heater having only a drain valve and no bypass valve.

Dual Reactor Recirculation Pump Runback

The following transient was a dual Reactor Recirculation Pump (RRP) runback from 100% power. Data from the stand alone model is again compared to data from the FAT.

Figure 4-12 shows the vessel level response to the transient. The secondary level peak above the 33 inch setpoint in the FAT transient was higher and lasted longer than the same transient from the stand alone model. This is again due to the faster response of the feedpumps in the stand alone model with the larger controller output range.

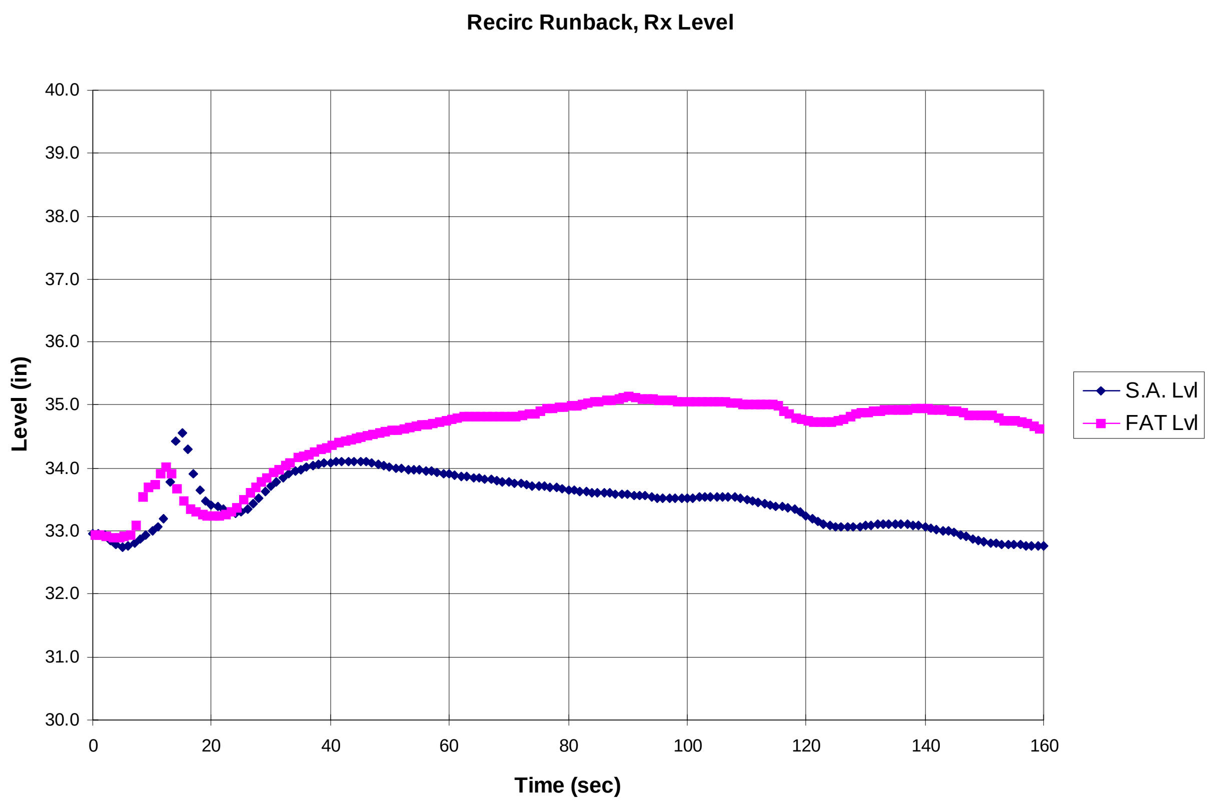

Figure 4-12 Dual RRP Runback, Reactor Level

Figure 4-13 shows the RFP A speed response. The stand alone speed starts out higher, and stays higher by about the same margin throughout the transient.

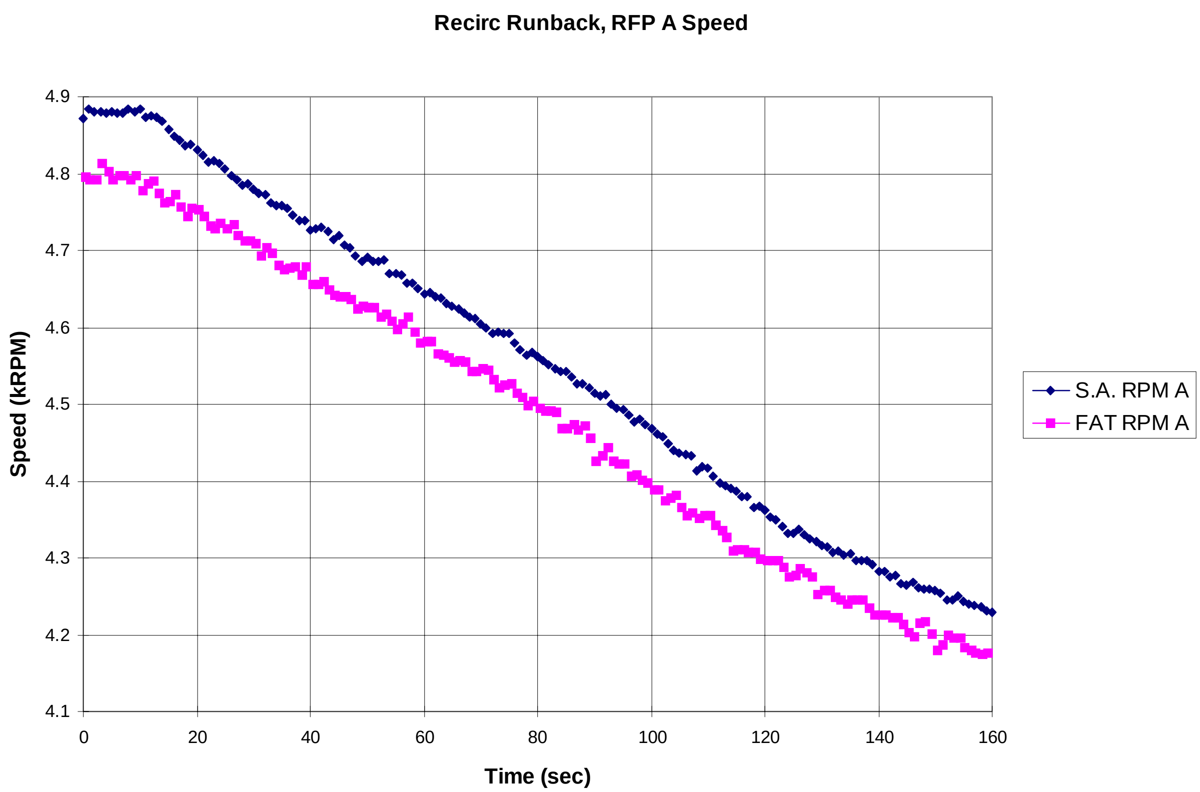

Figure 4-13 Dual RRP Runback, RFP A Speed

Figure 4-14 shows the total feed flows observed during this transient.

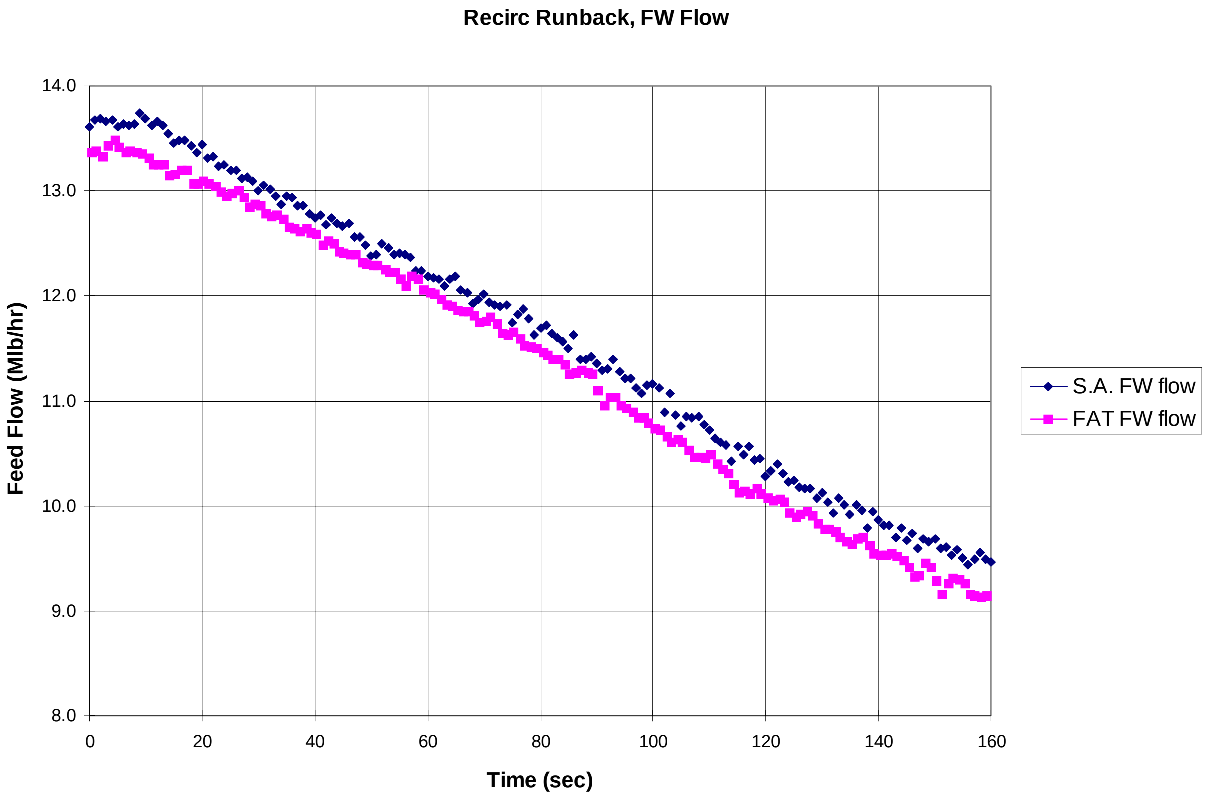

Figure 4-14 Dual RRP Runback, Total Feedwater Flow

Figure 4-15 shows reactor pressure during the transient. Again, good agreement was obtained, with the stand alone version having a slightly higher pressure due to operating at a slightly higher power level.

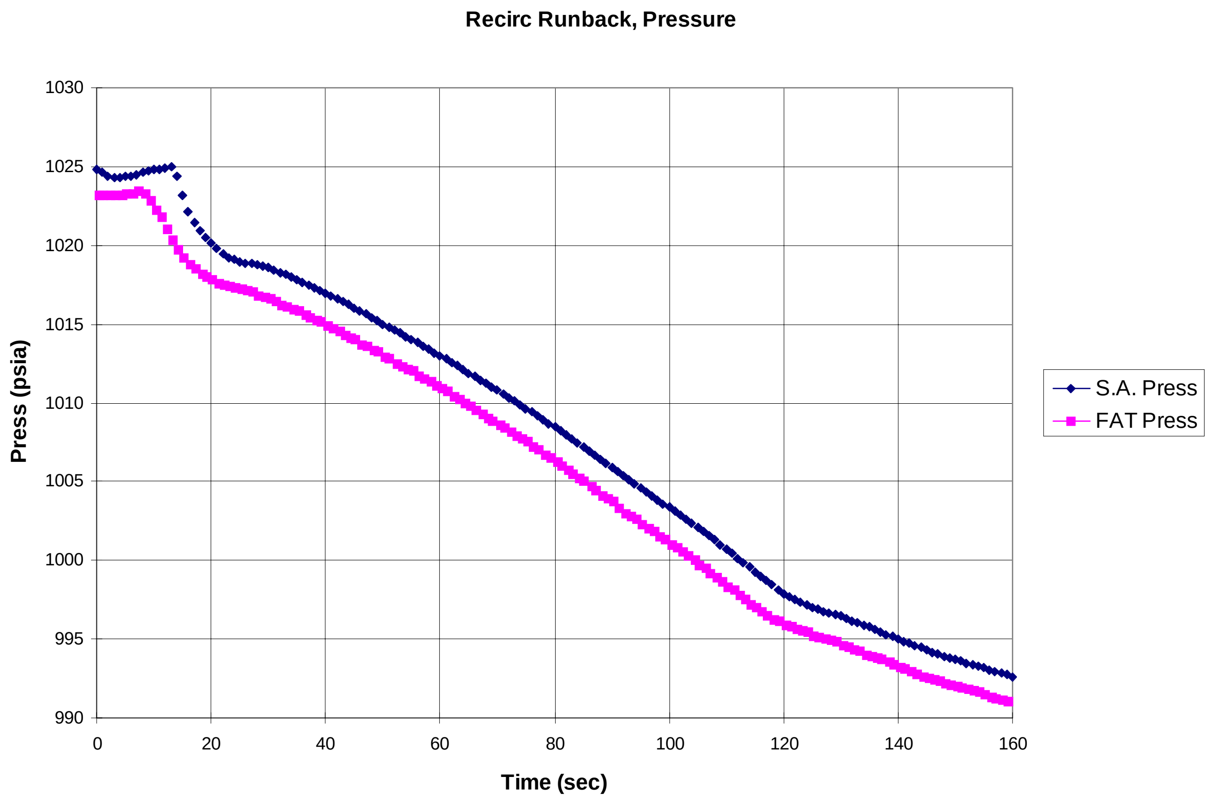

Figure 4-15 Dual RRP Runback, Reactor Pressure

Figures 4-16 to 4-20 show the feedwater heater level responses to the transient. Again, only the stand alone results are presented.

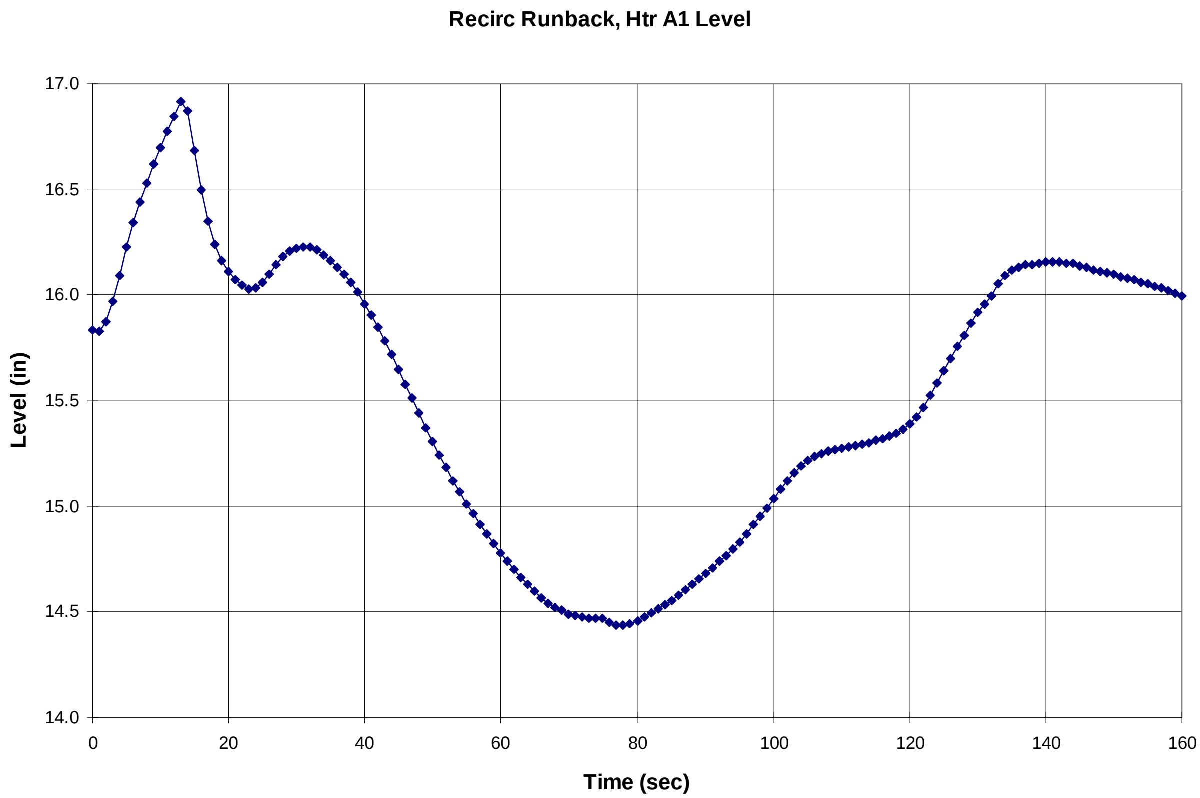

Figure 4-16 Dual RRP Runback, FW Heater A1 Level

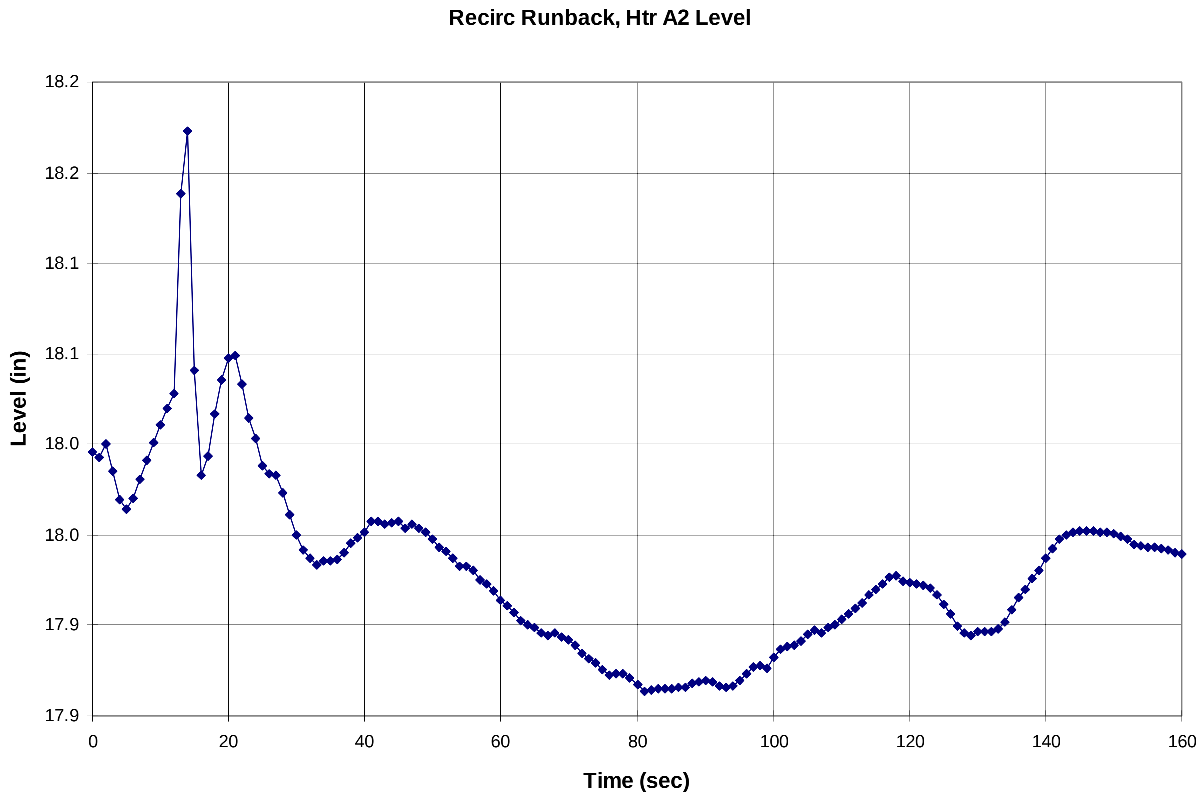

Figure 4-17 Dual RRP Runback, FW Heater A2 Level

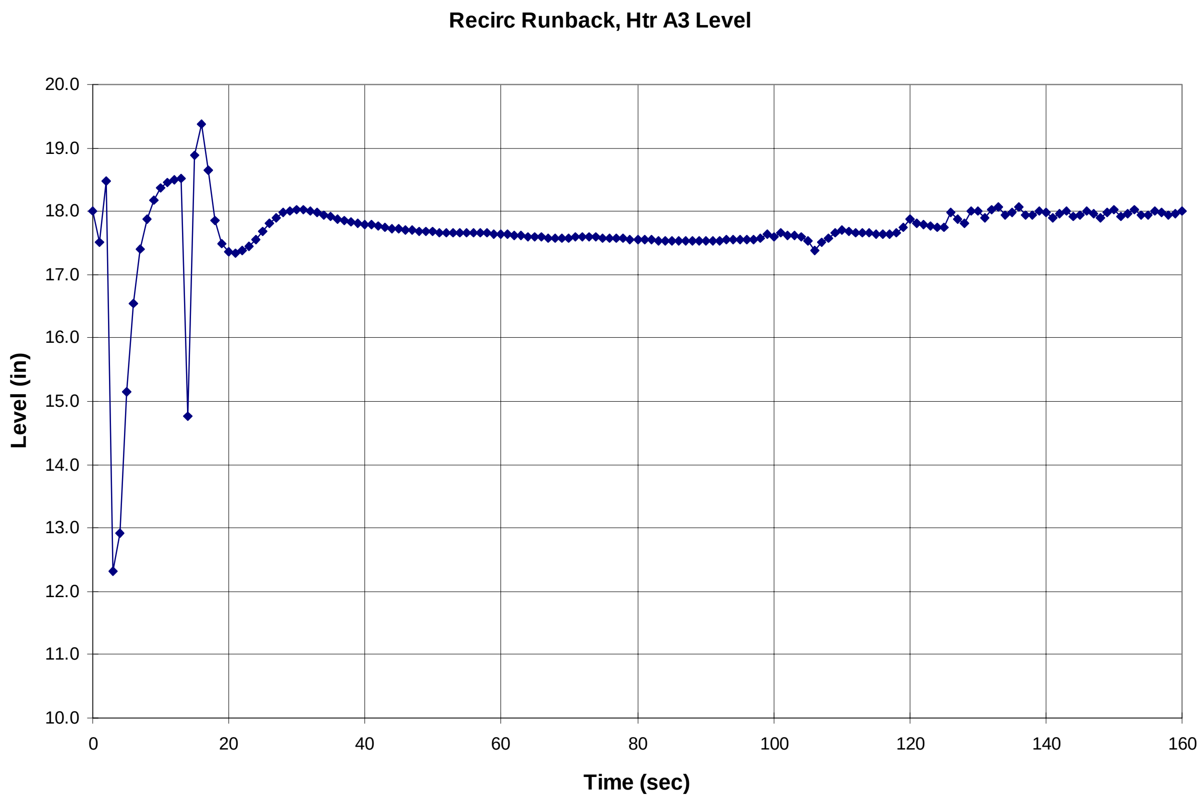

Figure 4-18 Dual RRP Runback, FW Heater A3 Level

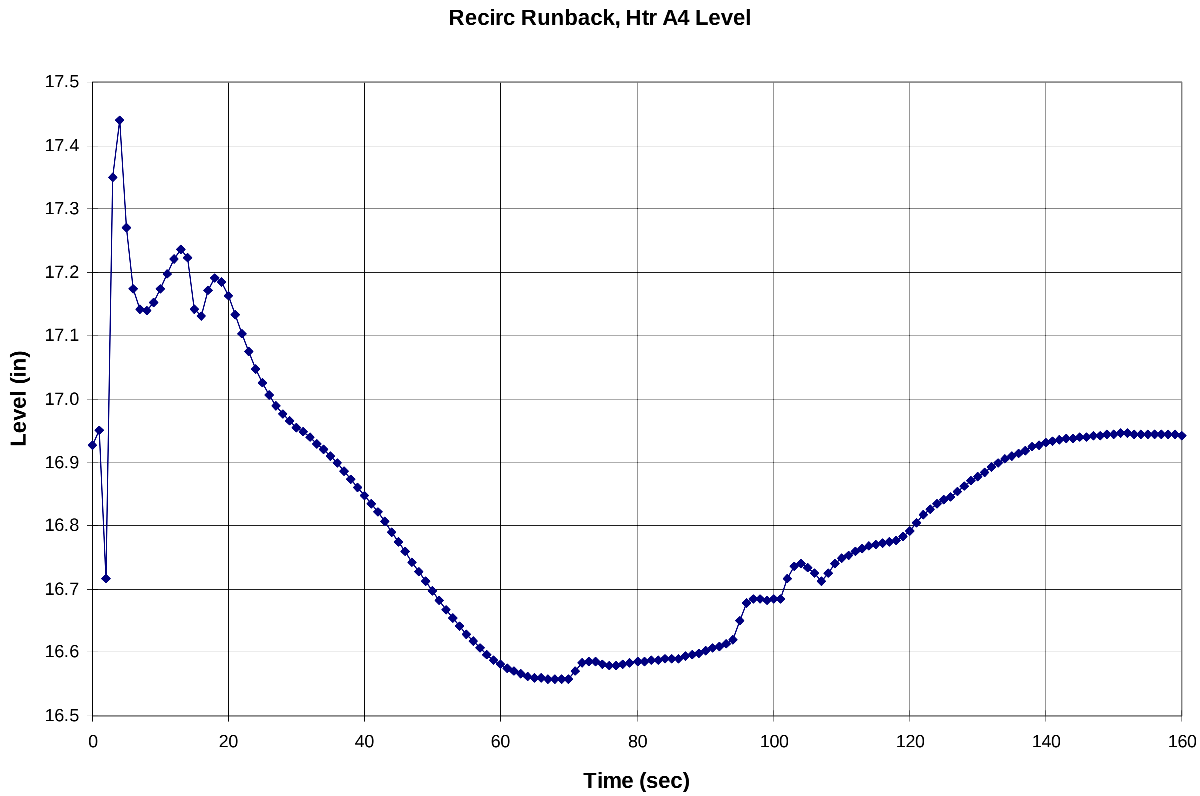

Figure 4-19 Dual RRP Runback, FW Heater A4 Level

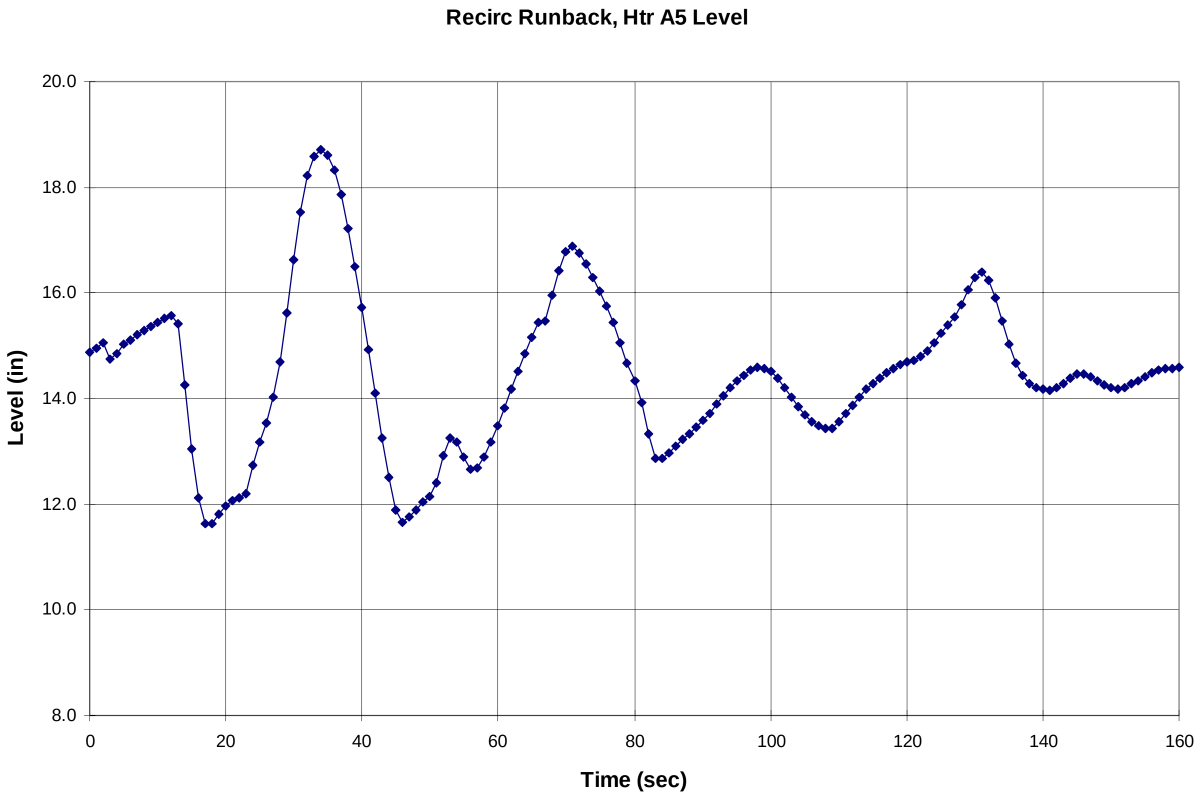

Figure 4-20 Dual RRP Runback, FW Heater A5 Level

Single Recirculation Pump Trip

A single Reactor Recirculation Pump (RRP) trip was also run for both the dynamic FAT and the stand alone model. Again, both trips began at 10 seconds.

The reactor level response is shown in Figure 4-21. Note that the secondary level peak in the FAT run was actually larger than the primary level peak. This discrepancy in the FAT results remains unexplained, and the stand alone model's run may be more believable. Also, note that the initial peaks agree very well.

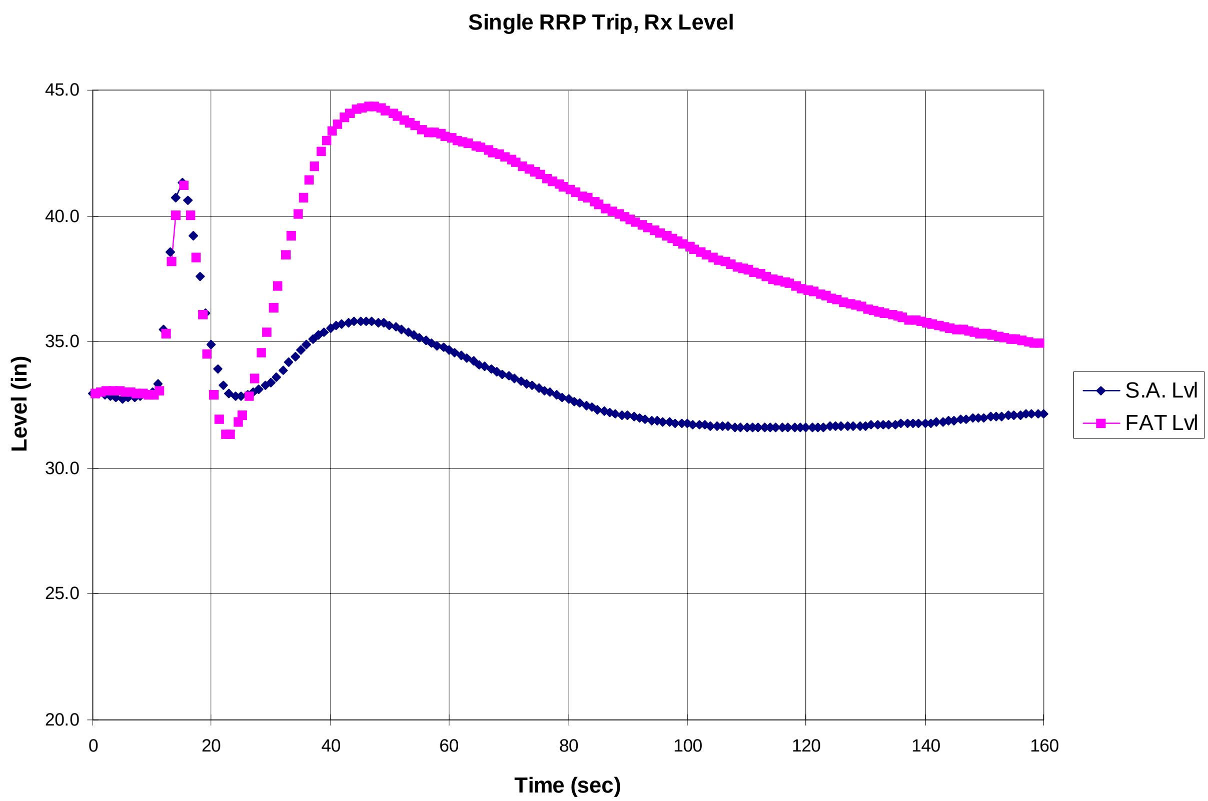

Figure 4-21 Single RRP Trip, Reactor Level

Figure 4-22 shows the response of total feedwater flow to the trip. The FAT results show a faster decrease due to level swell, followed by a sudden, marked increase with a very small level error. This leads to a level overshoot greater in magnitude than the original level swell. This also remains unexplained. The stand alone results seem to be more reasonable.

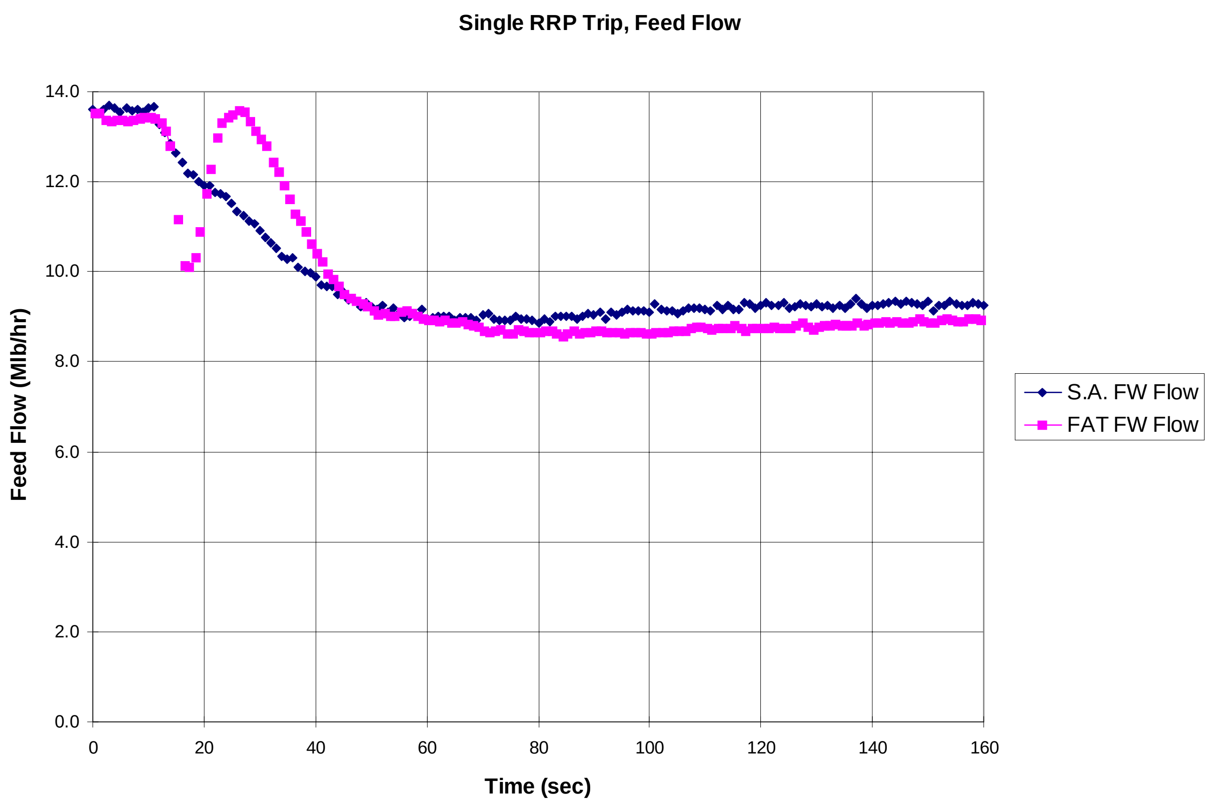

Figure 4-22 Single RRP Trip, Total Feedwater Flow

The pressure response is shown in Figure 4-23.

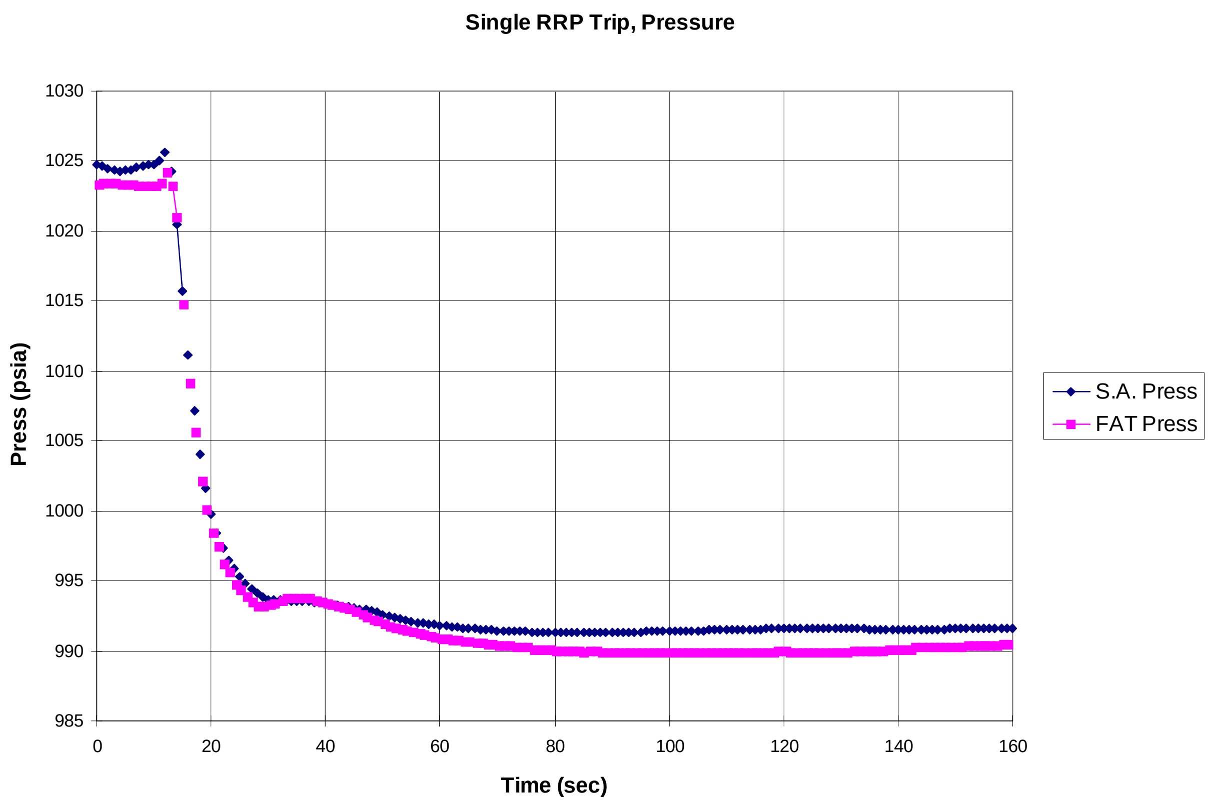

Figure 4-23 Single RRP Trip, Reactor Pressure

The responses of RFP speed (Figure 4-24) show the same results as discussed for the total feedwater flow.

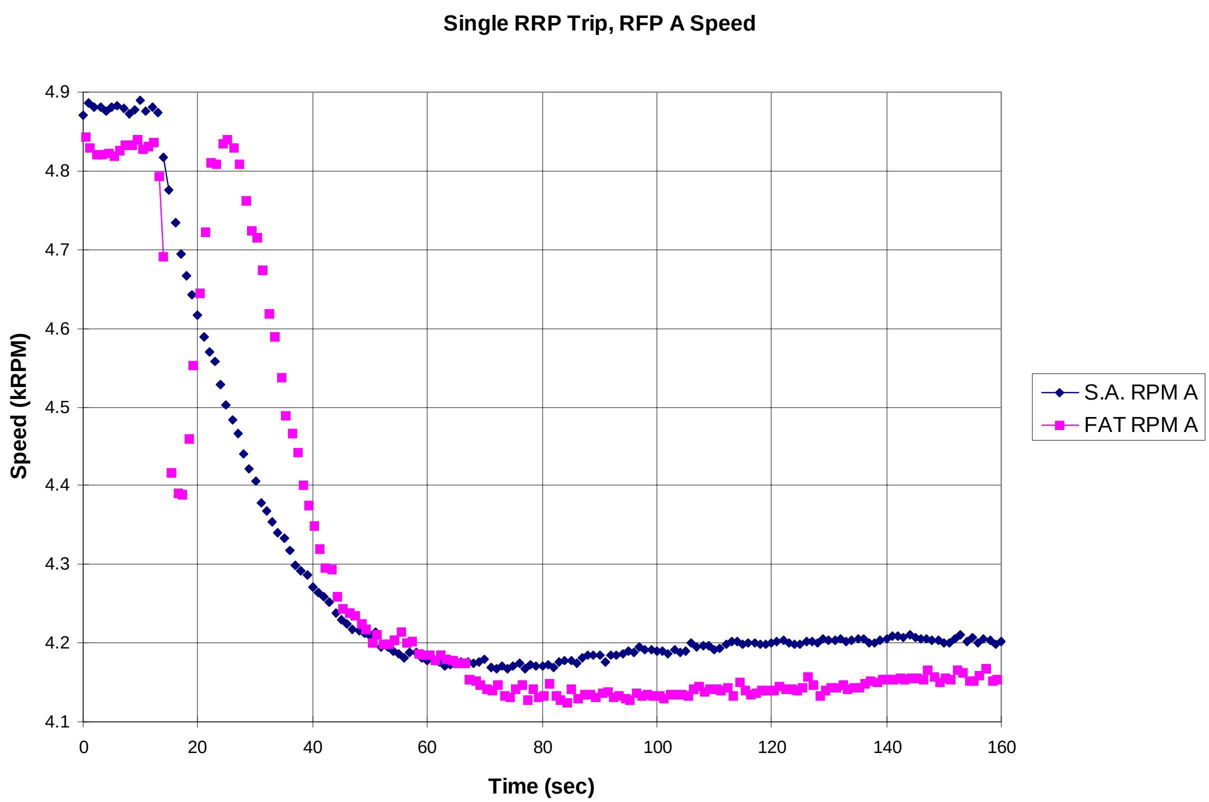

Figure 4-24 Single RRP Trip, RFP A Speed

Figures 4-25 to 4-29 show the transient responses of the feedwater heater levels in the stand alone model.

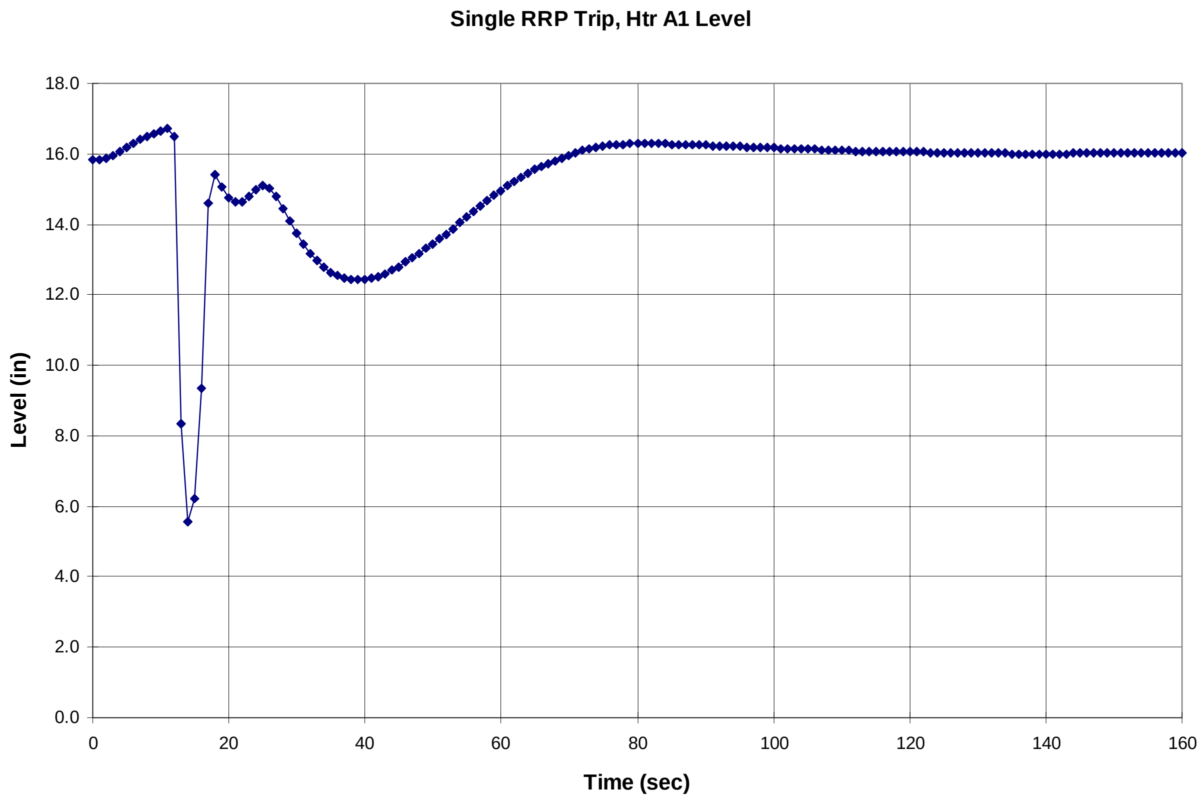

Figure 4-25 Single RRP Trip, FW Heater A1 Level

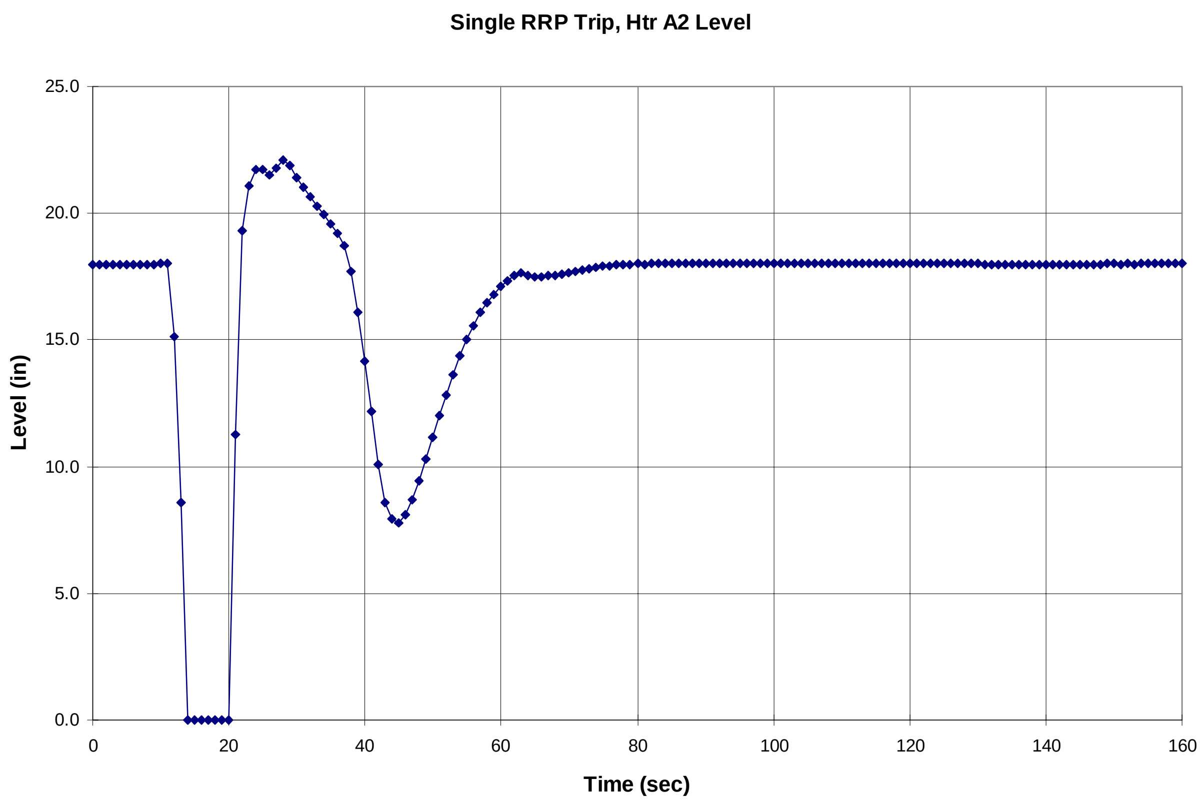

Figure 4-26 Single RRP Trip, FW Heater A2 Level

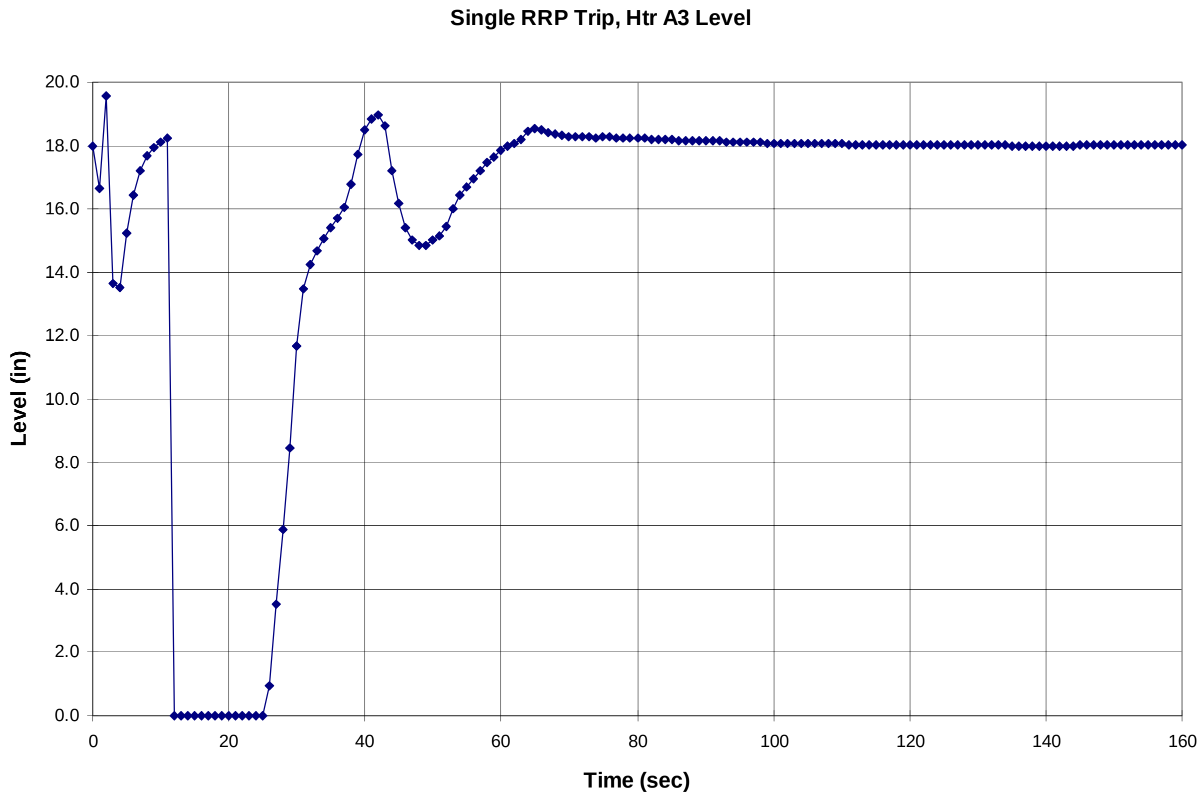

Figure 4-27 Single RRP Trip, FW Heater A3 Level

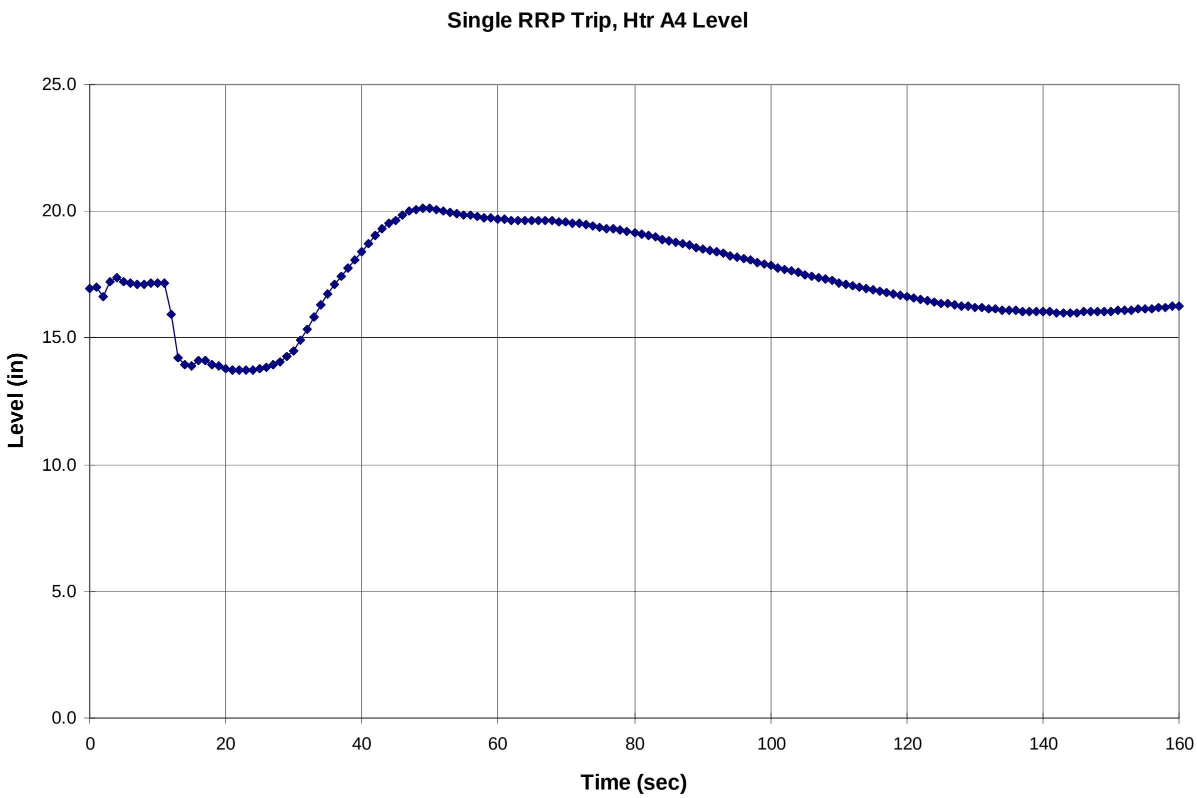

Figure 4-28 Single RRP Trip, FW Heater A4 Level

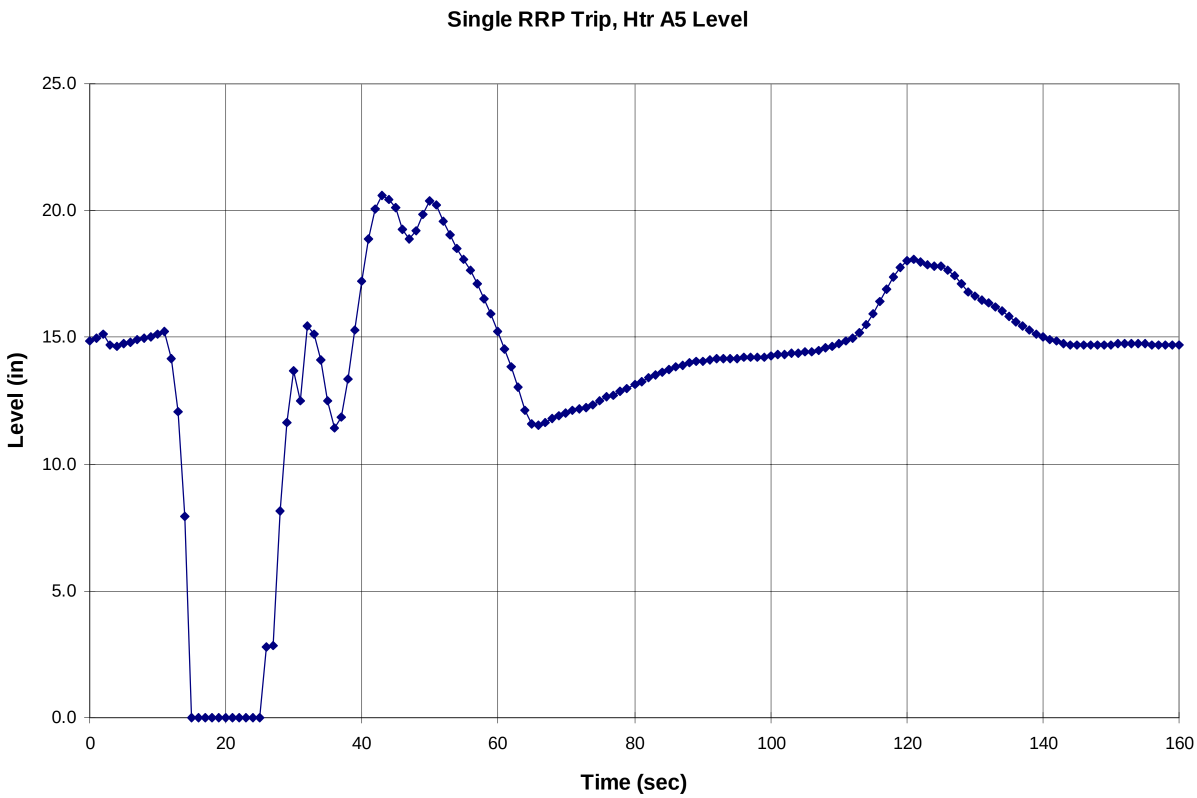

Figure 4-29 Single RRP Trip, FW Heater A5 Level

Single Condensate Booster Pump Trip

Figures 4-30 to 4-33 represent the FAT and stand alone model response to a single Condensate Booster Pump (CBP) trip. In both transients, CBP A was tripped off at 10 seconds problem time. Again, the stand alone model exhibits more responsiveness, probably due to the increased output range of the Foxboro I/A controller.

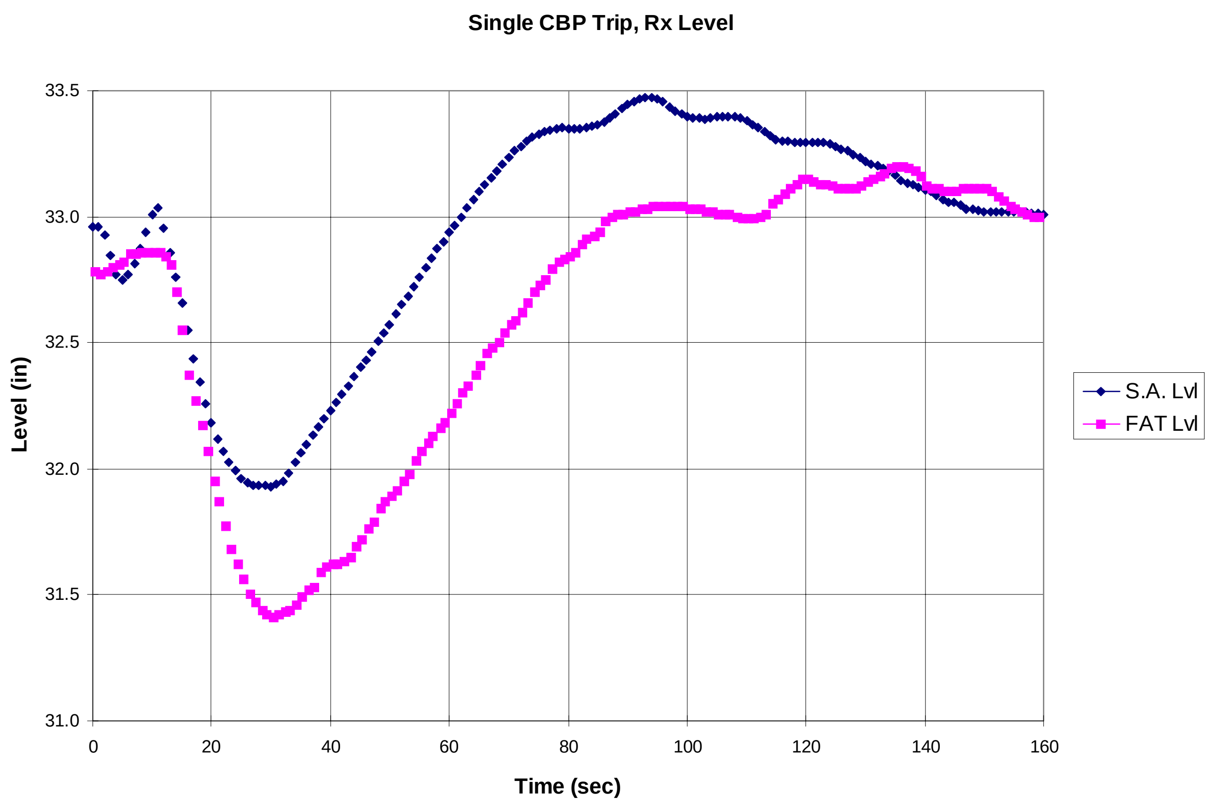

Figure 4-30 Single CBP Trip, Reactor Level

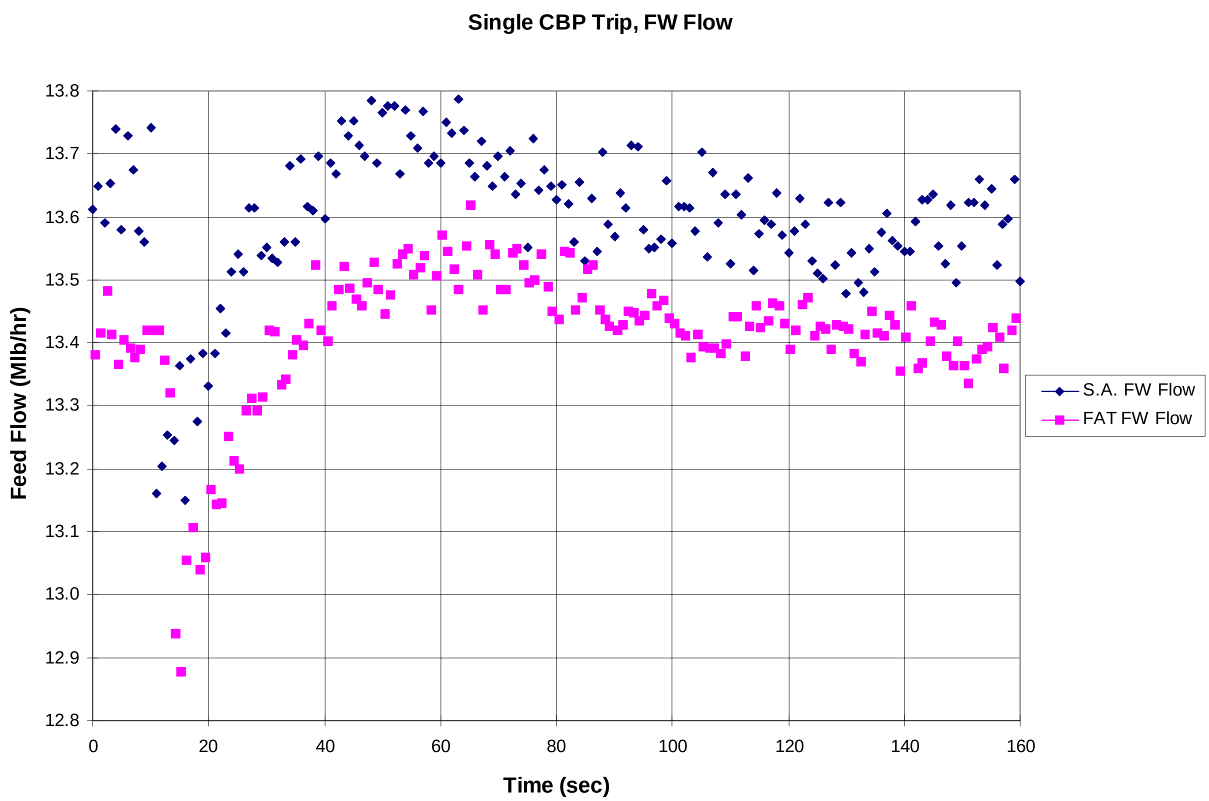

Figure 4-31 Single CBP Trip, Total Feedwater Flow

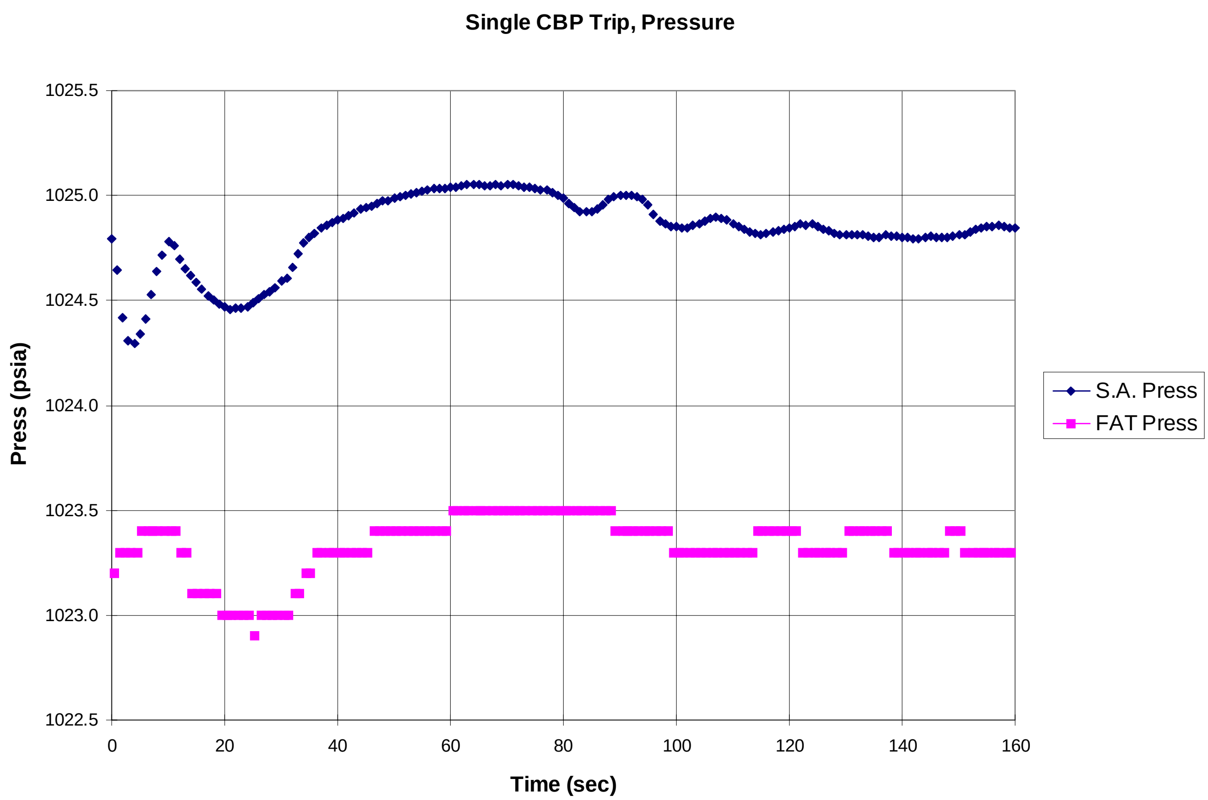

Figure 4-32 Single CBP Trip, Reactor Pressure

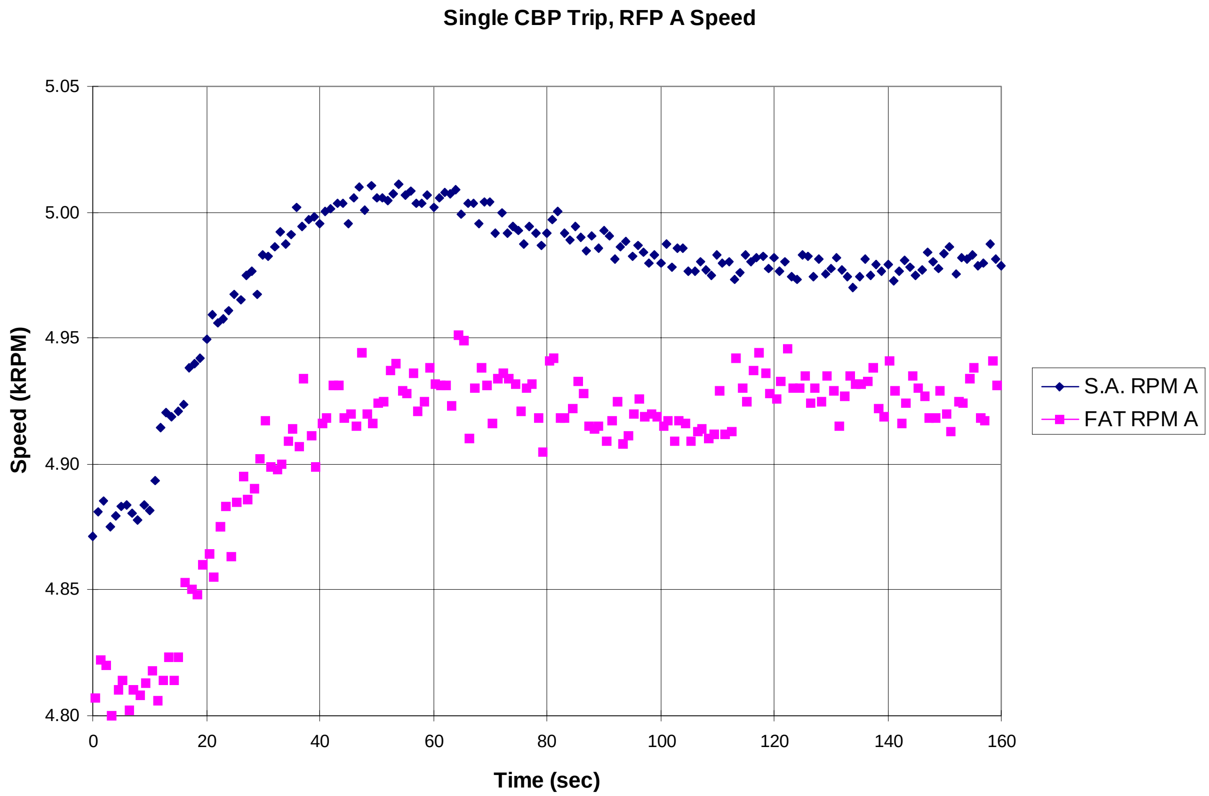

Figure 4-33 Single CBP Trip, RFP A Speed

There was very little change in feedwater heater level, so they are not plotted in this report

5

TRANSIENTS AND FAILURE ANALYSIS

After completion of the benchmark transients, the model was subjected to a series of transients designed to determine possible improvements to the control system and the effects of changes in model parameters. For instance, the effects of response times of the level instruments in the heaters was examined.

Effect of Heater Level Instrument Time Constants

In this transient, the effect of the level instrument time constants was examined. First, a change in heater level setpoint was made in the baseline model. All heater level instruments were assumed to have a time constant of 0.05 second in the baseline model. Then, the heater level instruments' time constants were changed to 0.1 second, and the level setpoint change was run again. The results were then compared.

As shown in the figure below, there was very little effect on doubling the lag time constant for the simulated level instrument for Feedwater Heater A1. In both cases, at approximately 10 seconds, the level setpoint was changed from 16 to 13 inches. At about 160 seconds, the level setpoint was returned to 16 inches. A slight increase in overshoot was observed in the long lag time run.

The level instrument with a lag time constant of 0.05 second is labeled as "fast lvl" in the figure; the run using a lag time constant of 0.1 second is labeled as "slow lvl".

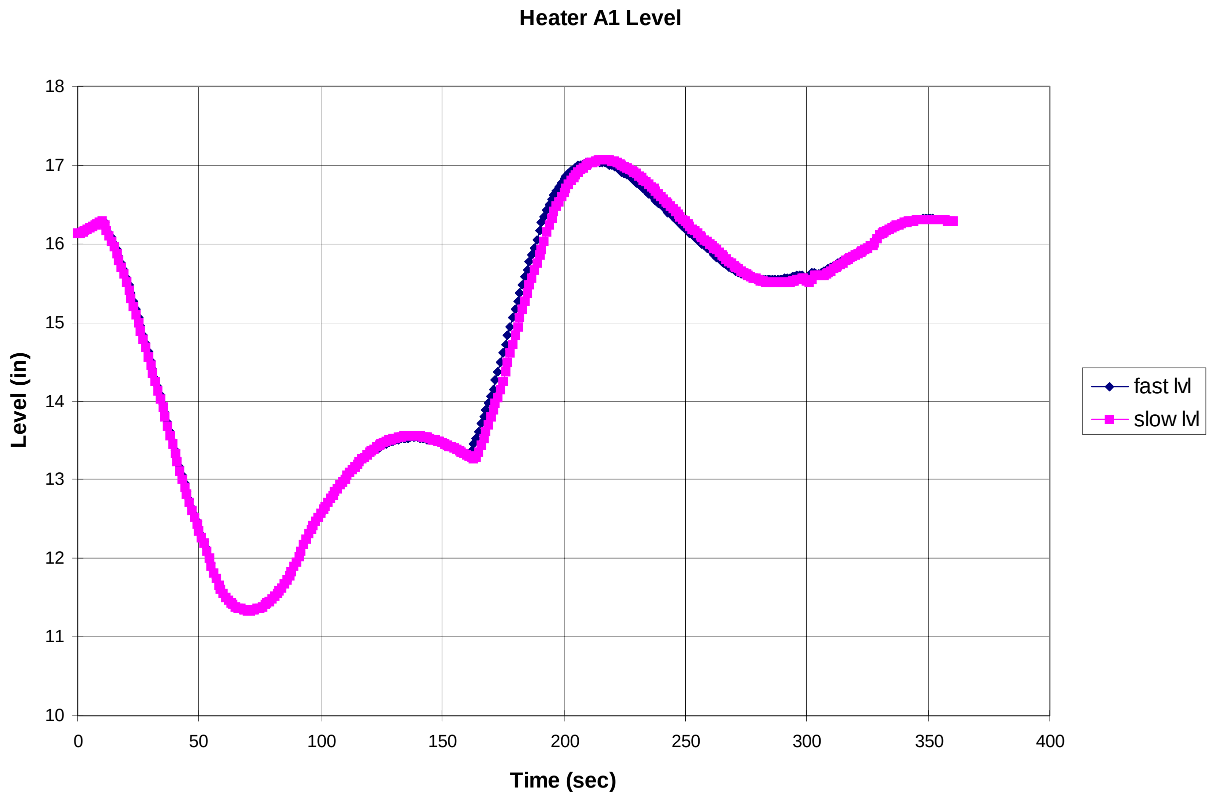

Figure 5-1 A1 Feedwater Heater Level for Setpoint Changes

Effect of Heater Drain and Bypass Valve Time Constants

In this transient, both the level instrument and the heater valve time constants were doubled from 0.05 to 0.1 second. The responses to level setpoint changes were then compared.

The figure below shows the effect of doubling both the heater valve and level instrument time constants on level upsets. In both cases, at approximately 10 seconds, the level setpoint was changed from 16 to 13 inches. At about 160 seconds, the level setpoint was returned to 16 inches. A slight increase in overshoot was observed in the run with longer lag times.

The level instrument with a lag time constant of 0.05 second is labeled as "fast lvl" in the figure; the run using a lag time constant of 0.1 second is labeled as "slow lvl".

These results show that as long as the instrument and valve response time constants are small compared with the sample time (in this case, controller update times were 0.5 second), they have very little effect. Very similar results were observed with valve lag time constants equal to 0.2 second. If the instrument time constants become larger than the sample time, a much larger effect would be observed.

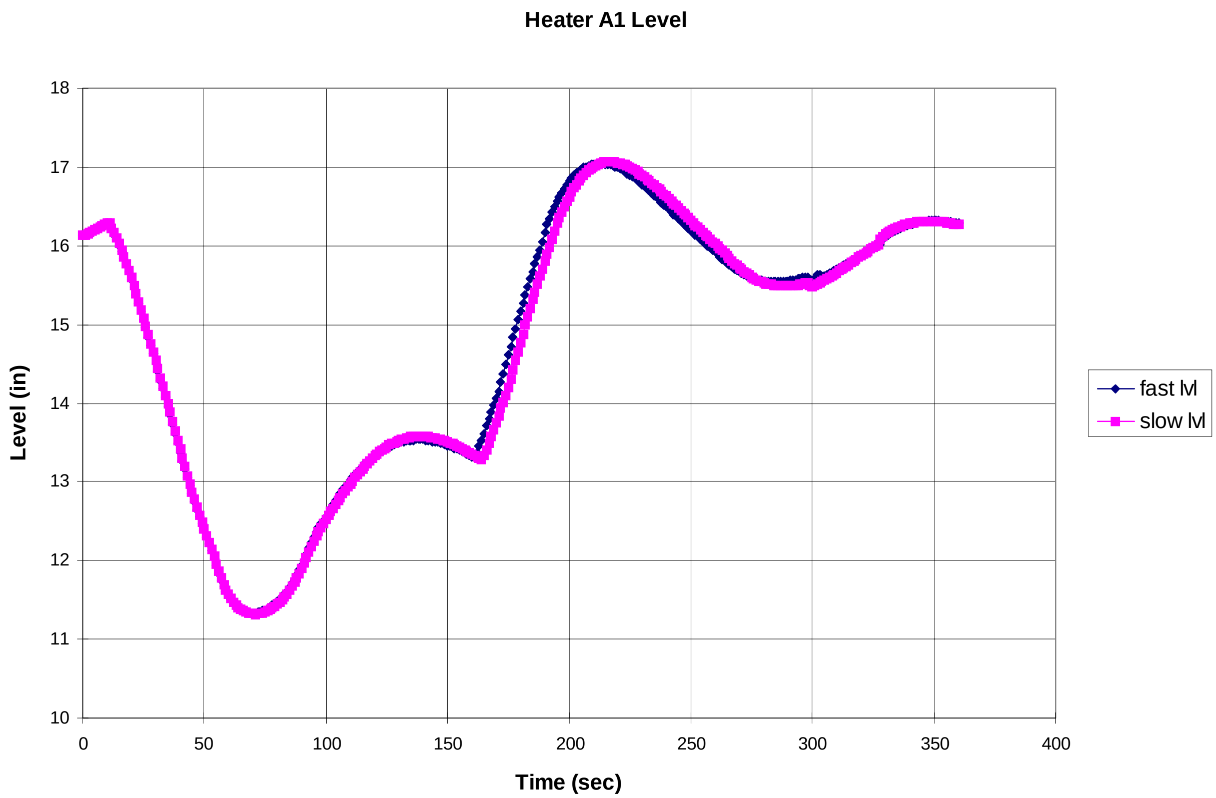

Figure 5-2. A1 Feedwater Heater Level for Setpoint Changes

Effect of Inadvertently Placing Level Controllers in Manual

In this case, placing a heater 3 level controller in manual and leaving it in this position was simulated. A single feedpump trip in another train was then simulated to determine the effects both on heater levels and the overall plant response. These results were then compared with the single RFP trip results from Section 4.

In order to test this effect, the A3 heater controller was placed in manual during steady state operations at 100% power. Level in the A3 heater was steady at 18 inches. This simulated placing a controller in manual at the last good automatic output, followed by a feedwater pump trip. At 10 seconds, the A3 controller was placed in manual by placing its MAN/AUTO button in MAN. The output was maintained at the last automatic value, freezing the A3 drain valve. The B RFP was then immediately tripped. The transient was allowed to proceed without interference from there. Figure 5-3 shows the results for reactor level.

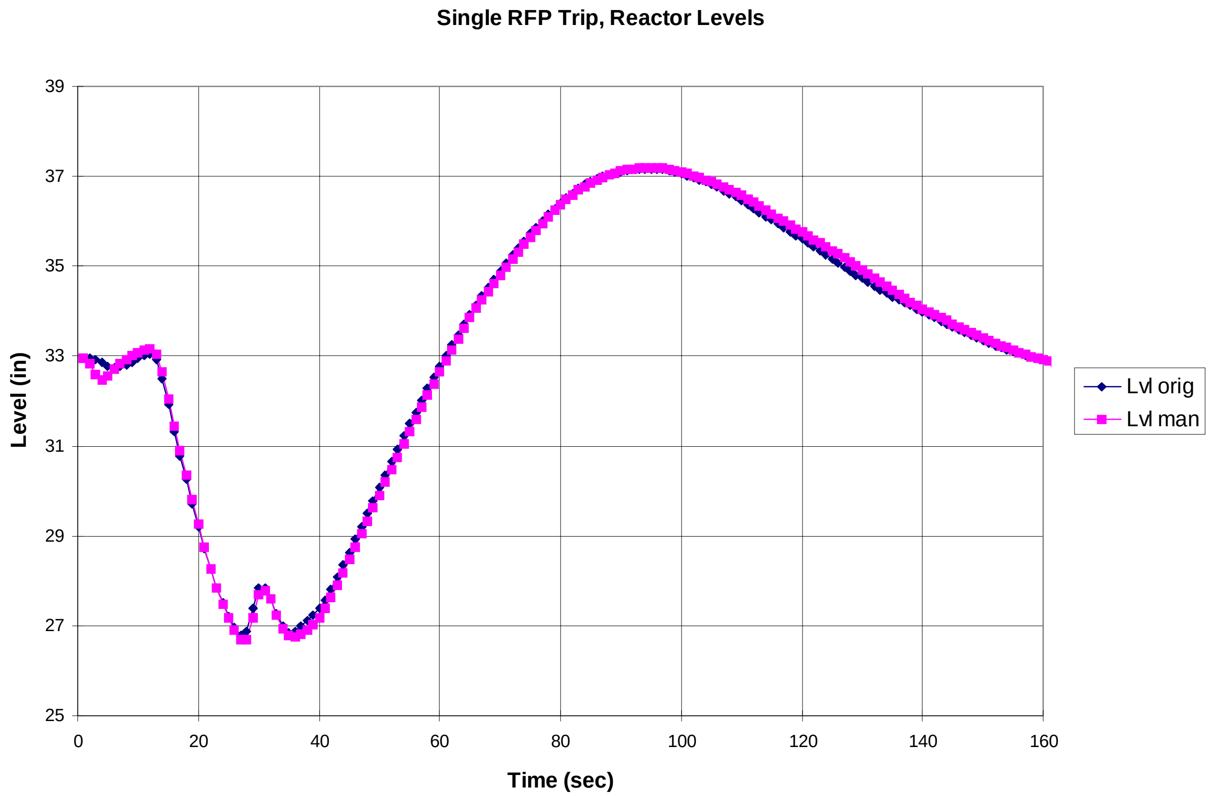

Figure 5-3 Single RFP Trip, Reactor Level Transients

As the figure shows, there is very little effect on reactor level. In fact, there was little effect on any plant parameters other than feedwater heater levels. The A3 heater emptied within 78 seconds of pump trip, as shown in Figure 5-4. Again, the feedpump trip took place at 10 seconds.

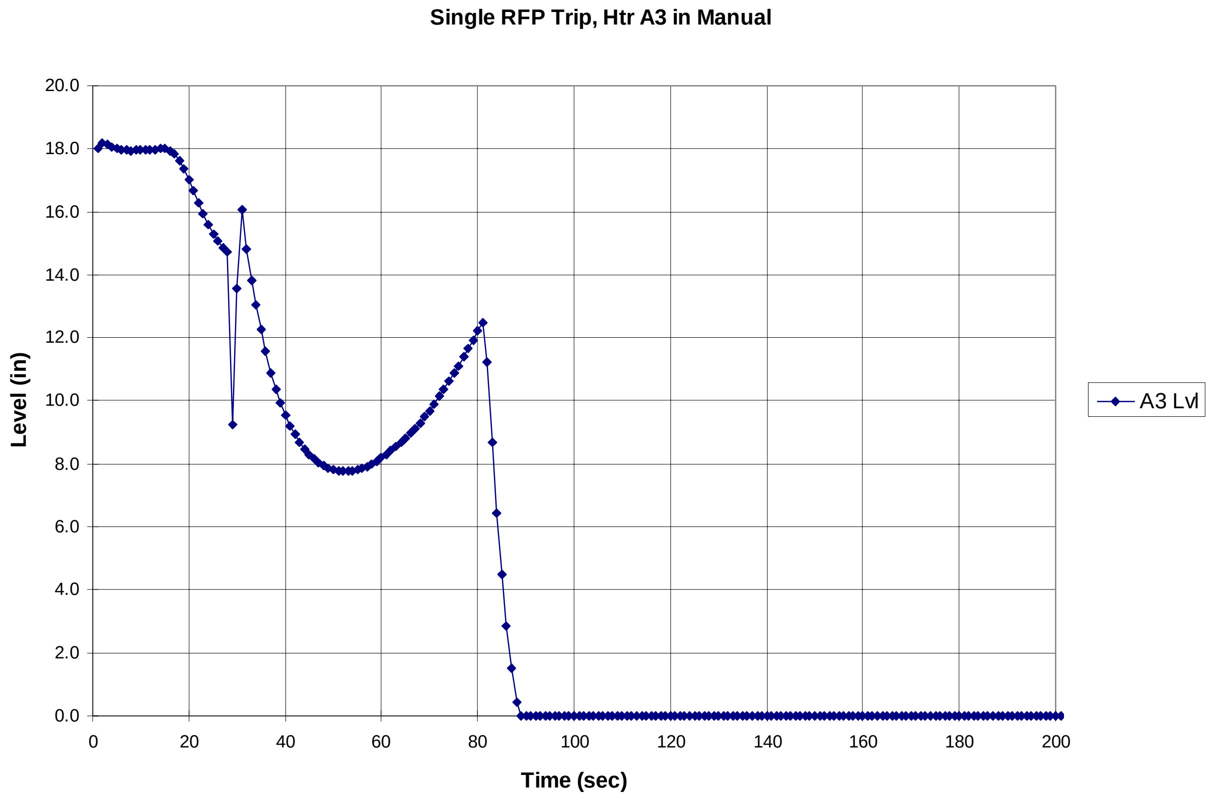

Figure 5-4 Single RFP Trip, Htr A3 Level, Drain in Manual

It should be noted that TVA has used level switches in the past to isolate a train of heaters on high level in a heater. At present, these switches have not been re-connected in the new control system. If used, placing a controller in manual and inadvertently leaving it there prior to a transient which causes heater level to increase could lead to isolation of a feed train. This would increase the difficulty of recovering from the transient.

Effect of Power Level

A setpoint change for heater A1 from 16 to 13 inches was performed at 100% power and at 50% power. All three trains were in operation at both power levels. Once level steadied out, the setpoint was once again changed to 16 inches.

Response of A1 heater level to these changes at 100% power are shown in Figure 5-1 above. Response time is defined as the time from setpoint change to level reaching 10% of the difference between initial and setpoint levels. Rise time is defined as the time level reaches 10% to 90%. Overshoot is the distance level overshoots the new setpoint. At 100% power, for a setpoint change from 16 to 13 inches, rise time is about 6 seconds;

this represents the time from setpoint change to level < 15.9 inches, because the transient began with level equal to 16.28 inches. The rise time was about 24 seconds. Overshoot was 1.67 inches to a level of 11.33 inches. The secondary overshoot was 0.54 inches at 13.54 inches. This meant that damping was 0.54/3.28 or 0.165; this is better than quarter wave damping which is usually considered acceptable.

On the increase in setpoint transient, the setpoint was changed back to 16 inches at a problem time of 162 seconds and a level of 13.30 inches. The "response time" was based on an increase to 13.57 inches or more. Response time was 2.5 seconds. Rise time up to 15.73 inches was 21 seconds. Overshoot was 1.04 inches, up to 17.04 inches. The secondary valley was 15.54 inches, or 0.46 inches below setpoint. This resulted in damping equal to 0.46/2.7 or 0.17.

The same transient was run at 50% power, as shown in Figure 5.5 below.

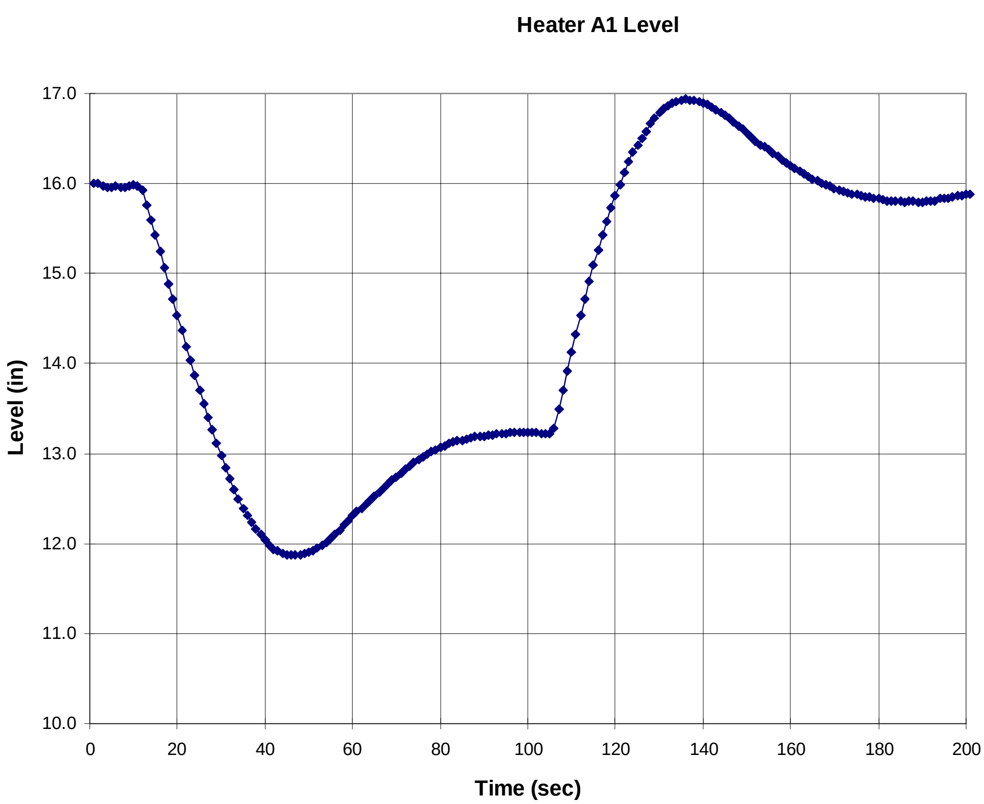

Figure 5-5 Heater A1 Setpoint Changes at 50% Power

When the level setpoint was changed from 16 to 13 inches at 10 seconds problem time, level was equal to 15.98 inches. Response time to a level of 15.68 was 1.5 seconds. Rise time was 15.5 seconds. Overshoot was 1.12 inches. The secondary peak was at a level of 13.23, or 0.23 inch. Damping was therefore 0.23/2.98 or 0.077.

On the subsequent change to a 16 inch setpoint, the transient began at 104 seconds problem time with level equal to 13.21 inches. Response time to 13.49 inches was 2 seconds. Rise time was 12 seconds. Overshoot was 0.93 inch, with a secondary valley at 15.79 inches. The damping was therefore equal to 0.21/2.79 or 0.075.

Obviously, the response to the A1 tuning parameters was much better at 50% power level. Based on this response, the 100% tuning parameters might be changed in order to maximize transient response at 100% power. This would mean setting up different tuning parameters based on power level. Power measurement is available on another Foxboro I/A system controlling vessel level. Interconnection of the two systems via the Foxboro node bus is possible. This would allow use of power or feed flow dependent tuning parameters for heater controllers.

To demonstrate the effect of tuning parameters on overshoot, the gain was increased and reset time was changed to 22.7 seconds from 17.9 seconds. Note that these parameters do not include the ratio between input and output ranges; they are normalized to 0 to 100%. The following figure shows the results. Generally, the response and rise times increased, while the overshoot decreased.

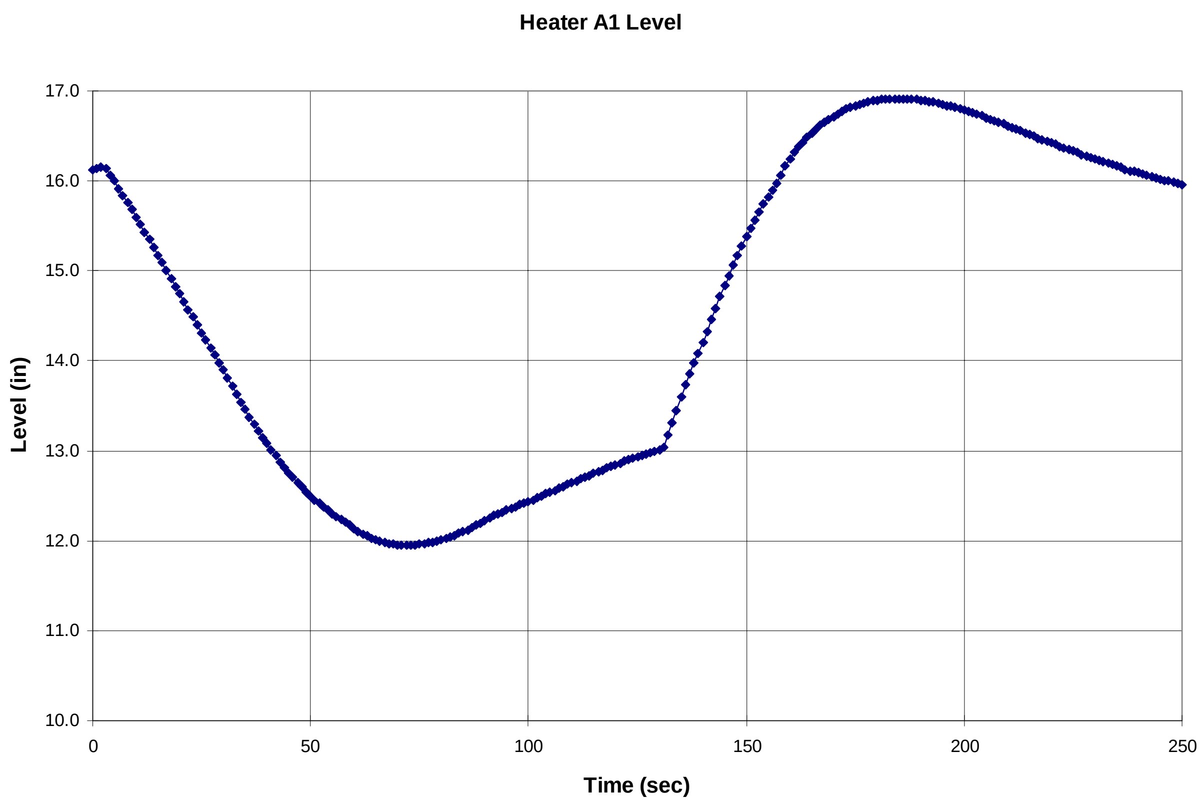

Figure 5-6 Heater A1 Level Responses to Setpoint Changes, Increased Gain and Reset Time

6

RECIRCULATION PUMP CONTROLS CHANGES

The recirculation pump controls in RELAP5 were rewritten to simulate variable speed motors. This will replace the oil vortex fluid couplings currently used in the Browns Ferry plant. The variable speed motor characteristics were not used in the test cases presented in Sections 3, 4, and 5.

Changes to Control Variables

Except the speed demand signal from the LabVIEW interface, all of the recirculation pump controls are simulated within RELAP5 by the use of control variables. Therefore, the change to variable speed drives was simulated entirely within RELAP5. The following changes were made to the control variables.

Control variables were deleted starting with those which had simulated the linearization of controller output to those which covered the recirculation pump generator speed based on oil vortex coupling. In addition, those control variables covering the drive motor speed were deleted.

In their place, generator speeds were directly coupled to controller outputs. The remainder of the control variables which determined pump speeds were left the same.

The following table lists those control variables which were deleted.

Table 6-1
Deleted Recirculation Pump Control Variables

Number	Description
222	Recirc Pump A Speed Controller Linearization
223	Recirc Pump B Speed Controller Linearization
224	Recirc Pump A Scoop Tube Natural Frequency
225	Recirc Pump B Scoop Tube Natural Frequency
226	Delay Spd Controller Function Generator, A

Table 6-1 Deleted Recirculation Pump Control Variables	
Number	**Description**
227	Delay Spd Controller Function Generator, B
228	Scoop Tube Actuator A Position Error
229	Scoop Tube Actuator B Position Error
230	Natural Freq **2 times Scoop Tube A Position Error
231	Natural Freq **2 times Scoop Tube B Position Error
232	Actuator Recirc Pump A Term 1
233	Actuator Recirc Pump B Term 1
234	Actuator Recirc Pump A Term 2
235	Actuator Recirc Pump B Term 2
236	Actuator Recirc Pump A Term 3
237	Actuator Recirc Pump B Term 3
238	Recirc Pump A Coupler Position
239	Recirc Pump B Coupler Position
240	Recirc Pump A Coupler Slip
241	Recirc Pump B Coupler Slip
242	Recirc Pump A Empirical Coupler Torque Term 1
243	Recirc Pump B Empirical Coupler Torque Term 1
244	Recirc Pump A Coupler Torque
245	Recirc Pump B Coupler Torque
246	Recirc Pump A Motor Power
247	Recirc Pump B Motor Power
248	Recirc Pump A Generator Torque

Table 6-1
Deleted Recirculation Pump Control Variables

Number	Description
249	Recirc Pump B Generator Torque
250	Recirc Pump A Generator Delta Torque
251	Recirc Pump B Generator Delta Torque
270	Recirc DM % Synchronous Spd
271	Recirc DM % Synchronous Spd
272	Recirc DM Torque
273	Recirc DM Torque
274	Recirc DM Speed Ratio
275	Recirc DM Speed Ratio
276	Recirc DM Coupler Input Torque
277	Recirc DM Coupler Input Torque
278	Recirc DM Torque Difference
279	Recirc DM Torque Difference
280	Recirc DM Speed
281	Recirc DM Speed

The terms developing the generator speed based on a torque balance between the pump and oil vortex which powered the generator are among those deleted. The terms for the drive motor for the vortex were also deleted. Control variables 252 and 253 were formerly the generator speed integrals based on torque imbalance. They have been converted to generator speeds expressed as first order lags of speed controller variables converted from 0 to 100% to 0 to 1800 RPM.

Appendix B contains the new model listing for the RELAP5 model with variable speed recirculation pump controls.

A

RELAP5 MODEL INPUT DECK WITH NEW FEEDWATER HEATER SYSTEM

```
= brown's ferry relap5 plant model
* Full implementation of 3-train FW heaters
*
*card    prob type      transnt/stdy-st
*0000100      new           stdy-st
0000100      new           transnt
*0000100      restart       transnt
*
*card    inp-chk/run
0000101  run
*0000101  unp-chk
*
*card    input units    output units
0000102      british       british
*103 3
*
*      restart file
*0000104 none *remove asterisk at beginning
*
*card    reference   elev     fluid     name
0000120      100010000   8.750        h2o      primary
0000121      960030000   597.020833     h2o       'FW-HTRS'
*
*
*------------------------------------------------------
*  time step control cards
*---------------------------------------------------------
*card     end   min     max    cntrl  minor   major   restrt
0000201   0.10  1.e-6   0.025   00003   1000    2000    5000
0000201   500.  1.e-6   6.25e-3 00003   9000    14000   14000
*0000202   250.  1.e-6   0.025   00003   1000    2000    5000
*0000203   350.  1.e-6   0.025   00003   50      4000    4000 *remove
*
*---------------
```

```
*  minor edits
*---------------
*
*0000301 cntrlvar 675       *stand alone
*0000301 cntrlvar 646       *labview
*0000302 cntrlvar 650
*0000303 cntrlvar 689
*0000305 mflowj   610012200     *HTR-A1 Feedwater flow (lb/sec)
*0000306 tempf    605010000     *HTR-A1 RFW outlet temperature
*0000310 cntrlvar 0306          *HTR-A1 level
*0000311 cntrlvar 0324          *HTR-A1 drain valve position
*0000312 cntrlvar 0811          *HTR-A1 power
*
*0000320 mflowj   588010000     *HTR-A2 Feedwater flow (lb/sec)
*0000321 tempf    595010000     *HTR-A2 RFW outlet temperature
*0000322 cntrlvar 0331          *HTR-A2 level
*0000323 cntrlvar 0349          *HTR-A2 drain valve position
*0000324 cntrlvar 0812          *HTR-A2 power
*
*0000330 mflowj   550010000     *HTR-A3 Feedwater flow (lb/sec)
*0000331 tempf    555010000     *HTR-A3 RFW outlet temperature
*0000332 cntrlvar 0361          *HTR-A3 level
*0000333 cntrlvar 0379          *HTR-A3 drain valve position
*0000334 cntrlvar 0813          *HTR-A3 power
*
*0000335 mflowj   540010000     *HTR-A4 Feedwater flow (lb/sec)
*0000336 tempf    545010000     *HTR-A4 RFW outlet temperature
*0000337 cntrlvar 0381          *HTR-A4 level
*0000338 cntrlvar 0399          *HTR-A4 drain valve position
*0000339 cntrlvar 0814          *HTR-A4 power
*
*0000340 mflowj   530010000     *HTR-A5 Feedwater flow (lb/sec)
*0000341 tempf    535010000     *HTR-A5 RFW outlet temperature
*0000342 cntrlvar 0410          *HTR-A5 level
*0000343 cntrlvar 0411          *HTR-A5 level lagged
*0000344 cntrlvar 0429          *HTR-A5 drain valve position
*0000345 cntrlvar 0815          *HTR-A5 power
*
*-----------------------------
* variable trip cards
*-----------------------------
*
* vessel level trips
0000401 cntrlvar      2 le    null       0 -1.2200e+02 n -1.0
```

```
0000402 cntrlvar        2 le     null        0 -4.5000e+01 n -1.0
0000403 cntrlvar        6 le     null        0  1.1200e+01 n -1.0
0000404 cntrlvar        7 le     null        0  2.7000e+01 n -1.0
0000405 cntrlvar        6 ge     null        0  5.1000e+01 n -1.0
0000406 cntrlvar        6 ge     null        0  5.5000e+01 l -1.0
*  ref. 55
*
* main turbine trips
0000407 cntrlvar      115 ge     null        0  1.0000e-01 l -1.0
*
* always true trip for tmdpjuns
0000408     time        0 ge     null        0   .0000e+00 l   .0
*
* always false for msiv open trip
0000409     time        0 ge     null        0  1.0000e+06 l -1.0
*
* msiv fast closure trips (all valves)
0000411 cntrlvar      500 le     null        0  8.5770e+02 l -1.0
* ref. 351, 358
*
* msiv single valve fast closure
0000415 cntrlvar      116 ge     null        0  1.0000e-01 l -1.0
*
* msiv single valve fast closure for dual msiv trip
0000416 cntrlvar      117 ge     null        0  1.0000e-01 l -1.0
*
* 30% permissive
0000417   mflowj 430000000 ge     null        0  1.1151e+03 n   .0
*   ref. 349
*
* recirc pump trips (both)
0000420     time        0 ge   timeof      402  1.7500e-01 l -1.0
0000421 cntrlvar       90 ge     null        0  1.1327e+03 n -1.0
0000422     time        0 ge   timeof      421  1.3500e-01 l -1.0
0000423 cntrlvar      114 ge     null        0  1.0000e-01 l -1.0
0000424     time        0 ge   timeof      640  1.6500e-01 l -1.0
* time for trip 424 based on 0.03 sec to tsv close setpt and 0.135 sec delay
* for recirc pump trip
*
* recirc pump a trip (single)
0000425 cntrlvar      113 ge     null        0  1.0000e-01 l -1.0
*
* 28% recirc pump runbacks (both)
0000427   mflowj 605040000 lt     null        0  7.4340e+02 n -1.0
```

```
0000430     time        0 ge   timeof      427  1.5000e+01 n -1.0
*
* RRP a 28% runback
0000431 cntrlvar      118 ge     null        0  1.0000e-01 n -1.0
*
* RRP b 28% runback
0000432 cntrlvar      119 ge     null        0  1.0000e-01 n -1.0
*
* RRP a seizure
0000433 cntrlvar      120 ge     null        0  1.0000e-01 l -1.0
*
* 75% recirc runback conditions
0000434   mflowj 570020000 lt     null        0  2.4780e+02 n -1.0
0000435   mflowj 571020000 lt     null        0  2.4780e+02 n -1.0
0000436   mflowj 572020000 lt     null        0  2.4780e+02 n -1.0
*
* feedwater single pump manual trips
0000437 cntrlvar      104 le     null        0  1.0000e-01 n -1.0
0000438 cntrlvar      105 le     null        0  1.0000e-01 n -1.0
0000439 cntrlvar      106 le     null        0  1.0000e-01 n -1.0
*
* manual hpci initiation
0000440 cntrlvar      121 ge     null        0  1.0000e-01 l -1.0
*
*manual RCIC initiation
0000442 cntrlvar      122 ge     null        0  1.0000e-01 l -1.0
*
* scram variable trips
0000445     time        0 ge   timeof      403  7.0000e-02 l -1.0
0000446 cntrlvar       90 ge     null        0  1.0577e+03 n -1.0
0000447     time        0 ge   timeof      605  4.5000e-01 l -1.0
* trip 447 assumes 4 sec msiv closure on trip, ref. 351 states 3 - 5 seconds
0000448 cntrlvar      123 ge     null        0  1.0000e-01 l -1.0
0000449     time        0 ge   timeof      640  8.0000e-02 l -1.0
0000450 cntrlvar       14 ge     null        0  1.1800e+02 l -1.0
0000451     time        0 ge   timeof      450  9.0000e-02 l -1.0
0000452     time        0 ge   timeof      446  7.0000e-02 l -1.0
* time delays on scram, except manual scram, include 0.05 sec time delay for
* scram solenoid deenergization per ref. 349
*
* srv setpoints
0000455        p 400010000 ge     null        0  1.1197e+03 n -1.0
0000456        p 400010000 ge     null        0  1.1297e+03 n -1.0
0000457        p 400010000 le     null        0  1.0860e+03 n   .0
```

```
0000458        p 400010000 le     null        0  1.0960e+03 n   .0
*
* condensate pump trips
0000460 cntrlvar       100 le     null        0  1.0000e-01 n -1.0
0000461 cntrlvar       101 le     null        0  1.0000e-01 n -1.0
*
* condensate booster pump trips
0000465 cntrlvar       102 le     null        0  1.0000e-01 n -1.0
0000466 cntrlvar       103 le     null        0  1.0000e-01 n -1.0
*
* small loca
0000468 cntrlvar       124 ge     null        0  1.0000e-01 l -1.0
*
* single element, feedwater pump control trips
0000470 cntrlvar       646 ge     null        0  9.0000e-01 n -1.0
* use 1st line with Labview, next line without Labview
0000471 cntrlvar       631 lt     null        0  2.6762e+00 n -1.0 * steam flow lt 20%
*0000471 cntrlvar       630 lt     null        0  2.6762e+00 n -1.0 * steam flow lt 20%
*
* trips to open minimum recirc valves in rfp trains
0000475   mflowj 570020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
0000476   mflowj 571020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
0000477   mflowj 572020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
*
* trips to close minimum recirc valves in rfp trains
0000478   mflowj 570020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
0000479   mflowj 571020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
0000480   mflowj 572020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
*
* runback reset trip
0000490 cntrlvar       125 ge     null        0   .9000e+00 n  -1.0 * when true, resets
*
* additional pump trips
0000501     time        0 le   timeof      614  .0000e+00 n   .0
0000502     time        0 le   timeof      612  .0000e+00 n   .0
0000506     time        0 le   timeof      460  .0000e+00 n   .0
0000507     time        0 le   timeof      461  .0000e+00 n   .0
0000508     time        0 le   timeof      465  .0000e+00 n   .0
0000509     time        0 le   timeof      466  .0000e+00 n   .0
*
* feed pump speed trips
0000510 pmpvel        570 lt   null       0    500.     n
0000511 pmpvel        571 lt   null       0    500.     n
0000512 pmpvel        572 lt   null       0    500.     n
```

```
*
* scram pump selection criteria
0000515 cntrlvar        7 le     null        0  1.1000e+01 n -1.0 * set scram response
0000516 time            0 le     timeof    649  6.0000e+01 n -1.0 * set scram response
0000517 cntrlvar        7 gt     cntrlvar  108  0.8        n -1.0 * reset scram response
0000518 time            0 gt     timeof    675  300.       l -1.0 * reset scram response
*
0000520 cntrlvar      675  gt    null        0  63.        n -1.0 *scram resp.
*
*------------------------------
* logic trip cards
*------------------------------
*
* main turbine trip
0000601  407  or  406 l  -1.0
*
* msiv fast closure (all vlvs)
0000605  401  or  411 l  -1.0
*
* recirc pumps trip (both)
0000610  420  or  422 l  -1.0
0000611  424  or  423 l  -1.0
0000612  610  or  611 l  -1.0
*
* recirc pump a trip
0000614  612  or  425 l  -1.0
*
* fw pump trips
0000618  437  or  406 n  -1.0
0000619  438  or  406 n  -1.0
0000620  439  or  406 n  -1.0
*
* 28% recirc pump runback, pump a
0000621  431  or  430 n  -1.0
*
* 28% recirc pump runback, pump b
0000622  432  or  430 n  -1.0
*
* 75% recirc pump runback
0000623  435  or  434 n  -1.0
0000624  623  or  436 n  -1.0
0000625  624 and  404 n  -1.0
*
* hpci initiation
```

0000629 440 or 402 n -1.0
0000630 631 or 629 n -1.0
0000631 630 and -405 n -1.0
*
*** inverse fwp trips for shell side ms tmdpjun's**
632 -618 or -618 n -1.0
633 -619 or -619 n -1.0
634 -620 or -620 n -1.0
*
* rcic initiation
0000635 402 or 442 n -1.0
0000636 637 or 635 n -1.0
0000637 636 and -405 n -1.0
*
* turbine stop valve closure and ge 30% flow
0000640 601 and 417 l -1.0
*
* reactor scram
0000645 445 or 447 l -1.0
0000646 448 or 449 l -1.0
0000647 451 or 452 l -1.0
0000648 645 or 646 l -1.0
0000649 647 or 648 l -1.0
*
* srv grp 1 lifted
0000655 656 or 455 n -1.0
0000656 655 and -457 n -1.0
*
* srv grp 2 lifted
0000660 661 or 456 n -1.0
0000661 660 and -458 n -1.0
*
* msiv single closure indication
0000665 415 or 605 l -1.0 * single closure, ok
*
* msiv single closure for dual msiv trip w/ trip 665
0000666 416 or 605 l -1.0 * single closure for dual trip, ok
*
* single element feed pump control
0000671 470 or 471 n -1.0
*
* feed pump scram response
0000675 515 and 516 l -1.0 * starts scram response
0000676 517 or 518 n -1.0 * resets response, allowing pump restoration

```
0000677  675  and -676 n -1.0 * initially sets max pump speeds, all pumps
0000678  675  and 676 l  -1.0 * reset response in past
0000679  677  and -678 n -1.0 * imposes max pump speeds
*
* pump b response to scram
0000681  675  and -512 l -1.0 * initially drive b to 600 rpm
*
* pump a response to scram
0000682 -512  or  -511 n  0.0 * true if pmp b or c >500 rpm
0000684  682  and  675 l -1.0 * initially drives pmp a to 600 rpm
*
* additional runback trips to incorporate new reset button
* 28% runback trips, pump a
0000685  621  or   686 n  0.0 * used to init runback
0000686  685  and -490 n  -1.0
* 28% runback trips, pump b
0000687  622  or   688 n  0.0 * used to init runback
0000688  687  and -490 n  -1.0
** 75 % runback trips
0000689  625  or   690 n  0.0 * used to init runback
0000690  689  and -490 n  -1.0
*
0000691  510  or   684 n  -1.0
0000692  511  or   681 n  -1.0
*
*-------------------------
* control system general tables
*-------------------------
*
* recirc pmp speed controller function gen output (%) vs. spd controller outpt
*-------------------------------- ref. 349
20222000 reac-t
20222001 0.     0.
20222002 58.3   25.
20222003 84.2   50.
20222004 91.8367  69.64874
20222005 95.46  100.
20222006 97.04  160.
*
* recirc coupler torque first term vs. coupler slip, ref. 349
*--------------------------------
20224200 reac-t
20224201 0.        0.
20224202 4.1667e-2  2.0e-4
```

```
20224203 8.3333e-2  4.0046e-4
20224204 1.25e-1    6.0234e-4
20224205 2.0833e-1  1.0181e-3
20224206 2.5e-1     1.2375e-3
20224207 3.3333e-1  1.7185e-3
20224208 0.5        3.0e-3
20224209 0.75       6.6375e-3
20224210 .97982     1.3551e-2
*
* "normalized" recirc pump motor torque vs. % synchronous speed, ref. 349
*--------------------------------
20225400 reac-t
20225401 0.        0.8
20225402 40.       0.9
20225403 80.       1.6
20225404 95.6      2.2
20225405 98.0      1.0
20225406 100.      0.
20225407 102.      -1.
20225408 104.4     -2.2
20225409 120.      -1.6
20225410 160.      -0.9
20225411 200.      -0.8
*
* recirc pump motor torque multiplier vs generator rpm
*--------------------------------
20225800 reac-t
20225801 0.        0.
20225802 501.83    0.4015
20225803 607.11    0.5554
20225804 825.      1.0
*
* normalized load torque vs. % main turbine speed, ref. 349
*--------------------------------
20230000 reac-t
20230001 1.        -3.
20230002 94.       -2.
20230003 96.       -1.
20230004 98.       0.
20230005 100.      1.
20230006 102.      2.
20230007 199.      3.
*
* turbine control vlv linearization (function generator), ref. 349 and 17
```

```
*-----------------------------------
20252000 reac-t
20252001 0.0       0.0
20252002 51.       20.
20252003 91.       40.
20252004 100.      52.2
20252005 102.      60.
20252006 111.      100.
*
* turbine control valve position multiplier vs. time since turbine trip
*-----------------------------------
20252700 reac-t
20252701 0.0       1.0
20252702 0.1       0.0
*
* turbine normalized steam flow vs tcv position in %, ref. 349
*-----------------------------------
20253500 reac-t
20253501 0.0   0.0
20253502 20.   0.51
20253503 40.   0.91
20253504 52.2  1.0
20253505 60.   1.02
20253506 100.  1.11
*
* single element controller gain based on # pumps and stm flow
*-----------------------------------
20261700 reac-t
20261701 100.0  0.36364
20261702 101.338 0.36364
20261703 104.04  0.83333
20261704 116.0  0.83333
20261705 200.0  0.5
20261706 204.014 0.5
20261707 206.69  0.66667
20261708 210.04  0.74074
20261709 216.0  0.74074
20261710 300.0  0.57143
20261711 306.69 0.57143
20261712 310.04 0.74074
20261713 313.38 0.86957
*
* three element level controller gain based on steam flow in Mlbm/hr
*-----------------------------------
```

```
20261800 reac-t
20261801 4.014 0.83333
20261802 6.690 0.74074
20261803 10.04 0.74074
20261804 13.38 0.86957
*
* three element steam/feed flow controller gain based on # pumps
*-----------------------------------
20261900 reac-t
20261901 100.0  0.16667
20261902 216.0  0.16667
20261903 300.0  0.20
20261904 316.0  0.20
*
* lp delta enthalpy in turbine vs inlet pressure
*-----------------------------------
20266300 reac-t
20266301  1.25   0.0
20266302  40.0   154.0
20266303  70.0   179.5
20266304  100.   199.0
20266305  130.   212.0
20266306  160.   220.0
20266307  180.   225.0
20266308  200.0  228.0
20266309  214.0  230.0
20266310  917.   222.
20266311  967.   264.5
*
*
*-------------------------
* control variables
*-------------------------
*20500000 999
*
* wide range level
*----------------
*
* instantaneous wide range level
20500100   instwr      sum  1.000e+00  3.3058701e+01 0
20500101 -528.00  380.638  voidf  140010000
20500102          152.868  voidf  150010000 * inst zero @ 528 inches per ref 195
20500103          74.004   voidf  160010000
20500104          1.0      cntrlvar 866
```

```
*
*
20586600 addlevel      sum  2.678e+02   0. 0  1  .000e+00
20586601 -0.05    1.0   voidf 190010000
*
* lagged yarway wide range level
* this level detector also used for yarway narrow range control functions
20500200  wrlevel   lag  1.000e+00 3.3052502e+01 0  3 -1.550e+02  6.000e+01
20500201 1.0      cntrlvar 001  * ref. 349
*
* narrow range level
*-------------------
*
* lagged narrow range level
20500600  nrlevel      lag  1.00       33.0          0  3  -10.  70.
20500601 0.5      cntrlvar 001  *lag time const. per ref. 349
*
* dummy return control variable for labview to return level signal in
* stand alone mode
20500700 levelret constant  3.3000000e+01
*
* aprm scram setpoint
*--------------------
*
* total reactor power (lagged) in %, sensed rx power
20501000    rxpwr      lag  3.037e-08  1.0059400e+02 0
20501001 0.03     rktpow   0  * 100% = 3293mw, ref. 349
*
* combined recirc pump mass flows (lb/sec)
20501100 rcrcflow      sum  2.205e+00  9.7047197e+03 0
20501101 0.0      1.0      mflowj   230010000 * ref. 349
20501102          1.0      mflowj   280010000
*
* sensed percentage recirc flow
20501200 perrecrc      lag  1.053e-02  1.0219100e+02 0
20501201 0.5      cntrlvar 011 * ref. 349
*
* flow bias in percent
20501300  flobias      sum  1.000e+00   0. 0  3   .000e+00  5.800e+01
20501301 58.      -.58    cntrlvar 012  * aprm scram setpt per ref. 359, per
* bob stegl?
*
* aprm in percent including flow bias
20501400  aprmflo      sum  1.000e+00  1.0059400e+02 0
```

```
20501401 0.0      1.0     cntrlvar 010  * ref. 349, 359
20501402          1.0     cntrlvar 013
*
* reactor steam dome pressure (lagged)
*-------------------------------------
20509000  rxpress      lag  1.450e-04  1.0233800e+03 0
20509001 0.5      p  190010000  * ref. 349
*
* dummy return control variable for labview to return pressure signal in
* stand alone mode
20509100 pressret constant  1.0233300e+03
*
*
* problem control inputs
*---------------------------------------------
*  note: some of these will not activate trips within the trip section
*  until the deck is altered for use with labview in the testing mode.
*
* condensate pump a control
20510000 condacnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate pump b/c control
20510100 condbcnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate booster pump a control
20510200 cndbacnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate booster pump b/c control
20510300 cndbbcnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump a control
20510400 rfpacont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump b control
20510500 rfpbcont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump c control
20510600 rfpccont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* manual speed setpoint, both recirc pumps
20510700 rrpmansp constant  9.7659264e+01
*
* level setpoint
20510800 lvlsetpt constant  3.3000000e+01 * ref. 348
```

```
*
* rod reactivity insertion rate (positive or negative)
20510900 reactrat constant   0.
*
* single rrp trip
20511300 sirrptrp constant   0. * 0. equals ok, 1.0 equals trip
*
* dual rrp trip
20511400 durrptrp constant   0. * 0. equals ok, 1.0 equals trip
*
* main turbine trip
20511500 mturbtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* single msiv trip
20511600 msiv1trp constant   0. * 0. equals ok, 1.0 equals trip
*
* single msiv trip
20511700 msiv2trp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp a runback trip
20511800 rrpartrp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp b runback trip
20511900 rrpbrtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp seizure trip
20512000 rrpseize constant   0. * 0. equals ok, 1.0 equals trip
*
* hpci trip
20512100 hpci_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* rcic trip
20512200 rcic_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* scram trip
20512300 scramtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* loca trip
20512400 loca_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* runback reset
20512500 runbkrst constant   0. * 0. equals no reset action
*
*
```

```
* inverse scram response tripunit
20520000 negscrtr tripunit   1.0           1.  0
20520001 -679
*
* recirc pump speeds, all ref. 349 uno
*---------------------------------------------
*
* tripunit for large torque during pump a seizure
20520200 seizurea tripunit  1.500e+05   0. 0 * s is adjustable
20520201 433
*
*
* recirc pumps speed demand limiters
*
* 28% runback trip unit, pump a
20520800  trip28a tripunit  1.000e+00   0. 0
20520801 685
*
* 28% runback trip unit, pump b
20520900  trip28b tripunit  1.000e+00   0. 0
20520901 687
*
* 28% limiter, pump a
20521000   lim28a      sum  1.000e+00  1.2800000e+02 0
20521001 128.0    -100.   cntrlvar 208  * =128 for no runback, 28 @ runback
*
* 28% limiter, pump b
20521100   lim28b      sum  1.000e+00  1.2800000e+02 0
20521101 128.0    -100.   cntrlvar 209  * =128 for no runback, 28 @ runback
*
* 75% runback trip unit
20521200   trip75 tripunit  1.000e+00   0. 0
20521201 689
*
* 75% limiter, both pumps
20521300    lim75      sum  1.000e+00  1.7500000e+02 0
20521301 175.     -100.   cntrlvar 212  * 175 for no runback, 75 @ runback
*
* recirc pump a demand limiter (in %)
20521400  admdlim stdfnctn  1.000e+00  9.7659302e+01 0
20521401 min      cntrlvar 213
20521402          cntrlvar 210
20521403          cntrlvar 107
*
```

```
* recirc pump b demand limiter (in %)
20521500  bdmdlim stdfnctn  1.000e+00  9.7659302e+01 0
20521501 min      cntrlvar 213
20521502          cntrlvar 211
20521503          cntrlvar 107
*
* recirc pumps speed controllers
*
* recirc pump a speed error
20521600 rrpaspde      sum  1.000e+00  3.6342631e-04 0  3 -1.000e+01  1.000e+01
20521601 0.0      1.0      cntrlvar 214
20521602         -.0906924 cntrlvar 252
*
* recirc pump b speed error
20521700 rrpbspde      sum  1.000e+00  3.6342631e-04 0  3 -1.000e+01  1.000e+01
20521701 0.0      1.0      cntrlvar 215
20521702         -.0906924 cntrlvar 253
*
* recirc pump a speed controller integral term
20521800 rpascint integral  2.712e-02  8.9533699e+01 0 * jam
20521801 cntrlvar 216
*
* recirc pump b speed controller integral term
20521900 rpbscint integral  2.712e-02  8.9533699e+01 0 * jam
20521901 cntrlvar 217
*
* recirc pump a speed controller
20522000 rpascont      sum  1.000e+00  8.9533798e+01 0
20522001 0.0      0.3      cntrlvar 216 * jam
20522002          1.0     cntrlvar 218
*
* recirc pump b speed controller
20522100 rpbscont      sum  1.000e+00  8.9533798e+01 0
20522101 0.0      0.3      cntrlvar 217 * jam
20522102          1.0     cntrlvar 219
*
* recirc pump a speed controller linearization
20522200 rpaliner function  1.000e+00  6.3723598e+01 0
20522201 cntrlvar 220  220
*
* recirc pump b speed controller linearization
20522300 rpbliner function  1.000e+00  6.3723598e+01 0
20522301 cntrlvar 221  220
*
```

```
* recirc pump coupler positions
*
* recirc pump a scoop tube natural frequency in rad/sec
20522400 rpaomega      sum  1.000e+00  1.7433600e+00 0  3  1.000e-01  2.000e+00
20522401 -0.5     2.08333e-3 cntrlvar 252
*
* recirc pump b scoop tube natural frequency in rad/sec
20522500 rpbomega      sum  1.000e+00  1.7433600e+00 0  3  1.000e-01  2.000e+00
20522501 -0.5     2.08333e-3 cntrlvar 253
*
* delay speed controller function generator, pump a
20522600 rrpadela    delay  1.000e+00  6.3723598e+01 0
20522601 cntrlvar 222  0.5  5
*
* delay speed controller function generator, pump b
20522700 rrpbdela    delay  1.000e+00  6.3723598e+01 0
20522701 cntrlvar 223  0.5  5
*
* scoop tube actuator a position error
20522800 scoopaer      sum  1.000e+00  1.3683370e-05 0
20522801 0.0       1.0     cntrlvar 226
20522802          -1.0     cntrlvar 238
*
* scoop tube actuator b position error
20522900 scoopber      sum  1.000e+00  1.3683370e-05 0
20522901 0.0       1.0     cntrlvar 227
20522902          -1.0     cntrlvar 239
*
* natural freq **2 times scoop tube a position error
20523000 scpaome2     mult  1.000e+00  4.1587929e-05 0
20523001 cntrlvar 228  cntrlvar 224  cntrlvar 224
*
* natural freq **2 times scoop tube b position error
20523100 scpbome2     mult  1.000e+00  4.1587929e-05 0
20523101 cntrlvar 229  cntrlvar 225  cntrlvar 225
*
* actuator recirc pump a term 1
20523200 scpatrm1      sum  1.000e+00  1.9645161e-06 0
20523201 0.0       1.0     cntrlvar 230
20523202          -1.0     cntrlvar 236
*
* actuator recirc pump b term 1
20523300 scpbtrm1      sum  1.000e+00  1.9645161e-06 0
20523301 0.0       1.0     cntrlvar 231
```

```
20523302          -1.0     cntrlvar 237
*
* actuator recirc pump a term 2
20523400 scpatrm2 integral  1.000e+00  1.9078579e-05 0  3 -2.000e+01  2.000e+01
20523401 cntrlvar 232
*
* actuator recirc pump b term 2
20523500 scpbtrm2 integral  1.000e+00  1.9078579e-05 0  3 -2.000e+01  2.000e+01
20523501 cntrlvar 233
*
* actuator recirc pump a term 3
20523600 scpatrm3     mult  1.200e+00  3.9913000e-05 0
20523601 cntrlvar 234  cntrlvar 224
*
* actuator recirc pump b term 3
20523700 scpatrm3     mult  1.200e+00  3.9913000e-05 0
20523701 cntrlvar 235  cntrlvar 225
*
* recirc pump a coupler position
20523800 rpacplps integral  1.000e+00  6.3723598e+01 0  3   .000e+00  1.750e+02
20523801 cntrlvar 236 * jam - retran value was 69.781
*
* recirc pump b coupler position
20523900 rpbcplps integral  1.000e+00  6.3723598e+01 0  3   .000e+00  1.750e+02
20523901 cntrlvar 237
*
* recirc pumps coupler torques
*
* recirc pump a coupler slip
20524000 acplrslp      sum  8.333e-04  8.2611509e-02 0
20524001 0.  1.0 cntrlvar 280  -1.0   cntrlvar 252
*
* recirc pump b coupler slip
20524100 bcplrslp      sum  8.333e-04  8.2611509e-02 0
20524101 0.  1.0 cntrlvar 281  -1.0   cntrlvar 253
*
* recirc pump a empirical coupler torque term 1
20524200 rpacplt1 function  1.000e+00  3.9698879e-04 0
20524201 cntrlvar 240  242
*
* recirc pump b empirical coupler torque term 1
20524300 rpbcplt1 function  1.000e+00  3.9698879e-04 0
20524301 cntrlvar 241  242
*
```

```
* recirc pump a coupler torque in lbf*ft
* scaling factor = 347.372/2 since two pumps in this model
20524400 rpacpltq     mult  3.474e+02  3.5686898e+04 0
20524401 cntrlvar 242  cntrlvar 238  cntrlvar 238  cntrlvar 238
*
* recirc pump b coupler torque in lbf*ft
20524500 rpbcpltq     mult  3.474e+02  3.5686898e+04 0
20524501 cntrlvar 243  cntrlvar 239  cntrlvar 239  cntrlvar 239
*
*
* recirc pump generator speeds
*
* recirc pump a motor power in units of lbf*ft*rpm
20524600 ramtrpwr     mult  9.549e+00  3.6494040e+07 0
20524601 cntrlvar 260  pmpvel 230  * s= conversion factor from rad/s to rpm
*
* recirc pump b motor power in units of lbf*ft*rpm
20524700 rbmtrpwr     mult  9.549e+00  3.6494040e+07 0
20524701 cntrlvar 261  pmpvel   280  * s= conversion factor from rad/s to rpm
*
* recirc pump a generator torque in lbf*ft
20524800 rpagentq      div  1.053e+00  3.5686898e+04 0
20524801 cntrlvar 252  cntrlvar 246  * jam-retran was 1.7469e4
*
* recirc pump b generator torque in lbf*ft
20524900 rpbgentq      div  1.053e+00  3.5686898e+04 0
20524901 cntrlvar 253  cntrlvar 247
*
* recirc pump a generator delta torque
20525000 rpagndtq      sum  1.000e+00 -2.6091021e-03 0
20525001 0.        1.      cntrlvar 244
20525002           -1.     cntrlvar 248
*
* recirc pump b generator delta torque
20525100 rpbgndtq      sum  1.000e+00 -2.6091021e-03 0
20525101 0.0       1.0     cntrlvar 245
20525102           -1.0    cntrlvar 249
*
* recirc pump a generator speed in rpm
* s={(60/2pi)(32.174)[(14,915.5 lb*ft**2)**(-1)]}, generator i is assumed
* from ref. 349
20525200 rpagensp integral  1.030e-02  1.0768101e+03 0
20525201 cntrlvar 250
*
```

```
* recirc pump b generator speed in rpm
* s={(60/2pi)(32.174)[(14,915.5 lb*ft**2)**(-1)]}, generator i is assumed
* from ref. 349
20525300 rpbgensp integral  1.030e-02  1.0768101e+03 0
20525301 cntrlvar 251
*
* recirc pump motor torques
*
* recirc pump a percent of synchronous speed
* s= (gen synch speed @ no load)/(mtr synch speed at no load) * 100 * (60/2pi)
* generator no load speed is 1200 rpm, mtr no load synch speed is 1800 rpm,
* 100 converts to percent and (60/2pi) converts pmpvel from rad/s to rpm.
20525400 rpasynch      div  6.366e+02  9.7945000e+01 0
20525401 cntrlvar 252  pmpvel   230
*
* recirc pump b percent of synchronous speed
* s= (gen synch speed @ no load)/(mtr synch speed at no load) * 100 * (60/2pi)
* generator no load speed is 1200 rpm, mtr no load synch speed is 1800 rpm,
* 100 converts to percent and (60/2pi) converts pmpvel from rad/s to rpm.
20525500 rpbsynch      div  6.366e+02  9.7945000e+01 0
20525501 cntrlvar 253  pmpvel   280
*
* recirc pump a motor torque in lbf*ft at 100% speed
* s = 0.5 (value from ref. 349) since single pump instead of double pump
20525600 rpamtrtq function  2.245e+04  2.3067900e+04 0
20525601 cntrlvar 254  254
*
* recirc pump b motor torque in lbf*ft at 100% speed
* s = 0.5 (value from ref. 349) since single pump instead of double pump
20525700 rpbmtrtq function  2.245e+04  2.3067900e+04 0
20525701 cntrlvar 255  254
*
* recirc pump a motor torque multiplier for speed
20525800 ratrqmul function  1.000e+00  1.0000000e+00 0
20525801 cntrlvar 252  258
*
* recirc pump b motor torque multiplier for speed
20525900 rbtrqmul function  1.000e+00  1.0000000e+00 0
20525901 cntrlvar 253  258
*
* recirc pump a motor torque
20526000 rpamtrtq     mult  1.000e+00  2.3067900e+04 0
20526001 cntrlvar 256  cntrlvar 258
*
```

```
* recirc pump b motor torque
20526100 rpbmtrtq     mult  1.000e+00  2.3067900e+04 0
20526101 cntrlvar 257  cntrlvar 259
*
*
* recirc pump speeds (with no trip)
*
* recirc pump a torque difference in lbf*ft
20526200 rpadlttq      sum  1.000e+00 -4.8878230e-03 0
20526201 0.0       1.0       cntrlvar 260
20526202           0.7376    pmptrq   230 * conversion factor is n*m to lbf*ft
20526203          -1.0       cntrlvar 202 * applies large stopping torque for
*                                  seizure of pump a
*
* recirc pump b torque difference in lbf*ft
20526300 rpbdlttq      sum  1.000e+00 -4.8878230e-03 0
20526301 0.0       1.0       cntrlvar 261
20526302           0.7376    pmptrq   280 * conversion factor is n*m to lbf*ft
*
* recirc pump a speed with no pump trip
* s={(60/2pi)(32.174)[(19,175 lb*ft**2)**(-1)]}, pump and motor i is assumed
* to be 17,044 lb*ft**2 based on 1/2 of ref. 349 value, which lists 2 values
20526400 rpaspeed integral  1.602e-02  1.5820800e+03 0
20526401 cntrlvar 262
*
* recirc pump b speed with no pump trip
* s={(60/2pi)(32.174)[(17,044 lb*ft**2)**(-1)]}, pump and motor i is assumed
* to be 17,044 lb*ft**2 based on 1/2 of ref. 349 value, which lists 2 values
20526500 rpbspeed integral  1.602e-02  1.5820800e+03 0
20526501 cntrlvar 263
*
* recirc dm %synchronous spd
20527000 dmsynchs     mult  8.333e-02  9.7992104e+01 0
20527001 cntrlvar 280
*
* recirc dm %synchronous spd
20527100 dmsynchb     mult  8.333e-02  9.7992104e+01 0
20527101 cntrlvar 281
*
* recirc dm torque in lbf-ft
20527200 dmtorque function  3.255e+04  3.2678400e+04 0
20527201 cntrlvar 270      254
*
* recirc dm torque in lbf-ft
```

```
20527300 dmtorqub function  3.255e+04  3.2678400e+04 0
20527301 cntrlvar 271      254
*
* recirc dm speed ratio
20527400 dmspdrat      div  1.000e+00  9.1569602e-01 0
20527401 cntrlvar 280  cntrlvar 252
*
* recirc dm speed ratio
20527500 dmspdrab      div  1.000e+00  9.1569602e-01 0
20527501 cntrlvar 281  cntrlvar 253
*
* recirc dm coupler input torque
20527600 dmcouptq     mult  1.000e+00  3.2678400e+04 0
20527601 cntrlvar 274  cntrlvar 244
*
* recirc dm coupler input torque
20527700 dmcouptb     mult  1.000e+00  3.2678400e+04 0
20527701 cntrlvar 275  cntrlvar 245
*
* recirc dm torque difference
20527800 dmdelttq      sum  1.000e+00 -3.6762829e-03 0
20527801 0.0   1.0 cntrlvar 272  -1.0 cntrlvar 276
*
* recirc dm torque difference
20527900 dmdelttb      sum  1.000e+00 -3.6762829e-03 0
20527901 0.0   1.0 cntrlvar 273  -1.0 cntrlvar 277
*
* recirc dm speed
20528000  dmspeed integral  1.173e-02  1.1759500e+03 0
20528001 cntrlvar 278
*
* recirc dm speed
20528100  dmspeeb integral  1.173e-02  1.1759500e+03 0
20528101 cntrlvar 279
*
* rod reactivity, cumulative
*---------------------------
*
20530000 rodrctdm integral  5.000e-02   0. 0  3 -2.300e+01  3.000e+00
20530001 cntrlvar 109
*
* normalized scram curve
*  s is the inverse of 28.9308, the scram shutdown reactivity margin
20530100 normscrm function  3.457e-02   0. 0
```

```
20530101 time      0         200
*
* scram multiplier
*  this term will remove the rod reactivity added by cntrlvar 300 at the same
*  rate as scram reactivity is inserted.
20530200 scrmmult      sum  1.000e+00  1.0000000e+00 0
20530201 1.0       1.0       cntrlvar   301
*
* rod reactivity, including provision to disable following a scram
20530300 rodreact     mult  1.000e+00   0. 0
20530301 cntrlvar  302       cntrlvar   300
*
*
* feedwater heater level controls
*-------------------------------
*
* cntrlvar 305: RFW HTRA1 collapsed liquid level (inches above lower tap)
20530500 'HTRA1LVL'     sum     12.     16.0     1
20530501 -2.6641        1.3307  voidf   722010000
20530502                2.6667  voidf   721030000
20530503                2.6667  voidf   721020000
*20530504               10.4596 voidf   721010000
*20530505               13.7904 voidf   720010000
*
* heater A1 level out to LabVIEW
20530600  a1lvlout     lag  1.00       16.0         0  3  0.  32.  *prb
20530601 0.05     cntrlvar 305  *lag time const.
*
* instant drain vlv position in %, A1
20532300 a1drinst     constant         32.0
*
* drain vlv position, heater a1, normalized to 1.0
20532400 a1drnpos    lag  0.01         0.32         0
20532401 0.05  cntrlvar 323
*
* cntrlvar 0330: RFW HTRA2 collapsed liquid level (inches above lower tap)
20533000 'HTRA2LVL'     sum     12.     18.0     1
20533001 -6.9974        5.4974  voidf   733010000
20533002                3.0000  voidf   732020000
20533003                3.0000  voidf   732010000
*20533004               8.8763  voidf   731010000
*20533005               10.2904 voidf   730010000
*
* heater A2 level out to LabVIEW
```

```
20533100  a2lvlout     lag  1.00       18.0        0  3  0.  36.     *prb
20533101 0.05     cntrlvar 330  *lag time const.
*
* instant drain vlv position in %, A2
20534800 a2drinst      constant         44.0
*
* drain vlv position, heater a2
20534900 a2drnpos    lag  0.01         0.44         0
20534901 0.05 cntrlvar 348
*
* instant A2 bypass vlv position, in %
20535400 a2byinst     constant        0.0                              *prb 01-18-96 10:09am
*
* bypass vlv position, heater a2, normalized to 1.0
20535500 a2byppos    lag  0.01         0.0          0                   *prb 01-18-96 10:10am
20535501 0.05 cntrlvar 354
*
* cntrlvar 0360: RFW HTRA3 collapsed liquid level (inches above lower tap)
20536000 'HTRA3LVL'     sum     12.     18.0     1
20536001 -15.6068       7.0534  voidf   742040000
20536002                7.0534  voidf   742030000
20536003                3.0000  voidf   742020000
20536004                3.0000  voidf   742010000
*20536005                11.1133 voidf   741010000
*20536006                12.4284 voidf   740010000
*
* heater A3 level out to LabVIEW
20536100  a3lvlout     lag  1.00       18.0        0  3  0.  36.     *prb
20536101 0.05     cntrlvar 360  *lag time const.
*
* instant drain vlv position, A3 in %
20537800 a3drinst     constant         34.0
*
* drain vlv position, heater a3
20537900 a3drnpos    lag  0.01         0.34         0
20537901 0.05  cntrlvar 378
*
* cntrlvar 0380: RFW HTRA4 collapsed liquid level (inches above shell bottom)
20538000 'HTRA4LVL'     sum     12.     16.9375  1
20538001 0.0    0.1667  voidf   751010000   * upper tap 2" above centerline
20538002        2.9375  voidf   752010000   * shell radius
*
* heater A4 level out to LabVIEW
20538100  a4lvlout     lag  1.00       16.9375      0  3  0.  37.25    *prb
20538101 0.05     cntrlvar 380  *lag time const.
```

```
*
* instant drain vlv position, A4 in %
20539800 a4drinst     constant        40.0
*
* drain vlv position, heater a4
20539900 a4drnpos    lag  0.01         0.40         0
20539901 0.05 cntrlvar 398
*
* instant bypass vlv position, A4 in %
20540400 a4byinst      constant       0.0                              *prb 01-24-96 10:34am
*
* bypass vlv position, heater a4, normalized to 1.0
20540500 a4byppos       lag     0.01    0.0            0                    *prb 01-24-96 10:35am
20540501 0.05 cntrlvar 404
*
* cntrlvar 0410: RFW HTRA5 collapsed liquid level (inches above shell bottom)
20541000 'HTRA5LVL'     sum     12.     15.0     0
20541001 -5.2188        2.500   voidf 760030000 * level taps are at top
20541002                5.2188  voidf 760040000 * & bottom of collector tank
*
* heater A5 level out to LabVIEW
20541100  a5lvlout     lag  1.00       15.0         0  3  0.  30.     *prb
20541101 0.05     cntrlvar 410  *lag time const.
*
* instant drain vlv position, A5 in %
20542800 a5drinst     constant           40.0
*
* drain vlv position, heater a5, normalized to 1.0
20542900 a5drnpos    lag  0.01         0.40         0
20542901 0.05 cntrlvar 428
*
* instant bypass vlv position, A5 in %
20543400 a5byinst     constant          0.0                            *prb 01-25-96 09:08pm
*
* bypass vlv position, heater a5, normalized to 1.0
20543500 a4byppos    lag  0.01         0.0          0                      *prb 01-25-96 09:09pm
20543501 0.05 cntrlvar 434
*
* cntrlvar 440: RFW HTRB1 collapsed liquid level (inches above lower tap)
20544000 'HTRB1LVL'     sum     12.     16.0     1
20544001 -2.6641        1.3307  voidf   822010000
20544002                2.6667  voidf   821030000
20544003                2.6667  voidf   821020000
*20544004                10.4596 voidf   821010000
*20544005                13.7904 voidf   820010000
```

```
*
* heater b1 level out to LabVIEW
20544100  b1lvlout     lag  1.00       33.0         0  3  0.  44.
20544101 0.05     cntrlvar 440  *lag time const.
*
* auto vlv position demand, b1 drain vlv
20544900 b1draut      constant          32.0
*
* drain vlv position, heater b1, normalized to 1.0
20545000 b1drnpos    lag  0.01         0.32         0
20545001 0.05     cntrlvar 449
*
* cntrlvar 0451: RFW HTRB2 collapsed liquid level (inches above lower tap)
20545100 'HTRB2LVL'     sum     12.     18.0     1
20545101 -6.9974        5.4974  voidf   833010000
20545102                3.0000  voidf   832020000
20545103                3.0000  voidf   832010000
*205045104                8.8763  voidf   831010000
*205045105                10.2904 voidf   830010000
*
* heater b2 level out to LabVIEW
*205045200  b2lvlout     lag  1.00       33.0         0  3  0.  36.    *prb
20545200  b2lvlout     lag  1.00       18.0         0  3  0.  36.     *prb
20545201 0.05     cntrlvar 451  *lag time const.
*
* auto vlv position demand, b2 drain vlv
20545700 b2draut      constant               44.0
*
* drain vlv position, heater b2, normalized to 1.0
20545800 b2drnpos    lag  0.01         0.44         0
20545801 0.05 cntrlvar 457
*
* auto vlv position demand, b2 bypass vlv
20545900 b2byaut     constant           0.0
*
* bypass vlv position, heater b2, normalized to 1.0
20546000 b2byppos    lag  0.01         0.0          0                    *prb 01-23-96 01:10pm
20546001 0.05 cntrlvar 459
*
* cntrlvar 0465: RFW HTRB3 collapsed liquid level (inches above lower tap)
20546500 'HTRB3LVL'     sum     12.     18.0     0
20546501 -15.6068       7.0534  voidf   842040000
20546502                7.0534  voidf   842030000
20546503                3.0000  voidf   842020000
20546504                3.0000  voidf   842010000
```

```
*20504655            11.1133 voidf   841010000
*20504656            12.4284 voidf   840010000
*
* heater b3 level out to LabVIEW
20546600  b3lvlout     lag  1.00       18.0         0  3  0.  36.
20546601 0.05     cntrlvar 465  *lag time const.
*
* auto vlv position demand, b3 drain vlv, in %
20547100 b3draut      constant         34.
*
* drain vlv position, heater b3
20547200 b3drnpos    lag  0.01         0.34         0
20547201 0.05  cntrlvar 471
*
* cntrlvar 0475: RFW HTRB4 collapsed liquid level (inches above shell bottom)
20547500 'HTRB4LVL'     sum     12.     16.9375  0
20547501 0.0    0.1667  voidf   851010000   * upper tap 2" above centerline
20547502        2.9375  voidf   852010000   * shell radius
*
* heater b4 level out to LabVIEW
20547600  b4lvlout     lag  1.00       16.9375      0  3  0.  37.25    *prb
20547601 0.05     cntrlvar 475  *lag time const.
*
* auto vlv position demand, b4 drain vlv, in %
20548100 b4draut      constant          40.
*
* drain vlv position, heater b4, normalized to 1.0
20548200 b4drnpos    lag  0.01         0.40         0
20548201 0.05 cntrlvar 481
*
* auto vlv position demand, b4 bypass vlv, in %
20548300 b4byaut     constant         0.0
*
* bypass vlv position, heater b4, normalized to 1.0
20548400 b4byppos    lag  0.01         0.5          0
20548401 0.05 cntrlvar 483
*
* cntrlvar 0486: RFW HTRB5 collapsed liquid level (inches above shell bottom)
20548600 'HTRB5LVL'     sum     12.     15.0     0
20548601 -5.2188        2.500   voidf 860030000 * level taps are at top
20548602                5.2188  voidf 860040000 * & bottom of collector tank
*
* heater b5 level out to LabVIEW
20548700  b5lvlout     lag  1.00       15.0         0  3  0.  30.     *prb
20548701 0.05     cntrlvar 486  *lag time const.
```

```
*
* auto vlv position demand, b5 drain vlv, in %
20549200 b5draut      constant    40.
*
* drain vlv position, heater b5, normalized to 1.0
20549300 b5drnpos    lag  0.01         0.40         0
20549301 0.05 cntrlvar 492
*
* auto vlv position demand, b5 bypass vlv, in %
20549400 b5byaut      constant       0.0
*
* bypass vlv position, heater b5, normalized to 1.0
20549500 b5byppos    lag  0.01         0.0          0                     *prb 01-25-96 09:13pm
20549501 0.05 cntrlvar 494
*
*
* turbine control valve flow
*--------------------------
*
* pressure control unit (other units not modelled since pressure control is
*  sufficient for transients of interest)
*
* steam line pressure (psia)
20550000  slpress      lag  1.450e-04  9.7806598e+02 0
20550001 0.5       p         420030000 * ref. 349 for time constant, ref. 13
*
* pressure error signal (psid)
20550100 presserr      sum  1.000e+00  3.0066700e+01 0
20550101 -947.99951 1.0    cntrlvar 500  * pressure setpoint from ref. 349
* also ref. 361, 13, 14
*
* lead-lag press error signal
20550200 ldlgpres lead-lag  3.333e+00  1.0019800e+02 0
20550201 2.0       5.0     cntrlvar 501 * ref. 14, 349, 361
*
* inverse turbine trip, load limiter & max combined flow limiter
* assumed that load limiter is set to 110. & max combined flow = 125.
20550400 invttrip tripunit  1.100e+02  1.1000000e+02 0
20550401 -601  * ref. 15, 349, 361
*
* pressure control unit signal (lvg output)
20550600 pcusignl stdfnctn  1.000e+00  1.0019800e+02 0
20550601 min       cntrlvar 502
20550602           cntrlvar 504  * ref. 15, 349, 361
```

```
*
* turbine control valves (tcv) relay
20550800 tcvrelay     lag  1.000e+00  1.0019800e+02 0
20550801 0.02     cntrlvar 506  * ref. 349
*
* tcv delay function
20551000 tcvdelay    delay  1.000e+00  1.0019800e+02 0
20551001 cntrlvar  508      0.1       2 * ref. 349
*
* turbine control valve linearization (dfg board output)
20551200 tcvliner function  1.000e+00  5.2970501e+01 0
20551201 cntrlvar  510  520 * ref. 17, 349
* normalized shape of the curve from ref. 349 is the same as the dfg board
* output voltage vs. input voltage signal shown on ref. 17; values from ref.
* 349 are used in the table.
*
* lagged tcv servo position demand in % open
20551400 tcvsrvpd     lag  1.000e+00  5.2970299e+01 0  3   .000e+00  1.000e+02
20551401 0.1     cntrlvar 512 * ref. 16, 349
*
* max tcv positive position change in % open in this time step
20551600 tcvchgmx     mult  1.000e+01  5.0000000e-01 0
20551601 dt      0 * ref. 349
*
* tcv position max value in this time step
20551800 tcvposmx     sum  1.000e+00  5.3470299e+01 0
20551801 0.0      1.0     cntrlvar 516
20551802          1.0     cntrlvar 524 * ref. 349
*
* minimum of tcv position demand & max posit
20552000  tcvmin1 stdfnctn  1.000e+00  5.2970299e+01 0
20552001 min     cntrlvar 514
20552002         cntrlvar 518
*
* tcv position minimum value in % open in this time step
20552200 tcvposmn     sum  1.000e+00  5.2260300e+01 0
20552201 0.0     -1.42     cntrlvar 516 * max closure rate is 14.2% per second
20552202          1.0      cntrlvar 524 * ref. 349
*
* tcv current position with no turbine trip
20552400 postcvnt stdfnctn  1.000e+00  5.2970299e+01 0  3   .000e+00  1.000e+02
20552401 max      cntrlvar 520
20552402          cntrlvar 522
*
```

```
* turbine trip
20552500 turbtrip tripunit  1.000e+00   0. 0
20552501 601
*
* time since turbine trip
20552600 turbtrpt integral  1.000e+00   0. 0
20552601 cntrlvar 525
*
* tcv position multiplier with turbine trip
20552700 trbtmult function  1.000e+00  1.0000000e+00 0
20552701 cntrlvar  526  527   * tcv closure on trip in 0.1 sec, ref. 349
*
* tcv position in current time step
20552800 tcvposit     mult  1.000e+00  5.2970299e+01 0
20552801 cntrlvar  524       cntrlvar  527
*
* steam flow in lb/sec for 978.00 psia (100% turbine inlet pressure)
20553200 untbflow function  3.717e+03  3.7243401e+03 0 * s= 100% flow in lb/s
20553201 cntrlvar  528  535 * ref. 349 for table
*
* steam flow through tcv in lb/sec
*  multiplicative constant s= 1.45038e-4 * 1/978psia, or conversion factor for
*  pa to psia divided by 978 psia.  this gives tcv steam flow at any pressure.
20553600  tcvflow     mult  1.483e-07  3.7255500e+03 0
20553601 cntrlvar 532 * ref. 349
20553602 p 420030000
*
* convert tcv mass flow to velocity
*
20553700  tcvrhoa     mult  6.720e-01  2.4019800e+01 0
20553701 rho       420030000 avol       420030000
*
20553800   tcvvel      div  1.000e+00  1.5510300e+02 0
20553801 cntrlvar  537       cntrlvar   536
*
*
* turbine bypass valve steam flow in lb/sec
*------------------------------------------
*
* pressure regulator and low value gate signal difference in %
20554000 ploaddif      sum  1.000e+00 -2.5000000e+00 0
20554001 -2.5      1.0       cntrlvar 502 * ref. 15, 349, 361
20554002          -1.0       cntrlvar 506 * -2.5 is small closing bias
*
```

```
* combined maximum flow limiter in %
20554200 maxflolm      sum  1.000e+00  2.4802401e+01 0
20554201 125.     -1.0       cntrlvar 506 * ref. 16, 349, 361
*
* bypass valve control signal, lvg output
20554400   bpvsig stdfnctn  1.000e+00   0. 0  3   .000e+00  2.620e+01
20554401 min       cntrlvar  540 * ref. 16, 349, 361
20554402           cntrlvar  542
*
* delayed bypass valve control signal
20554600 bpvsgdel    delay  1.000e+00   0. 0
20554601 cntrlvar  544       0.1  5 * ref. 349
*
* bpv position error signal
20554700 bpverror      sum  2.000e+01   0. 0  3 -1.050e+02  1.050e+02
20554701 0.0       1.0       cntrlvar 546 * ref. 16, 349, 361
20554702          -1.0       cntrlvar 548
*
* bpv servo position
20554800 bpvposit integral  1.000e+00   0. 0  3   .000e+00  2.620e+01
20554801 cntrlvar 547
*
* bpv steam flow in lb/sec
*  multiplicative factor is equal to conversion factor from pa to psia times
*  (1/978 psia) times 0.01 to convert from percentage flow at 978 psia.  s =
*  (1.45038e-4)*(1/978)* 0.01.
20555000 tbpvmflo     mult  5.512e-06   0. 0
20555001 p  420030000  * ref. 349
20555002 cntrlvar 548
*
* convert tbpv mdot to velocity
*
20555200  tbpvvel      div  1.000e+00   0. 0
20555201 cntrlvar  537       cntrlvar   550
*
*
* feedwater flow controller
*-----------------------------------
*
* feedpumps above min speed (in auto)
*
* rfp a above min speed tripunit
20558000 rfpaauto tripunit  1.0        1.0         0
20558001 -691
```

```
*
* rfp b above min speed tripunit
20558100 rfpbauto tripunit  1.0        1.0         0
20558101 -692
*
* rfp c above min speed tripunit
20558200 rfpcauto tripunit  1.0        1.0         0
20558201 -512
*
* woodward governor a error term
*  (in percent or error/100)
20558600 woodaerr      sum  0.02       0.0          0
20558601 0.0      1.0       cntrlvar   689
20558602         -9.549     pmpvel     570
*
* woodward governor b error term
20558700 woodberr      sum  0.02       0.0          0
20558701 0.0      1.0       cntrlvar   686
20558702         -9.549     pmpvel     571
*
* woodward governor c error term
20558800 woodcerr      sum  0.02       0.0          0
20558801 0.0      1.0       cntrlvar   683
20558802         -9.549     pmpvel     572
*
* fsubn a
20559500 fsubn_a      lag  1.0       0.0          0
20559501 0.1   cntrlvar 586
*
* fsubn b
20559600 fsubn_b      lag  1.0       0.0          0
20559601 0.1   cntrlvar 587
*
* fsubn c
20559700 fsubn_c      lag  1.0       0.0          0
20559701 0.1   cntrlvar 588
*
*
*
* level signal, level error
*
* level error in inches
20560200 lvlerror      sum  1.000e+00 -5.6445029e-02 0
20560201 0.0       1.0       cntrlvar   108
```

```
20506022         -1.0      cntrlvar   007     * use with labview
*
* bypass valve control
*
* bypass vlv control multiplier
20560400 byponoff constant   0. * equal 1.0 in bypass vlv auto control
*
* bypass proportional error
20560600 bypprope     mult  1.000e+00   0. 0
20560601 cntrlvar  602       cntrlvar   604 * s = tuning parameter
*
* bypass integral term
20560800 bypinter integral  1.667e-02   0. 0  3 0.  100. * s=tuning parameter in 1/sec
20560801 cntrlvar  606
*
* bypass valve controller lc-3-53 output
20560900  lc-3-53      sum  1.000e-02   0. 0 * s converts 100% demand to 1.0 position dmd
20560901 0.0       1.0       cntrlvar   606
20560902           1.0       cntrlvar   608 * ref. 104, 363
*
* bypass valve controller lc-3-53 switch
20561000  lc353swh     mult 1.0        0.0         0
20561001 cntrlvar  604       cntrlvar   609 * used to simulate manual closing when not in
use
*
* bypass valve position (normalized)
20561100 bypposit      lag  1.000e+00   0. 0  3   .000e+00  1.000e+00
20561101 2.0       cntrlvar  610 * time constant is a guess
*
* variable feedwater pump controller gains
*
* tripunit for feedpump a
20561300 rfpatrip tripunit 1.        1.        0
20561301 -618
*
* tripunit for feedpump b
20561400 rfpbtrip tripunit 1.        1.        0
20561401 -619
*
* tripunit for feedpump c
20561500 rfpctrip tripunit 1.        1.        0
20561501 -620
*
* dependent variable for single element gain
```

```
20561600 e1vargnx sum      1.        313.405    0
20561601 0.0      100.    cntrlvar   580
20561602          100.    cntrlvar   581
20561603          100.    cntrlvar   582
20506164          1.      cntrlvar   631      * use with Labview
*
* single element gain
20561700 e1vargny function 1.        0.86957    0 * tuning parameter
20561701 cntrlvar 616      617
*
* three element gain, level controller
20561800 e3vargny function 1.       0.86957     0 * tuning parameter
20506181 cntrlvar 631      618  * use with Labview
*
* three element gain, sf/fw mismatch controller
20561900 e3misgan function 1.       0.86957     0 * tuning parameter
20561901 cntrlvar 616      619
*
* feedwater flow signal
*
* lagged feedwater mass flow in Mlbm/hr
*  s= conversion factor from kg/sec to Mlb/hr; flow is sum of lagged flows
*  through feedwater lines a and b.  lag time constant is from ref. 349.
20562200 lmflowfw      lag  7.938e-03  1.3405000e+01 0
20562201 0.5       mflowj    605040000
*
* return feedwater mass flow from LabVIEW
20562300 labfwflo constant  1.34050000e+01
*
* steam flow signal
*
* steam mass flow for use without LabVIEW
20563000 stmflow       sum  1.000e+00  1.3400000e+01 0
20563001 0.0       1.0       cntrlvar   900
20563002           1.0       cntrlvar   901
20563003           1.0       cntrlvar   902
*
* return steam mass flow from LabVIEW
20563100 labstflo constant  1.34050000e+01
*
*
* single or three element control selection
*
* bypass valve not being controlled multiplier
```

```
*  = 1 when bypass valve is not used to control level, 0 when in use.
20563400 bypasnot      sum  1.000e+00  1.0000000e+00 0
20563401 1.0      -1.0       cntrlvar   604
*
* operator selected single element feed pump control
*  = 1 when selected, 0 otherwise
20564600 e1selctd constant   0.
*
* single element feed pump control multiplier
*  = 1 when operator selected or tripped, 0 otherwise
20564800 sngelmlt tripunit  1.000e+00   0. 0
20564801 671
*
* operator selected three element feed pump control
*  = 1 when operator selected, 0 otherwise
20565000 elem3sel constant  1.0000000e+00
*
* single element inverse tripunit
*  = 1 when single element feed pump control is not selected or tripped
20565200 notsngle tripunit  1.000e+00  1.0000000e+00 0
20565201 -671
*
* three element level controller
*
* level pi zeroing error for 1e operation
20563200 e3lvlzer     mult  -1.0       0.0           0
20563201 cntrlvar  655       cntrlvar  648
*
* level error term for three element control
20565300 e3lvlerr     mult  1.0       0.0           0
20565301 cntrlvar  602       cntrlvar  652
20565302 cntrlvar  634
*
* proportional error term for three element control
20565400 e3proper     mult  0.2       0.0           0 * jam 11/10 s = 16M#/hr/80"
20565401 cntrlvar  653       cntrlvar  618
*
* three element level error signal (1e or 3e)
20565500 e3lvler1     sum  1.0        0.0           0
20565501 0.0       1.0      cntrlvar  632
20565502           1.0      cntrlvar  654
*
* three element level integrand
20565600 e3integd  integral 9.5238e-03 0.0           0 3  -16.  16.
```

```
20565601 cntrlvar  655
*
* steam flow in 3e, 0 otherwise
20565700 e3stmflo     mult  1.0       13.407       0
20506571 cntrlvar 631  cntrlvar 650  cntrlvar 652       * use with Labview
*
* feed flow in 1e, 0 otherwise
20565800 e1fdflo      mult  1.0       0.          0
20506581 cntrlvar  648  cntrlvar 623    * use with labview
*
* three element controller when in 3e or tracking in 1e
20565900 e3-e3cnt      sum  1.0       13.407       0 3 0.  16.
20565901 0.0       1.0      cntrlvar  654
20565902           1.0      cntrlvar  656
20565903           1.0      cntrlvar  657
20565904           1.0      cntrlvar  658
*
*
* steam flow feedwater flow mismatch
*
* level controller + steam flow minus feed flow
20566000 fwstmdel      sum  1.000e+00  0.000          0 * equals 0 when not in 3e
20566001 0.0       1.0      cntrlvar   659 * level pi + stm flow, ff in 1e
20506602          -1.0      cntrlvar   623 * feedflow (with Labview)
*
* feed flow proportional error
20566100 ffproerr     mult  6.250e+00  0.0          0 *jam 11/10 s = 100%/16M#/hr
20566101 cntrlvar  660      cntrlvar   619
*
* track 1e error
20566200 e1errtr      sum  1.0       0.0          0
20566201 0.0       1.0      cntrlvar  682
20566202          -1.0      cntrlvar  665
*
* track 1e error times 1e multiplier
20566300 e1ertrp     mult  1.0       0.0          0
20566301 cntrlvar 662  cntrlvar 648
*
* total error for sf_fw integral
20566400 sffwerr      sum  1.0       0.0          0
20566401 0.0       1.0      cntrlvar  663
20566402           1.0      cntrlvar  661
*
* three element sf_fw integrand
```

```
20566500 sffwintg  integral 2.3813-01  84.324       0 3 0. 100.
20566501 cntrlvar  664
*
* three element sf_fw controller output
20566600 sffwout       sum  1.0       84.324       0 3 0. 100.
20566601 0.0       1.0       cntrlvar  665
20566602           1.0       cntrlvar  661
*
*
* single element controller
*
* level error term for single element control
20566700 e1lvlerr     mult  1.0       0.0          0
20566701 cntrlvar  602       cntrlvar  648
20566702 cntrlvar  634       cntrlvar  200
*
* proportional error term for single element control
20566800 e1proper     mult  1.25       0.0          0 *jam 11/10 s= 100%/80"
20566801 cntrlvar  667       cntrlvar  617
*
* three element tracking error
20566900 e3trerr       sum  1.0       0.0          0
20566901 0.0       1.0      cntrlvar  666
20566902          -1.0     cntrlvar  675
*
* three element tracking error when in 3e
20567000 e3trerrt     mult  1.0       0.0          0
20567001 cntrlvar  669  cntrlvar 650  cntrlvar 652
*
* single element integral error term
20567100 e1err        sum  1.0       0.0          0
20567101 0.0       1.0  cntrlvar  670
20567102           1.0  cntrlvar  668
20567103           1.0  cntrlvar  804
*
* single element integrand
20567400 e1integd  integral 1.667e-2   84.324       0 3 0. 100.
20567401 cntrlvar  671
*
* single element controller
20567500 e1-e1cnt      sum  1.0       84.324       0 3 0.  100.
20567501 0.0       1.0       cntrlvar  668
20567502           1.0       cntrlvar  674
*
```

```
* track 3E selection
20567600 track3el     mult  1.0       84.324       1
20567601 cntrlvar  652       cntrlvar  666
*
* track 1E selection
20567700 track1el     mult  1.0       0.          0
20567701 cntrlvar  648       cntrlvar  675
*
* controller output in 1e or 3e
20567800 e1-e1e3o      sum  1.0       84.324       0 3 0. 100.
20567801 0.0       1.0       cntrlvar  677
20567802           1.0       cntrlvar  676
*
* scram response tripunit
20567900 scrrespt tripunit 37.0       0.          0
20567901 679 * = 37 when scram respnse in, 0 otherwise
*
* max controller output following a scram response
20568000 scrrspmx      sum  1.0       100.         0
20568001 100.     -1.0       cntrlvar  679 * 63. when response in
*
* single element controller out in 1e/3e w/ scram response
20568100 e1scram  stdfnctn  1.0       84.324       0
20568101 min  cntrlvar 680  cntrlvar 678
*
* controller output with bypass zero feature
20568200 i_apiout     mult  1.0       84.324       0
20568201 cntrlvar  681       cntrlvar  634
*
* conversion of demand signal to speed demand
20568300 spddmd       sum  1.0       4816.2       0
20568301 600.     50.       cntrlvar  682
*
* individual pump responses
*
* pump b speed limiter tripunit
20568400 b600rpm  tripunit  9400.     0.0         0
20568401 681 * s = amt subtracted from large # to give limit
*
* pump b speed limit following scram response
20568500 b600limt sum       1.0       10000.      0
20568501 10000.  -1.0       cntrlvar   684
*
* pump b speed controller output
```

20568600 bcontout stdfnctn 1.0 4816.2 0
20568601 min cntrlvar 685 cntrlvar 683 * controller output to pump b
*
* pump a speed limiter tripunit
20568700 a600rpm tripunit 9400. 0.0 0
20568701 684 * s = amt subtracted from large # to give limit
*
* pump a speed limit following scram response
20568800 a600limt sum 1.0 10000. 0
20568801 10000. -1.0 cntrlvar 687
*
* pump a speed controller output
20568900 acontout stdfnctn 1.0 4816.2 0
20568901 min cntrlvar 688 cntrlvar 683 * controller output to pump a
*
*
* mathematical models of governors
*
*** woodward a governor differential term**
20569000 woodadif diffreni 3.5 0.0 0
20569000 woodadif diffreni .35 0.0 0
20569001 cntrlvar 595
*
*** woodward b governor differential term**
20569100 woodbdif diffreni .35 0.0 0
20569101 cntrlvar 596
*
*** woodward c governor differential term**
20569200 woodcdif diffreni .35 0.0 0
20569201 cntrlvar 597
*
* woodward a governor integral term
20569600 woodaint integral **2.8e+00** 37.983 0 3 0. 100.
20569601 cntrlvar **595**
*
* woodward b governor integral term
20569700 woodbint integral **2.8e+00** 37.983 0 3 0. 100.
20569701 cntrlvar **596**
*
* woodward c governor integral term
20569800 woodcint integral **2.8e+00** 37.983 0 3 0. 100.
20569801 cntrlvar **597**
*
* woodward a output in valve poppet dmd (sec op cyl pos)

```
*  s=  (6.37"/100%)
20569900 woodaout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20569901 0.0       7.00    cntrlvar  595
20569902           1.0     cntrlvar  690
20569903           1.0     cntrlvar  696
*
* woodward b output in valve poppet dmd (sec op cyl pos)
*  s=  (6.37"/100%)
20570000 woodbout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20570001 0.0       7.00    cntrlvar  596
20570002           1.0     cntrlvar  697
20570003           1.0     cntrlvar  691
*
* woodward c output in valve poppet dmd (sec op cyl pos)
*  s=  (6.37"/100%)
20570100 woodcout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20570101 0.0       7.00    cntrlvar  597
20570102           1.0     cntrlvar  698
20570103           1.0     cntrlvar  692
*
* woodward a output w/ pump tripunit
20570500 rfpasctr    mult  1.0       2.4195700e+00 0
20570501 cntrlvar 613  cntrlvar 699
*
* woodward b output w/ pump tripunit
20570600 rfpbsctr    mult  1.0       2.4195700e+00 0
20570601 cntrlvar 614  cntrlvar 700
*
* woodward c output w/ pump tripunit
20570700 rfpcsctr    mult  1.0       2.4195700e+00 0
20570701 cntrlvar 615  cntrlvar 701
*
* rfpt a secondary operating cylinder position (valve position)
20570800 secopaps     lag  1.000e+00  2.4195700e+00 0
20570801 0.1       cntrlvar  705 * lag time constant is a guess to acct for
*                         valve response to sec op cyl position
*
* rfpt b secondary operating cylinder position (valve position)
20570900 secopbps     lag  1.000e+00  2.4187300e+00 0
20570901 0.2       cntrlvar  706 * lag time constant is from governor tuning
*
* rfpt c secondary operating cylinder position (valve position)
20571000 secopcps     lag  1.000e+00  2.4187300e+00 0
20571001 0.2       cntrlvar  707 * lag time constant is from governor tuning
```

```
*
* steam inlet valve and turbine math models
*
* rfp a instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571100 rfpamdot     sum  2.911e+01  6.6794998e+01 0  3   .000e+00  8.020e+01
20571101 -.125     1.0       cntrlvar  708  * cntrlvar 708 is sec cyl travel
*
* rfp b instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571200 rfpbmdot     sum  2.911e+01  6.6770401e+01 0  3   .000e+00  8.020e+01
20571201 -.125     1.0       cntrlvar  709  * cntrlvar 709 is sec cyl travel
*
* rfp c instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571300 rfpcmdot     sum  2.911e+01  6.6770500e+01 0  3   .000e+00  8.020e+01
20571301 -.125     1.0       cntrlvar  710  * cntrlvar 710 is sec cyl travel
*
* rfp a instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571400 rfpahpfl     sum  2.381e+01   0. 0  1  .000e+00
20571401 -2.88     1.0       cntrlvar   708  * cntrlvar 708 is sec cyl travel
*
* rfp b instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571500 rfpbhpfl     sum  2.381e+01   0. 0  1  .000e+00
20571501 -2.88     1.0       cntrlvar   709  * cntrlvar 709 is sec cyl travel
*
* rfp c instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571600 rfpchpfl     sum  2.381e+01   0. 0  1  .000e+00
20571601 -2.88     1.0       cntrlvar   710  * cntrlvar 710 is sec cyl travel
*
* lp poppet inlet pressure, based on steam flow, see curves developed by saic
*  from heat balance information
20571700 lppopptp     sum  1.427e+01  1.9357700e+02 0  1 1.470e+01
20571701 0.1510    1.0       cntrlvar   900
20571702           1.0       cntrlvar   901
```

```
20571703          1.0      cntrlvar   902
*
* multiplicative factor for low press flow based on inlet pressure
*  assumed linear with p-inlet
20571800 flowmult     mult  5.035e-03  9.7465998e-01 0
20571801 cntrlvar  717
*
* multiplicative factor for high press flow based on inlet pressure
*  assumed linear with p-inlet
20571900 hflomult     mult  1.503e-07  1.0138201e+00 0
20571901 p         420030000 * s = (1/965psia)(1.450383-4 psi/pa)
*
* lp delta enthalpy across rfpt in btu/lbm vs. inlet pressure
20572000 rfptenth function  1.000e+00  2.2703700e+02 0
20572001 cntrlvar  717       663
*
* hp delta enthalpy across rfpt in btu/lbm vs. inlet pressure
20572100 hpdlenth function  1.000e+00  2.6450000e+02 0
20572101 p         420030000 663
*
* rfp a instantaneous turbine power output in hp from lp valves
20572200 talpipwr     mult  3.930e-01  5.8087798e+03 0
20572201 cntrlvar  720       cntrlvar   718
20572202 cntrlvar  711
*
* rfp b instantaneous turbine power output in hp from lp valves
20572300 tblpipwr     mult  3.930e-01  5.8066401e+03 0
20572301 cntrlvar  720       cntrlvar   718
20572302 cntrlvar  712
*
* rfp c instantaneous turbine power output in hp from lp valves
20572400 tclpipwr     mult  3.930e-01  5.8066499e+03 0
20572401 cntrlvar  720       cntrlvar   718
20572402 cntrlvar  713
*
* rfp a instantaneous turbine power output in hp from hp valves
20572500 tahpipwr     mult  3.930e-01   0. 0
20572501 cntrlvar  721       cntrlvar   719
20572502 cntrlvar  714
*
* rfp b instantaneous turbine power output in hp from hp valves
20572600 tbhpipwr     mult  3.930e-01   0. 0
20572601 cntrlvar  721       cntrlvar   719
20572602 cntrlvar  715
```

```
*
* rfp c instantaneous turbine power output in hp from hp valves
20572700 tchpipwr     mult  3.930e-01   0. 0
20572701 cntrlvar  721       cntrlvar   719
20572702 cntrlvar  716
*
* rfp a instantaneous turbine power output in hp
20573000 rfptaipw      sum  1.000e+00  5.8087798e+03 0
20573001 0.0       1.0       cntrlvar   725
20573002           1.0       cntrlvar   722
*
* rfp b instantaneous turbine power output in hp
20573100 rfptbipw      sum  1.000e+00  5.8066401e+03 0
20573101 0.0       1.0       cntrlvar   726
20573102           1.0       cntrlvar   723
*
* rfp c instantaneous turbine power output in hp
20573200 rfptcipw      sum  1.000e+00  5.8066499e+03 0
20573201 0.0       1.0       cntrlvar   727
20573202           1.0       cntrlvar   724
*
* rfp a turbine power output in hp
20573500 rfptapwr      lag  1.000e+00  5.8088701e+03 0
20573501 0.05      cntrlvar  730
*
* rfp b turbine power output in hp
20573600 rfptbpwr      lag  1.000e+00  5.8067700e+03 0
20573601 0.05      cntrlvar  731
*
* rfp c turbine power output in hp
20573700 rfptcpwr      lag  1.000e+00  5.8067798e+03 0
20573701 0.05      cntrlvar  732
*
* rfpa load power,pl, in hp
20574000 rfpalpwr     mult  1.341e-03 -5.8111099e+03 0
20574001 pmpvel    570       pmptrq     570
*
* rfpb load power,pl, in hp
20574100 rfpblpwr     mult  1.341e-03 -5.8104702e+03 0
20574101 pmpvel    571       pmptrq     571
*
* rfpc load power,pl, in hp
20574200 rfpclpwr     mult  1.341e-03 -5.8104800e+03 0
20574201 pmpvel    572       pmptrq     572
```

```
*
* rfp a differential power
20574500 rfpadpwr      sum  1.000e+00 -2.2463901e+00 0
20574501 0.0       1.0       cntrlvar   735
20574502           1.0       cntrlvar   740
*
* rfp b differential power
20574600 rfpbdpwr      sum  1.000e+00 -3.7010801e+00 0
20574601 0.0       1.0       cntrlvar   736
20574602           1.0       cntrlvar   741
*
* rfp c differential power
20574700 rfpcdpwr      sum  1.000e+00 -3.7016301e+00 0
20574701 0.0       1.0       cntrlvar   737
20574702           1.0       cntrlvar   742
*
* rfp a net angular acceleration, in rpm/sec
20575000 rfpaalfa      div  3.806e+02 -1.7738999e-01 0 * (550lbf-ft/hp-sec)(32.17lbm-ft**2/
20575001 cntrlvar  756  cntrlvar  745   * sec**2)(60sec/min)**2
*                                   /{(4239lbm-ft**2)(2pi)**2} = s
*
* rfp b net angular acceleration, in rpm/sec
20575100 rfpbalfa      div  3.806e+02 -2.9226699e-01 0
20575101 cntrlvar  757       cntrlvar   746
*
* rfp c net angular acceleration, in rpm/sec
20575200 rfpcalfa      div  3.806e+02 -2.9231101e-01 0
20575201 cntrlvar  758       cntrlvar   747
*
* rfp a delta rpm
20575300 rfpadrpm     mult  1.000e+00 -8.8695129e-03 0
20575301 cntrlvar  750       dt        0
*
* rfp b delta rpm
20575400 rfpbdrpm     mult  1.000e+00 -1.4613370e-02 0
20575401 cntrlvar  751       dt        0
*
* rfp c delta rpm
20575500 rfpcdrpm     mult  1.000e+00 -1.4615540e-02 0
20575501 cntrlvar  752       dt        0
*
* rfp a current rpm
20575600  rfparpm      sum  1.000e+00  4.8197402e+03 0
20575601 0.0       1.0       cntrlvar   753
```

```
20575602          1.0      cntrlvar   756
*
* rfp b current rpm
20575700  rfpbrpm     sum  1.000e+00  4.8196499e+03 0
20575701 0.0      1.0      cntrlvar   754
20575702          1.0      cntrlvar   757
*
* rfp c current rpm
20575800  rfpcrpm     sum  1.000e+00  4.8196499e+03 0
20575801 0.0      1.0      cntrlvar   755
20575802          1.0      cntrlvar   758
*
20580200 output01  tripunit 1.0       0.          0
20580201 520
*
20580300 scramerr     sum  7.5       0.          0
20580301 63.      -1.0      cntrlvar   675
*
20580400 scramer1     mult  .027027    0.          0
20580401 cntrlvar  679  cntrlvar 802 cntrlvar 803
*
*
*--------------------------------
* additional rfwcs output control variables *
*--------------------------------
* mass flow rate, steam line a, in mlbm/hr
20590000  stmfloa     mult  7.938e-03  3.3373001e+00 0
20590001 mflowj 412000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* mass flow rate, steam line b, in mlbm/hr
20590100  stmflob     mult  7.938e-03  3.3373001e+00 0
20590101 mflowj 411000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* mass flow rate, steam line c/d, in mlbm/hr
20590200 stmflocd     mult  7.938e-03  6.7396998e+00 0
20590201 mflowj 410000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* reactor scram signal
20590600 scramsig tripunit  1.000e+00   0. 0
20590601 649
*
* level 8 signal (trips all rfps)
20590700 lvl8_sig tripunit  1.000e+00   0. 0
20590701 406
```

```
*
*  problem time
20590800 probtime     mult  1.000e+00  1.0000000e+03 0
20590801  time    0
*
*
20591000  rfparpm     mult  9.549e+00  4.8196001e+03 0
20591001 pmpvel 570
*
20591100  rfparpm     mult  9.549e+00  4.8195098e+03 0
20591101 pmpvel 571
*
20591200  rfparpm     mult  9.549e+00  4.8195098e+03 0
20591201 pmpvel 572
*
* cntrlvar 940: RFW HTRC1 collapsed liquid level (inches above lower tap)
20594000 'HTRC1LVL'     sum     12.     16.0     1
20594001 -2.6641        1.3307  voidf   922010000
20594002                2.6667  voidf   921030000
20594003                2.6667  voidf   921020000
*20509404               10.4596 voidf   921010000
*20509405               13.7904 voidf   920010000
*
* heater c1 level out to LabVIEW
20594100  c1lvlout     lag  1.00       33.0         0  3  0.  44.
20594101 0.5      cntrlvar 940  *lag time const.
*
* auto vlv position demand, c1 drain vlv, in %
20594900 c1draut      constant       32.
*
* drain vlv position, heater c1
20595000 c1drnpos    lag  0.01         0.32         0
20595001 0.05  cntrlvar 949
*
* cntrlvar 0951: RFW HTRC2 collapsed liquid level (inches above lower tap)
20595100 'HTRC2LVL'     sum     12.     18.0     1
20595101 -6.9974        5.4974  voidf   933010000
20595102                3.0000  voidf   932020000
20595103                3.0000  voidf   932010000
*20509514               8.8763  voidf   931010000
*20509515               10.2904 voidf   930010000
*
* heater c2 level out to LabVIEW
20595200  c2lvlout     lag  1.00       18.0         0  3  0.  36.     *prb
```

```
20595201 0.5      cntrlvar 951  *lag time const.
*
* auto vlv position demand, c2 drain vlv, in %
20595700 c2draut      constant    44.
*
* drain vlv position, heater c2
20595800 c2drnpos    lag  0.01         0.44         0
20595801 0.05 cntrlvar 957
*
* auto vlv position demand, c2 bypass vlv, in %
20595900 c2byaut      constant       0.0
*
* bypass vlv position, heater c2, normalized to 1.0
20596000 c2byppos    lag  0.01         0.0          0
20596001 0.05 cntrlvar 959
*
* cntrlvar 0965: RFW HTRC3 collapsed liquid level (inches above lower tap)
20596500 'HTRC3LVL'     sum     12.     18.0     0
20596501 -15.6068       7.0534  voidf   942040000
20596502               7.0534  voidf   942030000
20596503               3.0000  voidf   942020000
20596504               3.0000  voidf   942010000
*20509655               11.1133 voidf   941010000
*20509656               12.4284 voidf   940010000
*
* heater c3 level out to LabVIEW
20596600  c3lvlout     lag  1.00       18.0         0  3  0.  36.      *prb
20596601 0.5      cntrlvar 965  *lag time const.
*
* auto vlv position demand, c3 drain vlv, in %
20597100 c3draut      constant       34.
*
* drain vlv position, heater c3
20597200 c3drnpos    lag  0.01         0.34         0
20597201 0.05  cntrlvar 971
*
* cntrlvar 0975: RFW HTRC4 collapsed liquid level (inches above shell bottom)
20597500 'HTRC4LVL'     sum     12.     16.9375  0
20597501 0.0    0.1667  voidf   951010000   * upper tap 2" above centerline
20597502        2.9375  voidf   952010000   * shell radius
*
* heater c4 level out to LabVIEW
20597600  c4lvlout     lag  1.00       16.9375      0  3  0.  37.25    *prb
20597601 0.05      cntrlvar 975  *lag time const.
*
```

```
* auto vlv position demand, c4 drain vlv, in %
20598100 c4draut      constant     40.
*
* drain vlv position, heater c4, normalized to 1.0
20598200 c4drnpos    lag  0.01         0.40         0
20598201 0.05 cntrlvar 981
*
* auto vlv position demand, c4 bypass vlv, in %
20598300 c4byaut      constant       0.0
*
* bypass vlv position, heater c4, normalized to 1.0
20598400 c4byppos    lag  0.01         0.0          0                       *prb 01-24-96 10:46am
20598401 0.05 cntrlvar 983
*
* cntrlvar 0986: RFW HTRC5 collapsed liquid level (inches above shell bottom)
20598600 'HTRC5LVL'     sum     12.    15.0    0
20598601 -5.2188        2.500   voidf 960030000 * level taps are at top
20598602                5.2188  voidf 960040000 * & bottom of collector tank
*
* heater c5 level out to LabVIEW
20598700  c5lvlout     lag  1.00       15.0        0  3  0.  30.     *prb
20598701 0.05      cntrlvar 986  *lag time const.
*
* auto vlv position demand, c5 drain vlv, in %
20599200 c5draut      constant       40.
*
* drain vlv position, heater c5, normalized to 1.0
20599300 c5drnpos    lag  0.01         0.40         0
20599301 0.05 cntrlvar 992
*
* auto vlv position demand, c5 bypass vlv, in %
20599400 c5byaut      constant        0.0
*
* bypass vlv position, heater c5, normalized to 1.0
20599500 c5byppos    lag  0.01        0.0          0                       *prb 01-25-96 09:22pm
20599501 0.05 cntrlvar 994
*
*
*-----------------------------------------------
*  hydrodynamic components
*-----------------------------------------------
*-----------------------------------------------
*  reactor vessel
*-----------------------------------------------
```

```
* note:  initial conditions are takent from the output
*       of a steady state calculation run for 1000 sec.
*
*       the brown's ferry retran input deck is
*       reference [349]
*-------------------------------------------
* (100)  entrance volume to core
*-------------------------------------------
1000000     lplenum    branch
*card      jun        vel/flow
1000001          1        0
*
*card     vol flow area   vol length    vol of vol   az angle
1000101     0.0           17.534      2230.000       0.
*card      inc angle    elev change roughness   hyd dia   pvbfe
1000102     90.         17.534        5.e-6      .8628    00000
*----------------------------------------------------------------
* volume length, volume, elev change, hyd dia are from ref. [349].
*----------------------------------------------------------------
*card      ebt       press     ul        ug       alpha
1000200   0 1.0450000e+03 5.1590997e+02 1.1091000e+03  0.
*
*  jun (100-01) lower plenum to core inlet
*-------------------------------------------
*card       from        to        area      kf      kr       fvcahs
1001101     100010000   110000000   37.503    0.0000  9.1510   001000
*------------------------------------------------------------------
* junction area is from ref. [349]
* kf:  modelling assumption
* kr:  ref. [349]
*------------------------------------------------------------------
*card      int. liq flow   int. vap flow      int vel
1001201     1.5436000e+01  1.7542999e+01   0.
*
*-------------------------------------------
*  (110) core inlet
*-------------------------------------------
*card      name        type
1100000    corein      branch
*
*card      jun        vel/flow
1100001          2        0
*
*card     vol flow area   vol length    vol of vol   az angle
```

```
1100101      0.0         0.492         37.710     0.
*card     inc angle    elev change roughness   hyd dia   pvbfe
1100102     90.        0.492        5.e-6      0.04461  00000
*---------------------------------------------------------------
* volume length, volume, elev change, hyd dia are from ref. [349].
*---------------------------------------------------------------
*card      ebt       press      ul      ug       alpha
1100200   0 1.0417000e+03 5.1590997e+02 1.1092000e+03  0.
*
*  jun (110-01) core inlet to reactor core
*-------------------------------------------
*card       from        to        area     kf     kr     fvcahs
1101101      110010000   120000000  83.9636  0.615385 0.07692  001000
*--------------------------------------------------------------------
* junction area, kf, and kr are from ref. [349].
*--------------------------------------------------------------------
*card       int. liq flow   int. vap flow      inter. vel
1101201      6.0906000e+00  9.3687000e+00   0.
1102201      1.0246000e+02  1.0581000e+02   0.
*
*  jun (110-02) core inlet to core bypass
*-------------------------------------------
*card       from        to        area     kf     kr      fvcahs
1102101      110010000   130000000   0.6590    0.084   0.648    001000
*--------------------------------------------------------------------
* junction area is from ref. [349].
* kf:  modelling assumption used to achieve a 0.119 bypass ratio
* kr:  ref. [349]
*--------------------------------------------------------------------
*
*  ---------------------------------------------------------
*  (111)  loca time dependent junction
*  ---------------------------------------------------------
*card     component name     type
1110000      locajun        tmdpjun
1110101      100000000   113000000  0.
1110200   1  468
1110201   -1.0  0.0  0.0  0.0
1110202    0.0  40.0 0.0  0.0
*
*
*  ---------------------------------------------------------
*  (112)  single junction:  core region (120) - core exit (170)
*  ----------------------------------------------------------
```

```
*card     component name     type
1120000     singjun        sngljun
*
*card   from vol    to vol     jun area    f loss    r loss  fvcahs
1120101 120010000  170000000    84.9744   0.10000   7.11200 001000
*-----------------------------------------------------------------
* junction area, kf, and kr are from ref. [349].
*-----------------------------------------------------------------
*
*card   vel/flow  int liq flow      int vapor flow      interface vel
1120201    0  1.6455999e+01  2.8388000e+01   0.
*
*--------------------------------------
*  (113) loca time dependent volume
*--------------------------------------
*card     component name     type
1130000   locavol           tmdpvol
1130101  0.  1. 1.  0.  0.  0.  0.  0.  00000
1130200  001
1130201 0.0 526. 0.
*
*--------------------------------------
*  (120) core region  (pipe)
*--------------------------------------
*card       component     type
1200000       core       pipe
*
*card       num vol
1200001        5
*card       vol flow area   vol
1200101        0.0          5
*card       jun flow area   jun
1200201        0.0          4
*card       vol length      vol
1200301        2.7386       5
*card       vol of vol      vol
1200401      232.7108       5
*card       azmuthal angle  vol
1200501        0.0          5
*card     inclination angle  vol
1200601       90.0          5
*card     elevation change   vol
1200701        2.7386       5
*card     wall roughness     hyd dia    vol
```

```
1200801        5.e-6      0.0446      5
*------------------------------------------
* vol length, vol, elev change are calculated in
* appendix a.  hyd dia from ref. [349].
*-------------------------------------------
*card       f loss coeff     r loss coeff    jun
1200901        2.0000           0.2500       4
*--------------------------------------------
* kf and kr are calculated in appendix a
*--------------------------------------------
*card         pvbfe          vol
1201001        11100           5
*
*card         fvcahs         jun
1201101        001000          4
*
*card    ebt   press       ul        ug     alpha      w5  vol
1201201 0 1.0410000e+03 5.3301001e+02 1.1092000e+03 1.1264000e-01  .0  1
1201202 0 1.0395000e+03 5.4077002e+02 1.1093000e+03 3.7233001e-01  .0  2
1201203 0 1.0377000e+03 5.4346002e+02 1.1093000e+03 4.7633001e-01  .0  3
1201204 0 1.0356000e+03 5.4379999e+02 1.1094000e+03 5.1504999e-01  .0  4
1201205 0 1.0334000e+03 5.4351001e+02 1.1095000e+03 6.8190002e-01  .0  5
*
*card        vel/flow
1201300 0
*
*card      int liq flow      int vap flow      inter vel  jun
1201301     6.8456001e+00  1.0574000e+01   0.          1
1201302     9.4076996e+00  1.5172000e+01   0.          2
1201303     1.0775000e+01  2.3551001e+01   0.          3
1201304     1.1115000e+01  3.1582001e+01   0.          4
*
*------------------------------
*  (130) core bypass  (branch)
*------------------------------
*card     component name     type
1300000     coreby          branch
*
*card       num jun        vel/flow
1300001           1        0
*
*card      vol flow area     vol length     vol of vol     az angle
1300101       0.0             13.693        952.140       0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
```

```
1300102      90.0       13.693       5.0e-6     0.1867     00000
*-----------------------------------------------------------------
* vol length, vol, elev change, hyd dia are from ref. [349].
*-----------------------------------------------------------------
*card    ebt    press      ul        ug        alpha
1300200   0 1.0351000e+03 5.1590997e+02 1.1094000e+03  0.
*
*  jun (130-01)   core bypass - core exit
*-------------------------------------------
*card    from vol     to vol   jun area    f loss    r loss    fvcahs
1301101  130010000  170000000   46.5040    0.747     0.374     001000
*-------------------------------------------------------------------
* junction area, kf, kr are from the ref. [349].
*-------------------------------------------------------------------
*card    int liq flow    int vap flow    inter vel
1301201      1.4520000e+00  6.1647000e+00   0.
*
*-----------------------------------------
*  (140)   lower downcomer  (branch)
*-----------------------------------------
*card     component name     type
1400000     lowerdc         branch
*card       num jun   vel/flow
1400001            2        0
*
*card      vol flow area     vol length     vol of vol   az angle
1400101         0.0           21.330         2004.467      0.0
*card      inc angle    elev change    rough       hyd dia      pvbfe
1400102      -90.0        -21.330      5.e-6     1.9452      00000
*----------------------------------------------------------------
* vol length, vol, elev change are calculated in app a
* hyd dia from ref. [349]
*----------------------------------------------------------------
*card       ebt      press       ul       ug    alpha
1400200   0 1.0323000e+03 5.1578003e+02 1.1095000e+03  0.
*
*  jun (140-01)    lower downcomer to recirculation pump suction(a)
*------------------------------------------------------------
*card   from vol    to vol   jun area    f loss   r loss  fvcahs
1401101 140010000  220000000   3.5410    0.005    1.00   001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf modelling assumption,
* kr from ref. [349]
*-----------------------------------------------------------------
```

```
*card    int liquid flow      int vapor flow    inter vel
1401201      2.8816000e+01  3.0966000e+01   0.
1402201      2.8816000e+01  3.0966000e+01   0.
*
*  jun (140-02)   lower downcomer to recirculation pump suction(b)
*------------------------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss  fvcahs
1402101 140010000  270000000   3.5410     0.005     1.00  001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf modelling assumption,
* kr from ref. [349]
*-----------------------------------------------------------------
*
*-----------------------------------
*  (150)  middle downcomer  (branch)
*-----------------------------------
*card     component name     type
1500000    middledc         branch
*card       num jun       vel/flow
1500001           1          0
*
*card      vol flow area     vol length      vol of vol     az angle
1500101       0.0            12.739       1411.466        0.0
*card      inc angle    elev change    roughness     hyd dia  pvbfe
1500102      -90.0        -12.739       5.e-6       2.716    00000
*----------------------------------------------------------------
* see note with card 1400101
*----------------------------------------------------------------
*card       ebt     press     ul      ug     alpha
1500200   0 1.0266000e+03 5.1595001e+02 1.1097000e+03  0.
*
*  jun (150-01)   middle downcomer to lower downcomer
*----------------------------------------------
*card   from vol    to vol    jun area  f loss   r loss  fvcahs
1501101 150010000  140000000   87.0380   0.00     0.00    001000
*-----------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*-----------------------------------------------------------------
*card    int liquid flow     int vapor flow   inter vel
1501201      2.3452001e+00  2.9754000e+00   0.
*
*-------------------------------------
*  (160) upper downcomer
*-------------------------------------
```

```
*card      name         type
1600000    uppdc        branch
*
*card      jun        vel/flow
1600001           1        0
*
*card     area   length of vol   vol of vol    az angle
1600101    0.        6.167         965.359      0.0
*card    inc angle   elev change   roughness    hyd dia    pvbfe
1600102    -90.      -6.167        5.e-6       0.8132    00000
*-----------------------------------------------------------
* see note with card 1400101
*-----------------------------------------------------------
*card     ebt    press       ul        ug         alpha
1600200   0 1.0242000e+03 5.2938000e+02 1.1099000e+03 6.2769002e-01
*
*   jun (160-01)   upper downcomer to middle downcomer
*---------------------------------------------------
*card     from        to         area      kf      kr     fvcahs
1601101   160010000   150000000   156.536    0.00   0.00   001000
*------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*------------------------------------------------------------
*card    int liq flow   int vap flow     inter. vel.
1601201     -1.8235701e-04 -1.7219000e+00   0.
*
*--------------------------------
*  (170)  core exit  (branch)
*--------------------------------
*card     component name     type
1700000     uplenum       branch
*card       num jun       vel/flow
1700001           0        0
*
*card      vol flow area     vol length     vol of vol     az angle
1700101       0.0            12.739        1330.250       0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1700102       90.0        12.739        5.e-6       0.5054    10000
*----------------------------------------------------------------
* vol length, vol, elev change, hyd dia from ref. [349]
*----------------------------------------------------------------
*card       ebt    press      ul      ug       alpha
1700200   0 1.0315000e+03 5.4301001e+02 1.1095000e+03 5.4667002e-01
*
```

```
*---------------------------------------------
*  (180) steam separator  (branch:separator)
*---------------------------------------------
*card     component name       type
1800000   seprt               separatr
*
*card       num jun         vel/flow
1800001           3        0
*
*card      vol flow area     vol length     vol of vol     az angle
1800101        0.0          6.167          461.676       0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1800102     90.0       6.167          5.e-6       0.7658     00010
*-----------------------------------------------------------------
* vol length, vol, elev change, hyd dia from ref. [349]
*-----------------------------------------------------------------
*card      ebt  pres      ul       ug     vapor void fraction
1800200   0 1.0251000e+03 5.4235999e+02 1.1096000e+03 6.9423002e-01
*
*  jun (180-01)   separator - steam dome
*------------------------------------
*card   from vol    to vol    jun area  f loss  r loss  fvcahs   void
1801101 180010000 190000000 280.478 150. 150.   001000 0.5 * kwr
*-----------------------------------------------------------------
* junction area is set equal to the volume flow area of the steam dome
* kf, kr from ref. [349]
*-----------------------------------------------------------------
*card   int liq flow   int vap flow  inter vel
1801201      3.4347999e-01  5.7609000e+00   0.
1802201      8.6007996e+00  8.6309996e+00   0.
1803201      1.0917000e+01  2.7964001e+01   0.
*
*   jun (180-02)   separator to middle downcomer
*---------------------------------------------
*card   from vol   to vol    jun area  f loss   r loss   fvcahs  void
1802101 180000000 150000000 60.0000 3.    3.    001000 0.15 * kwr

*-----------------------------------------------------------------
* junction area from ref. [349] (50.6358) was too small and restricted
* flow to the middle downcomer, so a new value was used that would allow
* the required mass flow to the middle downcomer.  kf and kr from ref.
* [349]
*-----------------------------------------------------------------
*   jun (180-03) core exit to steam separator
```

```
*----------------------------------------------
*card   from vol   to vol     jun area   f loss  r loss   fvcahs
1803101 170010000 180000000 104.423 13.4 13.4 001000 * kwr
*-----------------------------------------------------------------
* junction area from ref. [349].  kf and kr:  modelling assumption
* used to acheive the required flow
*-----------------------------------------------------------------
*
*---------------------------------
*  (190) steam dome  (branch)
*---------------------------------
*card     component name     type
1900000      stdome        branch
*
*card       num jun       vel/flow
1900001            2         0
*1900001       3           0
*
*card      vol flow area     vol length     vol of vol     az angle
1900101        0.0            22.318          6259.714        0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1900102        90.0        22.318        5.e-6        17.932    11000
*---------------------------------------------------------------
* vol length, vol, elev change, hyd dia from the retran input deck
*---------------------------------------------------------------
*card       ebt     press       ul         ug       alpha
1900200   0 1.0236000e+03 5.4206000e+02 1.1097000e+03 9.9997002e-01
*
*   jun (190-01)   steam dome to main steamline
*--------------------------------------
*card     from          to         area      kf      kr     fvcahs
1901101   190010000     400000000    12.6713    1.6937  1.6937 001000
*1901101   190010000     400000000    12.6713   1.2000  1.0000 001000
*----------------------------------------------------------------
* junction area from retran input deck.  kf and kr:  modelling
* assumption used to achieve the required flow
*----------------------------------------------------------------
*card     int. liq flow   int vap flow     inter. vel
1901201      1.2182000e+02  1.2764000e+02   0.
1902201      2.6910000e+00 -2.8625701e-04   0.
*1903201   3.4839001e+00  -3.3684799e-05  0.0000000e+00
*
*   jun (190-02) steam dome to upper downcomer
*---------------------------------------------------
```

```
*card     from        to         area     kf     kr     fvcahs
1902101   190000000   160000000  136.0630  0.00   0.00   001000
*-------------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*-------------------------------------------------------------------
*
*-------------------------------------------------------
*  jet pumps and recirculation loops
*-------------------------------------------------------
*  loop a
*-------------------------------------------------------
*--------------------------------------------
*****(200)  jet pump (a) (branch:*****jetmixer)
*--------------------------------------------
*card     component name     type
2000000     jetpa        jetmixer
*card       num jun       vel/flow
2000001            3        0
*
*card      vol flow area     vol length     vol of vol     az angle
2000101        0.0           7.0000         27.840           0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
2000102       -90.0       -7.0000        5.e-6      5.0       00000
*------------------------------------------------------------------
* see calculations in appendix c for vol length, vol, elev change.
* hyd dia from ref. [349]
*------------------------------------------------------------------
*card      ebt   press      ul        ug     alpha
2000200   0 1.0118000e+03 5.1594000e+02 1.1101000e+03  0.
*
*  jun (200-01)   recirculation discharge (a) to jetpump (a)
*-----------------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss  fvcahs
2001101 240010000  200000000    0.8226    1.1      1.100  001000
*------------------------------------------------------------------
* junction area, kf and kr used to achieve required flow.
*------------------------------------------------------------------
*card   int liq flow    int vapor flow    inter vel
2001201      1.2392000e+02  1.2392000e+02   0.
2002201      6.7608002e+01  7.0873001e+01   0.
2003201      7.8358002e+01  8.2028000e+01   0.
*
*  jun (200-02) middle downcomer to jet pump (a)
*--------------------------------------------
```

```
*card   from vol    to vol    jun area   f loss   r loss   fvcahs
2002101 150010000  200000000    2.7724   0.24     5.000   001000
*-----------------------------------------------------------------
* junction area, kf and kr used to achieve required flow.
*-----------------------------------------------------------------
*  jun (200-03)   jet pump (a) to jet pump diffuser
*----------------------------------------------
*card    from vol   to vol    jun area   f loss    r loss   fvcahs
2003101 200010000  210000000   3.6950     0.0       0.0     001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf and kr used to achieve required flow.
*-----------------------------------------------------------------
*
*------------------------------------------------
*  (210) jet pump diffuser (a)
*------------------------------------------------
*card          name         type
2100000        diffa        branch
*
*card      jun          vel/flow
2100001           1        0
*card      area    length     volume    az angle
2100101    0.0       7.1851     83.520     0.0
*card     incl angle    dz    rough     dh     pvbfe
2100102    -90.0     -7.1851   5.e-6     0.0     00000
*---------------------------------------------------------------
* see calculations in appendix c
*---------------------------------------------------------------
*card     ebt     press      ul       ug      alpha
2100200   0 1.0379000e+03 5.1594000e+02 1.1093000e+03  0.
*
* jun (210-01) jet pump diffuser (a) to lower plenum
*-------------------------------------------------
*card    from       to       area     kf     kr    fvcahs
2101101  210010000  100010000  19.689  0.15   0.15   001000
*---------------------------------------------------------------
* junction area from ref. [349].  kf and kr:  modelling
* assumption used to achieve the required pressure and flow.
*---------------------------------------------------------------
*card    init liq flow   init vap flow     inter vel
2101201      1.4702000e+01  1.6590000e+01   0.
*
*-------------------------------------------
*  (220) recirculation suction (a)
```

```
*-------------------------------------------
*card        component       type
2200000        recira        snglvol
*
*card     vol flow area    vol length   vol of vol    az angle
2200101      0.0             47.427     167.939       0.0
*card     inc angle    elev change   roughness    hyd dia   pvbfe
2200102     -28.95      -41.499       5.e-6       1.0617   01000
*------------------------------------------------------------------
* see calculations in appendix c.
*------------------------------------------------------------------
*card   ebt    press       ul         ug        alpha
2200200   0 1.0375000e+03 5.1578998e+02 1.1093000e+03  0.  0.
*
*-----------------------------------------
*  (230) recirculation pump (a)
*-----------------------------------------
*card    component      type
2300000     pumpa       pump
*
*card     vol flow area    vol length    vol of vol     az angle
2300101       0.0          28.235        76.344         0.0
*card     inc angle    elev change    pvbfe
2300102     13.22        6.457        00000
*------------------------------------------------------------------
* see calculations in appendix c.
*------------------------------------------------------------------
*
*pump junction geometry cards:
*card     from vol     jun area   f loss cof     r loss cof  vcahs
2300108   220010000      0.0       1.000         1.000      00000
*card     to vol       jun area   f loss cof     r loss cof  vcahs
2300109   240000000      0.0        10.00         10.00     00000
*------------------------------------------------------------------
* kf and kr from ref. [349]
*------------------------------------------------------------------
*pump initial condition cards:
*card     ebt   press      ul     ug      alpha
2300200  0 1.1499000e+03 5.1589001e+02 1.1059000e+03  0.  0.
*card      vel/flow     int liquid flow    int vapor flow     inter
2300201  0  3.7737000e+01  3.7737000e+01   0.
2300202  0  3.9660000e+01  3.9660000e+01   0.
*
*pump index and option card
```

```
*card   indic  2p    2pd   motor pump torq   tdp vel  pump trip  rev
2300301  280   -1    -3       -1            0       408      0
*
*pump description card (from ref. [1] pg 6i)
*card      pump vel    ratio     flow      head    torque    inertia
2300302   1.6200000e+03 9.7660494e-01 4.5200000e+04 7.6325000e+02 2.1326699e+04
2300303   1.9174500e+04
*card      density   motor torw      w1      w2   w3   w4
2300304    47.167       0.0         1122.5   0.0  0.0  0.0
*------------------------------------------------------------------
* since this model has two loops the flow, torque, and inertia values
* from ref. [349] were divided in half.
*------------------------------------------------------------------
*
* speed table
2306100 501 cntrlvar 264
2306101 0. 0.
2306102 1.e4 1.e4
*
*
*------------------------------------------
*  (240) recirculation discharge (a)
*------------------------------------------
*card        component       type
2400000         discha        snglvol
*
*card      vol flow area   vol length   vol of vol    az angle
2400101       0.0         115.912       297.963        0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2400102      29.10        56.372         5.e-6      0.949     01000
*-----------------------------------------------------------------
* see calculations in appendix c.
*-----------------------------------------------------------------
*card   ebt   press       ul        ug         alpha
2400200   0 1.1711000e+03 5.1591998e+02 1.1053000e+03  0. 0.
*
*--------------------------------------------------------
*  !jet pumps and recirculation loops
*--------------------------------------------------------
*  loop b
*--------------------------------------------------------
*----------------------------------------
*  (250)  jet pump (b) (branch:jet mixer)
*----------------------------------------
```

```
* see card 200 for reference.
*-----------------------------------------------------------
*card     component name     type
2500000    jetpb           jetmixer
*card       num jun        vel/flow
2500001             3        0
*
*card      vol flow area   vol length   vol of vol    az angle
2500101       0.0           7.0000      27.840         0.0
*card      inc angle    elev change    roughness     hyd dia   pvbfe
2500102       -90.0       -7.0000         5.0e-6      5.0      00000
*
*card        ebt      press       ul         ug    alpha
2500200   0 1.0118000e+03 5.1594000e+02 1.1101000e+03  0.
*
*  jun (250-01)   recirculation discharge (b) to jetpump (b)
*---------------------------------------------------------
*card   from vol    to vol     jun area   f loss   r loss   fvcahs
2501101 290010000  250000000    0.8226    1.1       1.100   001000
*
*card    int liquid flow    int vapor flow    inter vel
2501201      1.2392000e+02  1.2392000e+02   0.
2502201      6.7608002e+01  7.0873001e+01   0.
2503201      7.8358002e+01  8.2028000e+01   0.
*
*  jun (250-02)   middle downcomer to jet pump (b)
*---------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss   fvcahs
2502101 150010000  250000000    2.7724    0.24    5.000    001000
*-----------------------------------------------------------
*
*  jun (250-03)    jet pump (b) to jet pump diffuser
*--------------------------------------------
*card   from vol    to vol    jun area   f loss    r loss   fvcahs
2503101 250010000  260000000   3.695      0.0        0.0    001000
*
*-----------------------------------------------------------
*  (260) jet pump diffuser (b)
*-----------------------------------------------------------
* see card 210 for references.
*-------------------------------------------------------------------
*card        name           type
2600000      diffb          branch
*
```

```
*card        jun        vel/flow
2600001          1        0
* card      area     length   volume    az angle
2600101      0.0      7.1851   83.520       0.0
*card     incl angle    dz     rough     dh      pvbfe
2600102   -90.0      -7.1851   5.e-6     0.0     00000
*
*card     ebt     press      ul       ug      alpha
2600200   0 1.0379000e+03 5.1594000e+02 1.1093000e+03  0.
*
*  jun (260-01) jet pump diffuser (b) to lower plenum
*-------------------------------------------------------
*card    from        to        area    kf     kr     fvcahs
2601101  260010000  100010000  19.689 0.15   0.15    001000
*
*card   init liq flow  init vap flow   inter vel
2601201      1.4702000e+01  1.6590000e+01   0.
*
*------------------------------------------
*  (270)  recirculation suction (b)
*------------------------------------------
* see card 220 for references.
*------------------------------------------------------------
*card        component        type
2700000        recirb         snglvol
*
*card      vol flow area   vol length   vol of vol   az angle
2700101        0.0          47.427       167.939       0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2700102      -28.95      -41.499        5.0e-6       1.0617   01000
*card        ebt        press        ul         ug       alpha
2700200   0 1.0375000e+03 5.1578998e+02 1.1093000e+03  0.  0.
*
*----------------------------------------
*  (280)  recirculation pump (b) (pump)
*----------------------------------------
*see card 230 for references, unless otherwise noted.
*------------------------------------------------------------------
*card     component      type
2800000     pumpb       pump
*
*card      vol flow area   vol length   vol of vol   az angle
2800101       0.0          28.235        76.344       0.0
*card      inc angle    elev change    pvbfe
```

```
2800102      13.22        6.457        00000
*
*pump junction geometry cards:
*card      from vol     jun area   f loss cof     r loss cof  vcahs
2800108   270010000       0.0          1.000          1.000    00000
*card      to vol       jun area   f loss cof     r loss cof  vcahs
2800109   290000000       0.0          10.00          10.00     00000
*
*pump initial condition cards:
*card      ebt    press      ul        ug    alpha
2800200  0 1.1499000e+03 5.1589001e+02 1.1059000e+03  0.  0.
*
*card      vel/flow     int liquid flow    int vapor flow     inter vel
2800201  0  3.7737000e+01  3.7737000e+01   0.
2800202  0  3.9660000e+01  3.9660000e+01   0.
*
*pump index and option card
*card   indic  2p    2pd   m pump torq   tdp vel   pump trip   rev
2800301   0    -1    -3         -1          0        408      0
*
*pump description card
*card      pump vel    ratio     flow       head   torque    iner
2800302   1.6200000e+03 9.7660494e-01 4.5200000e+04 7.6325000e+02 2.1326699e+04
2800303   1.9174500e+04
*card      density    motor torw    w1          w2     w3    w4
2800304    47.167        0.0        1122.5       0.0    0.0   0.0
*
* single phase homologous curves (from ref. [349])
*
* pump head curves
*card      type    regime     phead1    phead2     phead1    phead2
2801100      1       1       0.0       1.41       0.25      1.365
2801101                      0.33      1.345      0.50      1.280
2801102                      0.67      1.195      0.75      1.150
2801103                      1.00      1.00
*
2801200      1      2        0.2      -0.32       0.25      -0.290
2801201                      0.33     -0.230      0.40      -0.170
2801202                      0.50     -0.05       0.60       0.100
2801203                      0.67      0.230      0.75       0.390
2801204                      0.80      0.500      1.00       1.000
*
2801300      1      3       -1.        1.920     -0.80       1.725
2801301                     -0.67      1.625     -0.50       1.540
```

```
2801302              -0.33    1.480   -0.25    1.465
2801303              -0.01    1.420    0.00    1.410
*
2801400    1    4    -1.00    2.24    -0.66    1.180
2801401              -0.50    0.800   -0.24    0.64
*
2801500    1    5     0.00    0.926    0.25    0.882
2801501               0.33    0.884    0.50    0.908
2801502               0.67    0.948    0.75    0.960
2801503               1.00    1.00
*
2801600    1    6     0.20   -0.314    0.25   -0.250
2801601               0.33   -0.140    0.40   -0.051
2801602               0.50    0.100    0.60    0.275
2801603               0.67    0.387    0.75    0.530
2801604               0.80    0.627    1.00    1.00
*
2801700    1    7    -1.00   -1.880   -0.67    1.450
2801701              -0.50    1.270   -0.33    1.140
2801702              -0.25    1.070   -0.01    0.930
2801703               0.00    0.926
*
2801800    1    8    -1.00    1.760    0.66    1.080
2801801              -0.50    0.920   -0.24    0.720
*
* pump torque curves
*card     type   regime   ptork1   ptork2   ptork1   ptork2
2801900    2      1      0.0     0.930    0.25     0.870
2801901                  0.33    0.890    0.50     0.900
2801902                  0.67    0.960    0.75     0.950
2801903                  1.00    1.000
*
2802000    2      2      0.20   -7.84     0.25    -4.000
2802001                  0.33   -1.16     0.40    -0.320
2802002                  0.50    0.40     0.60     0.820
2802003                  0.67    0.87     0.75     1.000
2802004                  0.80    0.98     0.99     0.999
*
2802100    2      3     -1.00    1.88    -0.67     1.450
2802101                 -0.50    1.27    -0.33     1.140
2802102                 -0.25    1.07    -0.01     0.930
*
2802200    2      4     -0.99    1.760   -0.66     2.400
2802201                 -0.50    3.840   -0.24    12.500
```

```
*
2802300     2       5      0.00     -0.720     0.30      -0.600
2802301                   0.42    -0.400     0.50     -0.050
2802302                   0.75     0.250     1.00      0.57
*
2802400     2       6      0.00      1.44      0.10      1.400
2802401                   0.22      1.20      0.33      1.100
2802402                   0.55      1.00      0.80      0.80
2802403                   1.00      0.57
*
2802500     2       7     -1.00     -2.00     -0.30     -1.500
2802501                  -0.18     -1.35     -0.07     -1.000
2802502                   0.00     -0.92
*
2802600     2       8     -1.00     -2.00     -0.25     -1.800
2802601                  -0.12     -1.50     -0.08     -1.400
2802602                   0.00     -1.00
*
* speed table
2806100 502 cntrlvar 265
2806101 0. 0.
2806102 1.e4 1.e4
*
* tmp - use simple target-core-flow controller
*2806100 408 cntrlvar 831
*
* tmp - ramp pump speed from somewhere to somewhere else and hold
*2806100 408
*2806101 0. 1581.48 60. 982.
*
*------------------------------------------
*  (290)  recirculation discharge piping (b)
*------------------------------------------
* see card 240 for references.
*---------------------------------------------------------------
*card        component       type
2900000        dischb         snglvol
*card     vol flow area    vol length    vol of vol    az angle
2900101      0.00           115.912      297.963        0.0
*card     inc angle    elev change    roughness    hyd dia   pvbfe
2900102      29.10       56.372        5.0e-6       0.949    01000
*
*card       ebt       press       ul        ug      alpha
2900200   0 1.1711000e+03 5.1591998e+02 1.1053000e+03  0.  0.
```

```
*
*--------------------------------------------------
*  hpci and rcic systems
*--------------------------------------------------
*------------------------------------------
*(300) hpci and rcic supply
*------------------------------------------
*card      name        type
3000000    rcicvola     tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3000101     5.0          10.0            0.0        0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3000102       90.          10.0        0.00015    1.0     00010
*-------------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-------------------------------------------------------------
*card      ebt         trip no.
3000200    001          408
*card     search variable     temp    quality
3000201       0.              99.99   0.0
*-------------------------------------------------------------
* the thermodynamic values are based on nominal pool temperature
*-------------------------------------------------------------
*
*------------------------------------------
*(301) hpci and rcic supply
*------------------------------------------
*card      name        type
3010000    rcicvolb     tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3010101     5.0          10.0            0.0        0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3010102       90.          10.0        0.00015    1.0     00010
*-------------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-------------------------------------------------------------
*card      ebt          trip no.
3010200    001            408
*card     search variable     temp    quality
3010201       0.              99.99   0.0
*-------------------------------------------------------------
* the thermodynamic values are based on nominal pool temperature
```

```
*--------------------------------------------------------------
*
*
*----------------------------------------
* (310) hpci supply valve
*----------------------------------------
*card     name      type
3100000   hpcijun   tmdpjun
*
*card   from       to        jun area
3100101 301000000  150000000  1.
*card   control word  table trip
3100200      1       631
*card   search var.  liq vel/flow  vap vel/flow  inter. vel
3100201   -1.          0.        0.        0.
3100202    0.          0.        0.        0.
3100203   20.        694.        0.        0.
*
*----------------------------------------
*(320) rcic supply valve
*----------------------------------------
*card     name      type
3200000   rcicjun   tmdpjun
*
*card   from       to        jun area
3200101 300000000  150000000  1.
*card   control word  table trip
3200200      1         637
*card   search var.  liq vel/flow  vap vel/flow  inter. vel
3200201   -1.          0.        0.        0.
3200202    0.          0.        0.        0.
3200203   20.         82.4       0.        0.
*
*------------------------------------------
*(350) hpci and rcic exhaust
*------------------------------------------
*card     name      type
3500000   exhausta   tmdpvol
*
*card  flow area  length of vol  vol of vol  az angle
3500101   5.0       10.0          0.0       0.0
*card   incl. angle  elev change  roughness  hyd dia  pvbfe
3500102    90.        10.0      0.00015   1.0    00010
*--------------------------------------------------------------
```

```
* length, vol, elev change, hyd dia values are assumed.
*-----------------------------------------------------------
*card     ebt        trip no.
3500200   001          408
*card     search variable    temp    quality
3500201      0.             212.0     1.0
*-----------------------------------------------------------
* the thermodynamic values are for steam at atmospheric conditions
*-----------------------------------------------------------
*
*-------------------------------------------
*(351) hpci and rcic exhaust
*-------------------------------------------
*card       name        type
3510000     exhaustb      tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3510101     5.0          10.0           0.0        0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3510102      90.           10.0       0.00015    1.0     00010
*-----------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-----------------------------------------------------------
*card     ebt        trip no.
3510200   001         408
*card     search variable    temp    quality
3510201      0.             212.0     1.0
*-----------------------------------------------------------
* the thermodynamic values are for steam at atmospheric conditions
*-----------------------------------------------------------
*
*-------------------------------------------
*(360) hpci turbine supply
*-------------------------------------------
*card       name        type
3600000     hpciturb    tmdpjun
*
*card     from          to          jun area
3600101   190000000    351000000     1.
*card     control word    table trip
3600200      1            631
*card     search var.    liq vel/flow  vap vel/flow    inter. vel
3600201     -1.           0.            0.          0.
3600202      0.           0.            58.3         0.
```

```
*
*--------------------------------------------
*(370) rcic turbine supply
*--------------------------------------------
*card       name        type
3700000    rcicturb     tmdpjun
*
*card    from         to         jun area
3700101   190000000    350000000    1.
*card    control word    table trip
3700200       1            636
*card    search var.    liq vel/flow  vap vel/flow    inter. vel
3700201      -1.          0.             0.         0.
3700202       0.          0.             9.17       0.
*
*------------------------------------------------
*  main steam system
*------------------------------------------------
*------------------------------------------
*  (400) main steam line
*------------------------------------------
*card        component       type
4000000       steamln        snglvol
*
*card       vol flow area    length   vol of vol   az angle
4000101          0.0         116.770    1507.501      0.0
*card        incl angle   elev change   roughness   hyd dia   pvbfe
4000102         33.777      64.720       5.e-6      8.108    11000
*----------------------------------------------------------------
* see calculations in appendix c.
*----------------------------------------------------------------
*card      ebt    press      ul      ug       alpha
4000200   0 1.0120000e+03 5.4041998e+02 1.1095000e+03 9.9992001e-01  0.
*
*------------------------------------------------
* main steam valve double (representative of 2 msivs)
*------------------------------------------------
*
4100000     msiv_d     valve
*
*card   from vol   to vol      jun area  f loss    r loss   fvcahs
4100101 400010000  420000000    6.4550     4.0       4.5    001020
*--------------------------------------------------------------
* junction flow area is representative of 2 msiv's.  see calculations
```

```
* in appendix c.  kf and kr are assumed.
*------------------------------------------------------------------
*card      flag      int liq flow   int vap flow   inter vel
4100201    0  1.2715000e+02  1.2715000e+02   0.
*
*card     valve type
4100300     mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4100301      409          666        0.25               1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4100401 0. 1.e6 1.e6
4100402 1. 1.e6 1.e6
*
*----------------------------------------------------
* main steam valve single 1 (representative of 1 msiv)
*----------------------------------------------------
*
4110000     msiv_s1     valve
*
*card   from vol   to vol      jun area  f loss     r loss   fvcahs
4110101 400010000  420000000     3.227     4.10      4.5    001020
*------------------------------------------------------------------
* junction flow area is representative of 1 msiv.  see calculations
* in appendix c.  kf and kr are assumed.
*------------------------------------------------------------------
*
*card      flag      int liq flow   int vap flow   inter vel
4110201    0  1.2594000e+02  1.2594000e+02   0.
*
*card     valve type
4110300     mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4110301      409          665        0.25               1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4110401 0. 1.e6 1.e6
4110402 1. 1.e6 1.e6
*
*----------------------------------------------------
```

```
* main steam valve single 2 (representative of 1 msiv)
*--------------------------------------------------------
*
4120000      msiv_s2     valve
*
*card   from vol   to vol      jun area  f loss    r loss   fvcahs
4120101 400010000  420000000     3.227     4.10      4.5    001020
*--------------------------------------------------------------------
* junction flow area is representative of 1 msiv.  see calculations
* in appendix c.  kf and kr are assumed.
*--------------------------------------------------------------------
*
*card      flag      int liq flow   int vap flow   inter vel
4120201    0  1.2594000e+02  1.2594000e+02   0.
*
*card     valve type
4120300    mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4120301      409          605       0.25               1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4120401 0. 1.e6 1.e6
4120402 1. 1.e6 1.e6
*
*-------------------------------------------
*  (420) main steam header to turbine -- 4 line
*-------------------------------------------
*        name                type
4200000   turbine              pipe
*
*card    number of vols
4200001      3
*
*card      vol area      vol number
4200101      0.0            3
*
*card     init jun flow area    jun number
4200201       10.875              2
*
*card    pipe vol length   vol number
4200301       58.271          1
4200302       35.670          2
```

```
4200303      12.000        3
*
*card    vol of vol       vol number
4200401    633.529         1
4200402    387.911         2
4200403    130.494         3
*
*card     az angle        vol number
4200501     0.0            3
*
*card     incl. angle      vol number
4200601     0.0            1
4200602     90.00           3
*
*card     elev change      vol number
4200701     0.0            1
4200702     35.670          2
4200703     12.000          3
*
*card     roughness    hyd dia    vol number
4200801     5.0e-6      7.442      3
*-----------------------------------------------------------------
* see calculations in appendix c for vol length, vol, elev change
* and hyd dia.
*-----------------------------------------------------------------
*card       kf          kr      jun number
4200901     2.500      2.500       1
4200902     0.000      1.710       2
*-----------------------------------------------------------------
* kf and kr values were used that would maintain the pressure in
* volume 420-03 equal to 970 psi.
*-----------------------------------------------------------------
*card     pvbfe       vol number
4201001   11000          3
*card     fvcahs      jun number
4201101   001020         2
*card     ebt    press    ul     ug    alpha
4201201 0 9.9373999e+02 5.3834998e+02 1.1090000e+03 9.9984998e-01  .0  1
4201202 0 9.7894000e+02 5.3546997e+02 1.1101000e+03 9.9967003e-01  .0  2
4201203 0 9.7832001e+02 5.3535999e+02 1.1103000e+03 9.9963999e-01  .0  3
*
*card  pipe vol control word
4201300 0
*card  init liq flow   init vap flow   inter vel    jun number
```

```
4201301    1.5260001e+02  1.5260001e+02   0.         1
4201302    1.5496001e+02  1.5496001e+02   0.         2
*
*
*-------------------------------------------
*(430) turbine control and stop valve
*-------------------------------------------
*card     name        type
4300000   tcs-valv    tmdpjun
*card    from        to         area
4300101  420010000   450000000    10.875
*-------------------------------------------------------------------
* area set equal to area of volume 420-03.
*-------------------------------------------------------------------
*card    vel/flow    table trip #    var req     num var req
4300200    0           408          cntrlvar    538
*card     search var     init liq vel   init vap vel    inter vel
4300201    -1.           152.99         152.99        0.
4300203     0.              0.              0.           0.
4300204     1.e+4          1.e+4          1.e+4        0.
*
*---------------------------
*(440)  turbine bypass valve
*---------------------------
4400000 bypsvlv tmdpjun
4400101 420010000 451000000 0.
4400200 0 408 cntrlvar 552
*
4400201 -1.   0.   0.   0.
4400202  0.   0.   0.   0.
4400203  1.e+4  1.e+4  1.e+4  0.
*
*--------------------------------------------
*  (450)  main condenser (steam exhaust)
*--------------------------------------------
*card     name      type
4500000   condns1a   tmdpvol
*card    vol flow area    length   vol of vol     az angle
4500101   1.0+6           0.0      1.0+6        0.0
*card     incl angle     elev change   roughness   hyd dia    pvbfe
4500102      0.0           0.0           0.0        0.0     00010
*------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*------------------------------------------------------------
```

```
*card     ebt        trip #
4500200   003        401
*card    search var    press    temp
4500201    0.0       916.0     544.
*--------------------------------------------------------------
* thermodynamic values are assumed.
*--------------------------------------------------------------
*
*
*--------------------------------------------
*  (451)  main condenser (steam exhaust)
*--------------------------------------------
*card     name      type
4510000   condns1b   tmdpvol
*card    vol flow area    length   vol of vol     az angle
4510101   1.0+6           0.0        1.0+6         0.0
*card     incl angle    elev change   roughness   hyd dia   pvbfe
4510102      0.0           0.0           0.0       0.0     00010
*--------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*--------------------------------------------------------------
*card     ebt          trip #
4510200   003          408
*card    search var    press    temp
4510201    0.0        14.7     212.
*--------------------------------------------------------------
* thermodynamic values are for steam at atmospheric conditions.
*--------------------------------------------------------------
*
*--------------------------------------------
* (460)  suppression pool
*--------------------------------------------
*card      name       type
4600000    spool1a    tmdpvol
*card    area     length    vol of vol     az angle
4600101  1.0e+6    0.0       1.0e+6        0.0
*card    incl angle   elev change   roughness   hyd dia   pvbfe
4600102    0.0          0.0          0.0         0.0     00010
*--------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*--------------------------------------------------------------
*card      ebt          trip #
4600200    003          408
*card     search var.    press    temp
```

```
4600201     0.0         14.7     212.
*---------------------------------------------------------------
* thermodynamic values are for steam at atmospheric conditions.
*---------------------------------------------------------------
*
*
*-------------------------------------------
* (461)  suppression pool
*-------------------------------------------
*card     name       type
4610000    spool1b    tmdpvol
*card    area     length    vol of vol     az angle
4610101  1.0e+6    0.0       1.0e+6        0.0
*card    incl angle   elev change   roughness   hyd dia   pvbfe
4610102    0.0          0.0          0.0         0.0     00010
*--------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*--------------------------------------------------------------
*card      ebt      trip #
4610200    003       408
*card     search var.    press     temp
4610201     0.0         14.7       212.
*---------------------------------------------------------------
* thermodynamic values are for steam at atmospheric conditions.
*---------------------------------------------------------------
*
*-----------------------------------------
* s/rv valves
*-----------------------------------------
*-----------------------------------------------
* (470) safety relief valve #1
*-----------------------------------------------
4700000 srv1 valve
4700101 400000000 460000000  0.4300   1.0  1.0  000100
* valve area required to achieve correct mass flow through
* each valve.  valves max flow = 950,000 lb/hr each.
* mass flow through bank #1 should be equal to 1056 lb/s.
4700201    0   0.   0.   0.
4700300 trpvlv
4700301 656
*
*----------------------------------------------
* (480) safety relief valve #2
*----------------------------------------------
```

```
4800000 srv2 valve
4800101 400000000 461000000  0.9800   1.0   1.0  000100
4800201    0   0.   0.   0.
* valve area required to achieve correct mass flow through
* each valve.  valves max flow = 950,000 lb/hr each.
* mass flow through bank #2 should be equal to 2375 lb/s.
4800300 trpvlv
4800301 661
*
*
*
*---------------------- |
*    heat structures    |
*---------------------- |
*---------------------------------------------
* (1)  nuclear heat structures  (core region)
* ---------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11201000    5    4    2    0    .00000e+00
*
*card      loc flag    format flag
11201100      0           1
*
*card      num intervals   right coordinate
11201101        1        .01708        *  uo-2 pellet
11201102        1        .01745        *  he-gap
11201103        1        .020117       *  zircaloy-2 clad
*-------------------------------------------------------
* coordinates from ref. [349]
*-------------------------------------------------------
*card       comp num    interval num
11201201      1             1
11201202     -2             2 * neg sign added - kwr
11201203     -3             3 * neg sign added - kwr
*
*card     source value   interval num (ref [1] pg 18)
11201301     1.00          1
11201302     0.00          3
*
11201400  -1
11201401 1.8951e+03 1.1451e+03 6.1207e+02 5.6766e+02
11201402 2.4940e+03 1.3402e+03 6.3223e+02 5.7362e+02
11201403 2.5437e+03 1.3544e+03 6.3439e+02 5.7483e+02
11201404 2.1243e+03 1.2240e+03 6.2057e+02 5.7044e+02
```

```
11201405 1.3737e+03 9.4812e+02 5.9176e+02 5.6189e+02
*
*
*
*card          temperature     mesh pt num
*-----------------------------------------------------------
* initial temperatures taken from the output of the steady state
* calculation after 1000 seconds.
*-----------------------------------------------------------
*
*card    left vol   incr   b.cond   sa code    area/factor    hs
11201501      0       0      0       0            0.0         5
*
*card    right vol   incr   b.cond    sa code    area/factor   hs
11201601 120010000   10000    1       0         14974.10       5
*-----------------------------------------------------------
* see calculations in appendix c for area/factor.
*-----------------------------------------------------------
*card       source type   mult     heat left   heat right    hs
11201701     1000      .1825      0.0          0.0        1
11201702     1000      .2424      0.0          0.0        2
11201703     1000      .2465      0.0          0.0        3
11201704     1000      .2066      0.0          0.0        4
11201705     1000      .1220      0.0          0.0        5
*-----------------------------------------------------------
* see calculations in appendix c for axial mult.
*
*  note -- 1000 in card 701-703 specifies total reactor power from
*  the reactor kinetics calculation
*-----------------------------------------------------------
*
*card       source type   mult     heat left   heat right    hs
*11201701    10099      .1825      0.0          0.0        1
*11201702    10099      .2424      0.0          0.0        2
*11201703    10099      .2465      0.0          0.0        3
*11201704    10099      .2066      0.0          0.0        4
*11201705    10099      .1220      0.0          0.0        5
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11201801   0.0        10.0    10.0  0.0   0.0  0.0  0.0  1.0    5
11201901   0.0        10.0    10.0  0.0   0.0  0.0  0.0  1.0    5
*
*------------------------------------------------------
* additional reactor vessel heat structures
```

```
*    see calculations in appendix c
*-------------------------------------------------------
*-------------------------------------------------------
* (1001) vessel bottom head
*-------------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11001000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11001100      0           1
*
*card      num intervals   right coordinate
11001101         1         10.9948
*
*card       comp num    interval num
11001201       5             1
*
*card     source value   interval num
11001301      0.00          1
*
11001400  -1
11001401 5.2595e+02 5.2293e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11001501  100010000   0      1       1          687.23       1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11001601   -100       0     3101     1          687.23       1
*
*card       source type
11001701     0   0   0   0   1
*
*card    qv dia      length   hlr   gslf   gslr glcf glcr  lbf   hs
11001801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11001901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*
*-------------------------------------------------------
* (1401) lower downcomer
*-------------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11401000    1    2    2    0   1.04583e+01
*
```

```
*card      loc flag    format flag
11401100      0           1
*
*card      num intervals   right coordinate
11401101        1          10.9948
*
*card       comp num    interval num
11401201       5             1
*
*card     source value   interval num
11401301      0.00          1
*
11401400  -1
11401401 5.2640e+02 5.2322e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11401501  140010000   0      1       1          1401.625     1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11401601  -100       0     3101     1          1401.625     1
*
*card       source type
11401701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11401801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11401901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*-------------------------------------------------------
* (1501) middle downcomer vessel barrel
*-------------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11501000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11501100      0           1
*
*card      num intervals   right coordinate
11501101        1         10.9948
*
*card       comp num    interval num
11501201       5             1
*
```

```
*card     source value   interval num
11501301      0.00          1
*
11501400  -1
11501401 5.2655e+02 5.2330e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11501501  150010000  0       1       1          837.098     1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11501601   -100      0      3101     1          837.098     1
*
*card       source type
11501701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11501801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11501901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*------------------------------------------------------
* (1601) upper downcomer vessel barrel
*------------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11601000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11601100      0          1
*
*card      num intervals   right coordinate
11601101        1         10.9948
*
*card       comp num    interval num
11601201       5            1
*
*card     source value   interval num
11601301      0.00          1
*
11601400  -1
11601401 5.3686e+02 5.3481e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11601501  160010000   0      1       1         405.242      1
```

```
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11601601   -100      0     3101     1          405.242      1
*
*card      source type
11601701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11601801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11601901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*--------------------------------------------------------
* (1901) steam dome
*--------------------------------------------------------
*card      num hs   mesh pts   geom type   int flag    left coord
11901000    1    2    2    0   1.04583e+01
*
*card     loc flag    format flag
11901100     0          1
*
*card     num intervals   right coordinate
11901101        1         10.9948
*
*card       comp num    interval num
11901201      5             1
*
*card     source value   interval num
11901301      0.00          1
*
11901400  -1
11901401 5.4718e+02 5.4300e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11901501  190010000   0      1       1          687.230      1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11901601  -100       0     3101     1          687.230      1
*
*card      source type
11901701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11901801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
```

```
11901901   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
* temperature
*---------------------------
20210000   temp
20210001   0.   135.
*---------------------------
* from section 4.2.4.9 of the fsar (bfnp-7)
* outside air temperature
*---------------------------
*
* heat transfer coefficient
*---------------------------
20210100     htc-t
20210101      -1.0     5.3458e-5
20210102       0.0     5.3458e-5
20210103       1.0e6   5.3458e-5
*---------------------------
* see calculations in app. c
* from section 4.2.4.9 of the fsar (bfnp-7)
*---------------------------
*
*-----------------------------------------------------
* point kinetics
*-----------------------------------------------------
30000000       point        separabl
*
*               total      init.   delay/     f.p.    u238
*               power       react.  prompt    yield    yield
30000001     gamma    3293.e+6    0.     165.000     1.      1.
*-----------------------------------------------------
* above values are from ref. [349]
*-----------------------------------------------------
*
* scram
30000011 200
*
* rod insertion
30000012 10300  *jam steady-state
*
* density reactivity feedback
*       density  reactivity
*       (lb/ft3) (dollars)
*-----------------------------------------------------
```

```
* see calculations in app. c
*-------------------------------------------------------
30000501  0.  -9.
30000502 47.2   0.
* density feedback adjusted to give good power response to changes
* in core flow
*
* doppler reactivity feedback
*       temperature reactivity
*       (deg f)     (dollars)
30000601  500.  0.
30000602 4172. -1.6
*-------------------------------------------------------
* see calculations in app. c
*-------------------------------------------------------
* doppler feedback adjusted to give good power response to changes
* in core flow
*
* volume weighting factors
*30000701      120010000    0  .1583      0.
*30000702      120020000    0  .2795      0.
*30000703      120030000    0  .2887      0.
*30000704      120040000    0  .2028      0.
*30000705      120050000    0  .0707      0.
30000701      120020000     0 1.          0.
*
* heat structure weighting factors
*30000801       1201001      0  .1583      0.
*30000802       1201002      0  .2795      0.
*30000803       1201003      0  .2887      0.
*30000804       1201004      0  .2028      0.
*30000805       1201005      0  .0707      0.
30000801       1201002      0  1.          0.
*-----------------------------------------------------------------
* see calculations in appendix c for vol weighting factors and
* heat structure weighting factors.
*-----------------------------------------------------------------
* weighting tied to the most dynamic hydro cell and fuel segment
* to give good power response to changes in core flow
*
* reactor scram curve
*
*card        table type    trip no.
20220000        reac-t        649
```

```
*
*card      argument    function
20222001    -1.0        0.
20222002     .270       0.
20222003     .620      -0.7859
20222004     .970      -1.3479
20222005    1.337      -2.2928
20222006    1.703      -4.0022
20222007    2.070      -6.7163
20222008    2.445     -10.7728
20222009    2.820     -17.0824
20222010    3.195     -24.6860
20222011    3.570     -28.4429
20222012    3.945     -28.9308
20222013    1.0e+6    -28.9308
*-----------------------------------------------------------------
* scram curve is from fig 3.6-13 of the fsar (bfnp-7).
*-----------------------------------------------------------------
*
*
*
*-------------------------------------------
*-------------------------------------------
*  heat structure thermal property data
*-------------------------------------------
*-------------------------------------------
* u0-2 fuel  table  (1)
* ---------------------
* card     material type    format flag     vol heat cap flag
20100100     tbl/fctn          1                1
*
* thermal conductivity data
*-------------------------------------------------------
*card      temp   thermal cond       temp   thermal cond
20100101    500.0    9.281e-4        650.0    8.253e-4
20100102    800.0    7.436e-4        950.0    6.775e-4
20100103   1100.0    6.228e-4       1250.0    5.772e-4
20100104   1400.0    5.389e-4       1550.0    5.064e-4
20100105   1700.0    4.789e-4       1850.0    4.553e-4
20100106   2000.0    4.272e-4       2150.0    4.186e-4
20100107   2300.0    4.047e-4       2450.0    3.931e-4
20100108   2600.0    3.839e-4       3100.0    3.675e-4
20100109   3600.0    3.703e-4       4100.0    3.906e-4
20100110   4600.0    4.272e-4       5100.0    4.806e-4
```

```
20100111    1.0e+6     4.806e-4
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*volumetric heat capacity data
*---------------------------------------------------
*card        temp   vol heat cap         temp   vol heat cap
20100151      32.0    34.45             122.0     38.35
20100152     212.0    40.95             392.0     43.55
20100153     752.0    46.80            2012.0     51.35
20100154    2732.0    52.65            3092.0     56.55
20100155    3452.0    63.05            3812.0     72.80
20100156    4352.0    89.70            4532.0     94.25
20100157    4532.1    98.15            4892.0    100.10
20100158    5144.0   101.40            1.0e+6    101.40
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*
*
* he-gap     table  (2)
* --------------------
* card       material type     format flag       vol heat cap flag
20100200       tbl/fctn           1                  1
*
* thermal conductivity data
*---------------------------------------------------
*card        thermal cond
20100201      3.09410e-5
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*volumetric heat capacity data
*---------------------------------------------------
*card       vol heat cap
20100251       0.010
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*
```

```
* zircaloy   table  (3)
* --------------------
* card       material type     format flag       vol heat cap flag
20100300       tbl/fctn           1                  1
*
* thermal conductivity data
*--------------------------------------------------
*card        temp    thermal cond        temp     thermal cond
20100301       32.0    2.170e-3          212.0      2.220e-3
20100302      392.0    2.280e-3          572.0      2.440e-3
20100303      752.0    2.650e-3          932.0      2.889e-3
20100304     1112.0    3.119e-3         1292.0      3.469e-3
20100305     1472.0    3.661e-3         1652.0      3.881e-3
20100306     1832.0    4.111e-3         2012.0      4.481e-3
20100307     2192.0    4.939e-3         2372.0      5.461e-3
20100308     2552.0    6.050e-3         2732.0      6.681e-3
20100309     3092.0    8.031e-3         3360.0      9.200e-3
20100310     1.0e+6    9.200e-3
*-----------------------------------------------------------------
* data from ref. [349]
*-----------------------------------------------------------------
*
*volumetric heat capacity data
*--------------------------------------------------
*card        temp    vol heat cap        temp     vol heat cap
20100351       0.0     28.39            1480.3     34.48
20100352    1675.0     85.18            1787.5     34.48
20100353    1.0e+6     34.48
*-----------------------------------------------------------------
* data from ref. [349]
*-----------------------------------------------------------------
*
* steel table  (5)
* --------------------
* card       material type     format flag       vol heat cap flag
20100500       tbl/fctn           1                  1
*
* thermal conductivity data
*--------------------------------------------------
*card        temp    thermal cond      temp     thermal cond
20100501       0.0    2.500e-3         200.0      2.500e-3
20100502   1600.0     4.167e-3         1.0e+6     4.167e-3
*-----------------------------------------------------------------
* data from ref. [349]
```

```
*-----------------------------------------------------------------------
*
*volumetric heat capacity data
*---------------------------------------------------
*card        temp    vol heat cap       temp     vol heat cap
20100551    200.0     60.00             2200.0     80.00
20100552   1.0e+6     80.00
*-----------------------------------------------------------------------
* data from ref. [349]
*-----------------------------------------------------------------------
*
*
******
* table for normal valve area vs. stem position
******
*
*   the following table gives valve flow area vs stem position
*   valve area = ( stem position )**3.
*
20254500       normarea
20254501        .0          .0
20254502        .16675      .059
20254503        .3334       .089
20254504        .43339      .098
20254505        .5          .457
20254506        .583375     .667
20254507        .6666       .819
20254508        .79435     1.
20254509       1.          1.
*
*
*-----------------
* feedwater train
*-----------------
*
* feedwater train hydro components
*---------------------------------
*
*** condensate supply (at the base of the condensers) ***
*   press. and temp. per refs. [368] and [188], respectively
*
5000000 condensr tmdpvol
5000101 0. 100. 1.e6 0. 0. 0.
5000102 0. 0. 00010
```

5000200 003
5000201 0. 0.9824 101.1
*
*** piping from condensers to condensate pumps ***
* 3 36" dia. sch. 40 pipes 100' long are represented here. see app. d
* for reasoning elev. change per ref. [285 & 368].
*
5020000 cnd_pmp branch
5020001 1 0
5020101 19.4754 100. 0. 0. -5.3 -9.20 0.00015 2.8750 01000
5020200 0 2.8822999e+00 6.9094002e+01 1.0562000e+03 0.
5021101 500000000 502000000 0. 0. 0. 001000
5021201 3.0864000e+00 3.0864000e+00 0.
*
*** condensate pump (single) ***
* geometry and performance from ref. [90] as per calculations of app. d.
*
5050000 cndpmp_s pump
5050101 0. 50.2 277. 0. 0. 0. 00000
5050108 502010000 7.069 0. 0. 001000
5050109 508000000 3.142 262. 1.e99 001000
5050200 0 7.2176003e+01 6.9154999e+01 1.1005000e+03 0. 0.
5050201 0 2.8364000e+00 2.8364000e+00 0.
5050202 0 6.3801999e+00 6.3801999e+00 0.
5050301 0 -1 -3 -1 0 460 0
5050302 1.1700000e+03 1.0000000e+00 1.0830000e+04 2.8400000e+02
* need correct inertia
5050303 3983. 1355. 62.4 0.
5050304 0. 0. 0. 0.
* han
5051100 1 1
5051101 0. 1.276421
5051102 0.05 1.270980
5051103 0.1 1.262995
5051104 0.15 1.253315
5051105 0.2 1.242654
5051106 0.25 1.231591
5051107 0.3 1.220570
5051108 0.35 1.209902
5051109 0.4 1.199759
5051110 0.45 1.190182
5051111 0.5 1.181074
5051112 0.55 1.172205
5051113 0.6 1.163208

5051114 0.65 1.153582
5051115 0.7 1.142693
5051116 0.75 1.129767
5051117 0.8 1.113900
5051118 0.85 1.094051
5051119 0.9 1.069043
5051120 0.95 1.037564
5051121 1.   1.
* hvn
5051200 1 2
5051201 0.52 0. *jam
5051202 0.75 0.434464
5051203 0.775 0.489052
5051204   0.8 0.541027
5051205 0.825 0.592472
5051206 0.85 0.644935
5051207 0.875 0.699426
5051208   0.9 0.756421
5051209 0.925 0.815858
5051210 0.95 0.877137
5051211 0.975 0.939126
5051212   1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5051300 1 3 0. 1.276421
5051400 1 4 0. 1.276421
* ban
5051500 2 1
5051501   0. 0.658983
5051502 0.05 0.657930
5051503 0.1 0.660392
5051504 0.15 0.666062
5051505 0.2 0.674639
5051506 0.25 0.685835
5051507 0.3 0.699368
5051508 0.35 0.714969
5051509 0.4 0.732377
5051510 0.45 0.751340
5051511 0.5 0.771615
5051512 0.55 0.792970
5051513 0.6 0.815183
5051514 0.65 0.838039
5051515 0.7 0.861334
5051516 0.75 0.884874

5051517 0.8 0.908474
5051518 0.85 0.931959
5051519 0.9 0.955161
5051520 0.95 0.977925
5051521 1. 1.
* bvn
5051600 2 2
5051601 0.35 0. * extrapolated value
5051602 0.75 0.617190
5051603 0.775 0.659431
5051604 0.8 0.697266
5051605 0.825 0.733179
5051606 0.85 0.768990
5051607 0.875 0.805856
5051608 0.9 0.844273
5051609 0.925 0.884074
5051610 0.95 0.924429
5051611 0.975 0.963845
5051612 1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5051700 2 3 0. 0.658983
5051800 2 4 0. 0.658983
*
* velocity table
5056100 506
5056101 0. 1170.
*
*** condensate pump (double) ***
* geometry and performance from ref. [90] as per calculations of app. d.
*
5060000 cndpmp_d pump
5060101 0. 50.2 554. 0. 0. 0. 00000
5060108 **502**010000 14.138 0. 0. 001000
5060109 **508**000000 6.284 262. 1.e99 001000
5060200 0 7.2193001e+01 6.9154999e+01 1.1005000e+03 0. 0.
5060201 0 2.8334000e+00 2.8334000e+00 0.
5060202 0 6.3734002e+00 6.3734002e+00 0.
5060301 **505** -1 -3 -1 0 461 0
5060302 1.1700000e+03 1.0000000e+00 2.1660000e+04 2.8400000e+02
5060303 7966. 2710. 62.4 0.
5060304 0. 0. 0. 0.
*
* velocity table

5066100 507
5066101 0. 1170.
*
*** piping from condensate pumps to condensate booster pumps ***
* 3 18" dia. sch. 40 pipes 100' long are represented here. see app. d
* for explanation. elev. change per ref. [285 & 327].
*
5080000 pmp_pmp branch
5080001 0 0
5080101 4.6599 100. 0. 0. 3.3 5.75 0.00015 1.4063 01000
5080200 0 6.5344002e+01 6.9155998e+01 1.0992000e+03 0.
*
*** condensate booster pump (single) ***
* pump performance from "turbine cycle performance monitoring instruction
* unit 2", 2-ti-266 rev. 0004 as per calculations of app. d.
*
5100000 bstpmp_s pump
* need true length/volume
5100101 1.5533 0. 20. 0. 0. 0. 00000
5100108 **508**010000 1.5533 0. 0. 001000
5100109 **515**000000 1.5533 0. 1.e99 001000
5100200 0 1.8571001e+02 6.9267998e+01 1.1128000e+03 0. 0.
5100201 0 1.2955000e+01 1.2955000e+01 0.
5100202 0 1.2951000e+01 1.2951000e+01 0.
5100301 0 -1 -3 -1 0 465 0
* need true inertia
5100302 1.7800000e+03 1.0000000e+00 1.0800000e+04 5.3500000e+02 4.8920000e+03
5100303 9.0000000e+02 6.2099998e+01
5100304 0. 0. 0. 0. 0.
* han
5101100 1 1
5101101 0. 1.192908
5101102 0.05 1.186873
5101103 0.1 1.181114
5101104 0.15 1.175519
5101105 0.2 1.169975
5101106 0.25 1.164371
5101107 0.3 1.158596
5101108 0.35 1.152542
5101109 0.4 1.146100
5101110 0.45 1.139163
5101111 0.5 1.131625
5101112 0.55 1.123380
5101113 0.6 1.114325

5101114 0.65 1.104356
5101115 0.7 1.093370
5101116 0.75 1.081268
5101117 0.8 1.067948
5101118 0.85 1.053312
5101119 0.9 1.037261
5101120 0.95 1.019698
5101121 1. 1.
* hvn
5101200 1 2
5101201 0.60 0. *jam
5101202 0.75 0.432022
5101203 0.775 0.496009
5101204 0.8 0.555960
5101205 0.825 0.612788
5101206 0.85 0.667405
5101207 0.875 0.720723
5101208 0.9 0.773656
5101209 0.925 0.827115
5101210 0.95 0.882014
5101211 0.975 0.939264
5101212 1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5101300 1 3 0. 1.192908
5101400 1 4 0. 1.192908
* ban
5101500 2 1
5101501 0. 0.557646
5101502 0.05 0.572111
5101503 0.1 0.586739
5101504 0.15 0.601668
5101505 0.2 0.617028
5101506 0.25 0.632941
5101507 0.3 0.649524
5101508 0.35 0.666885
5101509 0.4 0.685126
5101510 0.45 0.704341
5101511 0.5 0.724618
5101512 0.55 0.746038
5101513 0.6 0.768675
5101514 0.65 0.792593
5101515 0.7 0.817854
5101516 0.75 0.844509

5101517 0.8 0.872603
5101518 0.85 0.902176
5101519 0.9 0.933257
5101520 0.95 0.965871
5101521 1. 1.
* bvn
5101600 2 2
5101601 0.05 0. *jam
5101602 0.85 0.833692
5101603 0.875 0.858738
5101604 0.9 0.883908
5101605 0.925 0.909902
5101606 0.95 0.937417
5101607 0.975 0.967152
5101608 1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5101700 2 3 0. 0.557646
5101800 2 4 0. 0.557646
*
* velocity table
5106100 508
5106101 0. 1780.
*
*** condensate booster pump (double) ***
* pump performance from "turbine cycle performance monitoring instruction
* unit 2", 2-ti-266 rev. 0004 as per calculations of app. d.
*
5110000 bstpmp_d pump
* need true length/volume
5110101 3.1066 0. 40. 0. 0. 0. 00000
5110108 **508**010000 3.1066 0. 0. 001000
5110109 **515**000000 3.1066 0. 1.e99 001000
5110200 0 1.8573000e+02 6.9268997e+01 1.1128000e+03 0. 0.
5110201 0 1.2868000e+01 1.2868000e+01 0.
5110202 0 1.2864000e+01 1.2864000e+01 0.
5110301 510 -1 -3 -1 0 466 0
* need true inertia
5110302 1.7800000e+03 1.0000000e+00 2.1600000e+04 5.3500000e+02 9.7840000e+03
5110303 1.8000000e+03 6.2099998e+01
5110304 0. 0. 0. 0. 0.
*
* velocity table
5116100 509

5116101 0. 1780.
*
*** piping from condensate booster pumps to drain coolers ***
*   3 18" dia. sch. 40 pipes 100' long are represented here. see app. d
*   for explanation. elev. change per ref. [327].
*
5150000 pmp_dc branch
5150001 3 0
5150101 4.6599 100. 0. 0. 0.3 30. 0.00015 1.4063 01000
5150200 0 3.0087000e+02 6.9269997e+01 1.1172000e+03 0.
5151101 515010000 **520**000000 0. 0. 0. 001000
5152101 515010000 **521**000000 0. 0. 0. 001000
5153101 515010000 522000000 0. 0. 0. 001000
5151201 5.5050998e+00 5.5050998e+00 0.
5152201 5.5050998e+00 5.5050998e+00 0.
5153201 5.5050998e+00 5.5050998e+00 0.
*
*** drain cooler A ***
*   geometry per vendor spec shts. included with app. d
5200000 'drcool-A' snglvol
5200101 3.65 92. 0. 0. 0.
5200102 0. 5.e-6 0.0567 01000
5200200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03 0. 0.
*
*** **drain cooler B** ***
*   **geometry per vendor spec shts. included with app. d**
5210000 'drcool-B' snglvol
5210101 3.65 92. 0. 0. 0.
5210102 0. 5.e-6 0.0567 01000
5210200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03 0. 0.
*
*** **drain cooler C** ***
*   **geometry per vendor spec shts. included with app. d**
5220000 'drcool-C' snglvol
5220101 3.65 92. 0. 0. 0.
5220102 0. 5.e-6 0.0567 01000
5220200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03 0. 0.
*
*** piping from drain cooler A to heater A5 ***
*   geometry per refs. [324, 326, 327, & 328]
5250000 'DC-HTRA5' pipe
5250001 1
5250101 1.5533 1
5250301 14. 1

5250401 0. 1
5250501 0. 1
5250601 42.7 1
5250701 9.5 1
5250801 0.00015 1.4063 1
5251001 01000 1
5251201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03 0. .0 1
*
*** piping from drain cooler B to heater B5 ***
* geometry per refs. [324, 326, 327, & 328]
5260000 'DC-HTRB5' pipe
5260001 1
5260101 1.5533 1
5260301 14. 1
5260401 0. 1
5260501 0. 1
5260601 42.7 1
5260701 9.5 1
5260801 0.00015 1.4063 1
5261001 01000 1
5261201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03 0. .0 1
*
***** piping from drain cooler C to heater C5 *****
*** geometry per refs. [324, 326, 327, & 328]**
5270000 'DC-HTRC5' pipe
5270001 1
5270101 1.5533 1
5270301 14. 1
5270401 0. 1
5270501 0. 1
5270601 42.7 1
5270701 9.5 1
5270801 0.00015 1.4063 1
5271001 01000 1
5271201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03 0. .0 1
*
*
*** component 530 - RFW Heater A5 Tubes**
5300000 'HTRA5-p' pipe
*
*** nv**
5300001 8
*
*** varea vn**

```
5300101  3.0778       8     *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea        jn
5300201  3.0778       7
*
*      vlength      vn
5300301  9.7917       8     * total tube length = (2)(39' 2")
*
*      volume       vn
5300401  0.0          8
*
*      incl         vn
5300601  0.0          8
*
*      roughness    dhyd   vn
5300801  1.5e-4       0.0462  8
*
*      kf    kr    jn
5300901  0.0   0.0    7
*
*      pvbfe        vn
5301001  00000        8
*
*      fvcahs       jn
5301101  001000       7
*
*      ebt  press.  temp.                   vn
5301201  3    281.31   147.046 0.    0.    0.    1
5301202  3    279.96   160.125 0.    0.    0.    2
5301203  3    278.61   169.237 0.    0.    0.    3
5301204  3    277.26   174.520 0.    0.    0.    4
5301205  3    275.92   180.835 0.    0.    0.    5
5301206  3    274.57   184.710 0.    0.    0.    6
5301207  3    273.22   186.605 0.    0.    0.    7
5301208  3    271.87   187.884 0.    0.    0.    8
*
*      vel/flow
5301300  0
*
*      liq-flo      vap-flo      int    jn
5301301  6.5111       6.5111       0.     1
5301302  6.5184       6.5184       0.     2
5301303  6.5268       6.5268       0.     3
5301304  6.5343       6.5343       0.     4
5301305  6.5723       6.5723       0.     5
```

```
5301306  6.5960      6.5960         0.     6
5301307  6.6071      6.6071         0.     7
*
*
* component 531 - RFW Heater B5 Tubes
5310000  'HTRB5-p'      pipe
*
*       nv
5310001  8
*
*       varea        vn
5310101  3.0778        8      *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea        jn
5310201  3.0778        7
*
*       vlength      vn
5310301  9.7917        8      * total tube length = (2)(39' 2")
*
*       volume       vn
5310401  0.0           8
*
*       incl         vn
5310601  0.0           8
*
*       roughness     dhyd   vn
5310801  1.5e-4       0.0462  8
*
*       kf    kr     jn
5310901  0.0    0.0    7
*
*       pvbfe        vn
5311001  00000         8
*
*       fvcahs       jn
5311101  001000        7
*
*       ebt   press.   temp.                  vn
5311201  3     281.31   147.046 0.    0.    0.    1
5311202  3     279.96   160.125 0.    0.    0.    2
5311203  3     278.61   169.237 0.    0.    0.    3
5311204  3     277.26   174.520 0.    0.    0.    4
5311205  3     275.92   180.835 0.    0.    0.    5
5311206  3     274.57   184.710 0.    0.    0.    6
5311207  3     273.22   186.605 0.    0.    0.    7
```

```
5311208  3     271.87   187.884 0.     0.     0.     8
*
*      vel/flow
5311300  0
*
*      liq-flo       vap-flo       int    jn
5311301  6.5111      6.5111        0.     1
5311302  6.5184      6.5184        0.     2
5311303  6.5268      6.5268        0.     3
5311304  6.5343      6.5343        0.     4
5311305  6.5723      6.5723        0.     5
5311306  6.5960      6.5960        0.     6
5311307  6.6071      6.6071        0.     7
*
*
* component 532 - RFW Heater C5 Tubes
5320000  'HTRC5-p'     pipe
*
*      nv
5320001  8
*
*      varea        vn
5320101  3.0778       8      *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea        jn
5320201  3.0778       7
*
*      vlength      vn
5320301  9.7917       8      * total tube length = (2)(39' 2")
*
*      volume       vn
5320401  0.0          8
*
*      incl         vn
5320601  0.0          8
*
*      roughness     dhyd   vn
5320801  1.5e-4       0.0462  8
*
*      kf    kr    jn
5320901  0.0   0.0    7
*
*      pvbfe        vn
5321001  00000        8
*
```

```
*       fvcahs        jn
5321101  001000        7
*
*       ebt   press.   temp.                    vn
5321201  3     281.31   147.046 0.     0.     0.     1
5321202  3     279.96   160.125 0.     0.     0.     2
5321203  3     278.61   169.237 0.     0.     0.     3
5321204  3     277.26   174.520 0.     0.     0.     4
5321205  3     275.92   180.835 0.     0.     0.     5
5321206  3     274.57   184.710 0.     0.     0.     6
5321207  3     273.22   186.605 0.     0.     0.     7
5321208  3     271.87   187.884 0.     0.     0.     8
*
*       vel/flow
5321300  0
*
*       liq-flo       vap-flo        int     jn
5321301  6.5111       6.5111          0.     1
5321302  6.5184       6.5184          0.     2
5321303  6.5268       6.5268          0.     3
5321304  6.5343       6.5343          0.     4
5321305  6.5723       6.5723          0.     5
5321306  6.5960       6.5960          0.     6
5321307  6.6071       6.6071          0.     7
*
*** piping from heater A5 to heater A4 ***
*   geometry per refs. [324, 326, 327, & 328]
5350000 'htrA5_4'       pipe
5350001 1
5350101 1.5533 1
5350301 21. 1
5350401 0. 1
5350501 0. 1
5350601 0. 1
5350701 0. 1
5350801 0.00015 1.4063 1
5351001 01000 1
5351201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*** piping from heater B5 to heater B4 ***
*   geometry per refs. [324, 326, 327, & 328]
5360000 'htrB5_4'       pipe
5360001 1
5360101 1.5533 1
```

```
5360301 21. 1
5360401 0. 1
5360501 0. 1
5360601 0. 1
5360701 0. 1
5360801 0.00015 1.4063 1
5361001 01000 1
5361201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*** piping from heater C5 to heater C4 ***
*   geometry per refs. [324, 326, 327, & 328]
5370000 'htrC5_4'       pipe
5370001 1
5370101 1.5533 1
5370301 21. 1
5370401 0. 1
5370501 0. 1
5370601 0. 1
5370701 0. 1
5370801 0.00015 1.4063 1
5371001 01000 1
5371201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*
* component 540 - RFW Heater A4 Tubes
*
5400000  'HTRA4-p'      pipe
*
*       nv
5400001  10
*
*       varea          vn
5400101  2.9736        10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea          jn
5400201  2.9736        9
*
*       vlength        vn
5400301  7.8333        10      * total tube length = (2)(39' 2")
*
*       volume         vn
5400401  0.0           10
*
*       incl           vn
5400601  0.0           10
```

```
*
*       roughness      dhyd    vn
5400801  1.5e-4         0.0462  10
*
*       kf     kr      jn
5400901  0.0    0.0     9
*
*       pvbfe          vn
5401001  00000          10
*
*       fvcahs         jn
5401101  001000         9
*
*       ebt   press.   temp.                  vn
5401201  3     273.96   189.940 0.    0.     0.     1
5401202  3     272.49   195.815 0.    0.     0.     2
5401203  3     271.03   212.726 0.    0.     0.     3
5401204  3     269.56   224.282 0.    0.     0.     4
5401205  3     268.09   231.955 0.    0.     0.     5
5401206  3     266.61   237.355 0.    0.     0.     6
5401207  3     265.13   240.458 0.    0.     0.     7
5401208  3     263.66   242.113 0.    0.     0.     8
5401209  3     262.18   242.934 0.    0.     0.     9
5401210  3     260.70   243.473 0.    0.     0.     10
*
*       vel/flow
5401300  1
*
*       liq-flo        vap-flo        int     jn
5401301  1232.9         0.0            0.      9
*
*
* component 541 - RFW Heater B4 Tubes
*
5410000  'HTRB4-p'      pipe
*
*       nv
5410001  10
*
*       varea          vn
5410101  2.9736         10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea          jn
5410201  2.9736         9
*
```

```
*       vlength       vn
5410301  7.8333        10      * total tube length = (2)(39' 2")
*
*       volume        vn
5410401  0.0           10
*
*       incl          vn
5410601  0.0           10
*
*       roughness     dhyd    vn
5410801  1.5e-4        0.0462  10
*
*       kf    kr    jn
5410901  0.0   0.0   9
*
*       pvbfe         vn
5411001  00000         10
*
*       fvcahs        jn
5411101  001000        9
*
*       ebt   press.   temp.                vn
5411201  3    273.96   189.940 0.   0.   0.   1
5411202  3    272.49   195.815 0.   0.   0.   2
5411203  3    271.03   212.726 0.   0.   0.   3
5411204  3    269.56   224.282 0.   0.   0.   4
5411205  3    268.09   231.955 0.   0.   0.   5
5411206  3    266.61   237.355 0.   0.   0.   6
5411207  3    265.13   240.458 0.   0.   0.   7
5411208  3    263.66   242.113 0.   0.   0.   8
5411209  3    262.18   242.934 0.   0.   0.   9
5411210  3    260.70   243.473 0.   0.   0.   10
*
*       vel/flow
5411300  1
*
*       liq-flo       vap-flo       int    jn
5411301  1232.9        0.0           0.     9
*
*
* component 542 - RFW Heater C4 Tubes
*
5420000  'HTRC4-p'     pipe
*
*       nv
```

```
5420001  10
*
*       varea         vn
5420101  2.9736        10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea         jn
5420201  2.9736        9
*
*       vlength       vn
5420301  7.8333        10      * total tube length = (2)(39' 2")
*
*       volume        vn
5420401  0.0           10
*
*       incl          vn
5420601  0.0           10
*
*       roughness     dhyd   vn
5420801  1.5e-4        0.0462  10
*
*       kf    kr     jn
5420901  0.0    0.0    9
*
*       pvbfe         vn
5421001  00000         10
*
*       fvcahs        jn
5421101  001000        9
*
*       ebt   press.   temp.                   vn
5421201  3     273.96   189.940 0.     0.     0.     1
5421202  3     272.49   195.815 0.     0.     0.     2
5421203  3     271.03   212.726 0.     0.     0.     3
5421204  3     269.56   224.282 0.     0.     0.     4
5421205  3     268.09   231.955 0.     0.     0.     5
5421206  3     266.61   237.355 0.     0.     0.     6
5421207  3     265.13   240.458 0.     0.     0.     7
5421208  3     263.66   242.113 0.     0.     0.     8
5421209  3     262.18   242.934 0.     0.     0.     9
5421210  3     260.70   243.473 0.     0.     0.     10
*
*       vel/flow
5421300  1
*
*       liq-flo       vap-flo       int    jn
```

5421301 1232.9 0.0 0. 9
*
*
*** piping from heater A4 to heater A3 ***
* geometry per refs. [324, 326, 327, & 328]
5450000 'htrA4_3' pipe
5450001 1
5450101 1.5533 1
5450301 116. 1
5450401 0. 1
5450501 0. 1
5450601 -3.6 1
5450701 -7.25 1
5450801 0.00015 1.4063 1
5451001 01000 1
5451201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03 0. .0 1
*
***** piping from heater B4 to heater B3 *****
*** geometry per refs. [324, 326, 327, & 328]**
5460000 'htrB4_3' pipe
5460001 1
5460101 1.5533 1
5460301 116. 1
5460401 0. 1
5460501 0. 1
5460601 -3.6 1
5460701 -7.25 1
5460801 0.00015 1.4063 1
5461001 01000 1
5461201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03 0. .0 1
*
***** piping from heater C4 to heater C3 *****
*** geometry per refs. [324, 326, 327, & 328]**
5470000 'htrC4_3' pipe
5470001 1
5470101 1.5533 1
5470301 116. 1
5470401 0. 1
5470501 0. 1
5470601 -3.6 1
5470701 -7.25 1
5470801 0.00015 1.4063 1
5471001 01000 1
5471201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03 0. .0 1

```
*
*
* component 550 - RFW Heater A3 Tubes
5500000  'HTRA3-p'     pipe
*
*      nv
5500001  12
*
*      varea        vn
5500101  3.1315       12      *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea        jn
5500201  3.1315       11
*
*      vlength      vn
5500301  7.0534       1       *
5500302  7.0534       2       *
5500303  3.0000       3       *volume center = lower level tap
5500304  3.0000       4       *volume center = upper level tap
5500305  11.1133      5       *remaining 35.5' total tube length
5500306  11.1133      6       *remaining 35.5' total tube length
5500307  11.1133      7       *remaining 35.5' total tube length
5500308  11.1133      8       *remaining 35.5' total tube length
5500309  3.0000       9       *volume center = lower level tap
5500310  3.0000       10      *volume center = upper level tap
5500311  7.0534       11      *
5500312  7.0534       12      *
*
*      volume       vn
5500401  0.0          12
*
*      incl         vn
5500601  90.0         6
5500602  -90.0        12
*
*      roughness    dhyd   vn
5500801  1.5e-4       0.0462  12
*
*      kf    kr    jn
5500901  0.0   0.0    11
*
*      pvbfe        vn
5501001  00000        12
*
*      fvcahs       jn
```

```
5501101  001000       11
*
*      ebt   press.   temp.                    vn
5501201  3     259.34   244.415 0.     0.     0.     1
5501202  3     255.25   246.066 0.     0.     0.     2
5501203  3     252.33   247.155 0.     0.     0.     3
5501204  3     250.59   254.653 0.     0.     0.     4
5501205  3     246.53   272.296 0.     0.     0.     5
5501206  3     240.14   283.712 0.     0.     0.     6
5501207  3     238.21   291.042 0.     0.     0.     7
5501208  3     240.73   295.669 0.     0.     0.     8
5501209  3     242.32   296.721 0.     0.     0.     9
5501210  3     242.99   297.405 0.     0.     0.     10
5501211  3     244.12   297.600 0.     0.     0.     11
5501212  3     245.70   297.363 0.     0.     0.     12
*
*      vel/flow
5501300  1
*
*      liq-flo       vap-flo       int    jn
5501301  1232.9       0.0           0.     11
*
*
* component 551 - RFW Heater B3 Tubes
5510000  'HTRB3-p'     pipe
*
*      nv
5510001  12
*
*      varea         vn
5510101  3.1315       12      *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea         jn
5510201  3.1315       11
*
*      vlength       vn
5510301  7.0534       1      *
5510302  7.0534       2      *
5510303  3.0000       3      *volume center = lower level tap
5510304  3.0000       4      *volume center = upper level tap
5510305  11.1133      5       *remaining 35.5' total tube length
5510306  11.1133      6       *remaining 35.5' total tube length
5510307  11.1133      7       *remaining 35.5' total tube length
5510308  11.1133      8       *remaining 35.5' total tube length
5510309  3.0000       9      *volume center = lower level tap
```

```
5510310  3.0000        10     *volume center = upper level tap
5510311  7.0534        11     *
5510312  7.0534        12     *
*
*      volume        vn
5510401  0.0          12
*
*      incl        vn
5510601  90.0         6
5510602  -90.0        12
*
*      roughness     dhyd   vn
5510801  1.5e-4       0.0462  12
*
*      kf    kr     jn
5510901  0.0   0.0    11
*
*      pvbfe        vn
5511001  00000        12
*
*      fvcahs       jn
5511101  001000       11
*
*      ebt   press.   temp.                    vn
5511201  3     259.34   244.415 0.     0.     0.     1
5511202  3     255.25   246.066 0.     0.     0.     2
5511203  3     252.33   247.155 0.     0.     0.     3
5511204  3     250.59   254.653 0.     0.     0.     4
5511205  3     246.53   272.296 0.     0.     0.     5
5511206  3     240.14   283.712 0.     0.     0.     6
5511207  3     238.21   291.042 0.     0.     0.     7
5511208  3     240.73   295.669 0.     0.     0.     8
5511209  3     242.32   296.721 0.     0.     0.     9
5511210  3     242.99   297.405 0.     0.     0.     10
5511211  3     244.12   297.600 0.     0.     0.     11
5511212  3     245.70   297.363 0.     0.     0.     12
*
*      vel/flow
5511300  1
*
*      liq-flo       vap-flo        int    jn
5511301  1232.9       0.0            0.     11
*
*
* component 552 - RFW Heater C3 Tubes
```

```
5520000  'HTRC3-p'      pipe
*
*       nv
5520001  12
*
*       varea         vn
5520101  3.1315        12      *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea         jn
5520201  3.1315        11
*
*       vlength       vn
5520301  7.0534        1       *
5520302  7.0534        2       *
5520303  3.0000        3       *volume center = lower level tap
5520304  3.0000        4       *volume center = upper level tap
5520305  11.1133       5       *remaining 35.5' total tube length
5520306  11.1133       6       *remaining 35.5' total tube length
5520307  11.1133       7       *remaining 35.5' total tube length
5520308  11.1133       8       *remaining 35.5' total tube length
5520309  3.0000        9       *volume center = lower level tap
5520310  3.0000        10      *volume center = upper level tap
5520311  7.0534        11      *
5520312  7.0534        12      *
*
*       volume        vn
5520401  0.0           12
*
*       incl          vn
5520601  90.0          6
5520602  -90.0         12
*
*       roughness     dhyd   vn
5520801  1.5e-4        0.0462  12
*
*       kf    kr     jn
5520901  0.0   0.0    11
*
*       pvbfe         vn
5521001  00000         12
*
*       fvcahs        jn
5521101  001000        11
*
*       ebt   press.   temp.                  vn
```

```
5521201  3    259.34   244.415 0.    0.    0.    1
5521202  3    255.25   246.066 0.    0.    0.    2
5521203  3    252.33   247.155 0.    0.    0.    3
5521204  3    250.59   254.653 0.    0.    0.    4
5521205  3    246.53   272.296 0.    0.    0.    5
5521206  3    240.14   283.712 0.    0.    0.    6
5521207  3    238.21   291.042 0.    0.    0.    7
5521208  3    240.73   295.669 0.    0.    0.    8
5521209  3    242.32   296.721 0.    0.    0.    9
5521210  3    242.99   297.405 0.    0.    0.    10
5521211  3    244.12   297.600 0.    0.    0.    11
5521212  3    245.70   297.363 0.    0.    0.    12
*
*      vel/flow
5521300  1
*
*      liq-flo      vap-flo       int    jn
5521301  1232.9       0.0           0.     11
*
*
*** piping from heaters 3 to feed pumps ***
*   geometry per refs. [216, 324, 326, 327, 328]
5550000 htr3_pmp branch
5550001 4        0
5550101 4.6599 12. 0. 0. 0. 0. 0.00015 1.4063 01000
5550200   0 2.5089999e+02 2.6672000e+02 1.1158000e+03  0.
5551101 550010000 555000000 0. 0. 0. 001000
5552101 551010000 555000000 0. 0. 0. 001000
5553101 552010000 555000000 0. 0. 0. 001000
5554101 555010000 557000000 0.3491 7.301 7.417 001000
5551201      6.9323001e+00  6.9323001e+00   0.
5552201      6.9323001e+00  6.9323001e+00   0.
5553201      6.9323001e+00  6.9323001e+00   0.
5554201      6.0248899e-06  6.0249299e-06   0.
*
* feedwater bypass valve inlet
5570000 bypinlet snglvol
5570101 0.3491  40.  0.  0.  20.55  14.04  .00015  0.  01000
5570200   0 2.4930000e+02 2.6673999e+02 1.1158000e+03  0. 0.
*
* feedwater bypass valve
5580000 bypvalve valve
5580101 557010000  559000000 0.3491 4.76  9.99e+99 000100
5580201    0   0.   0.   0.
```

5580300 srvvlv
5580301 611
*
* feedwater bypass valve outlet
5590000 bypotlet snglvol
5590101 0.3491 40. 0. 0. 20.55 14.04 .00015 0. 01000
5590200 0 1.0997000e+03 2.6729001e+02 1.1074000e+03 0. 0.
*
*** feed pump (a) inlet volume
5600000 apmpin branch
5600001 1 0
5600101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5600200 0 2.4492000e+02 2.6673001e+02 1.1156000e+03 0.
5601101 **555**010000 **560**000000 1.5533 0. 0. 001000
5601201 1.3924000e+01 1.3924000e+01 0.
*
*** feed pump (b) inlet volume
5610000 bpmpin branch
5610001 1 0
5610101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5610200 0 2.4492000e+02 2.6673001e+02 1.1156000e+03 0.
5611101 **555**010000 **561**000000 1.5533 0. 0. 001000
5611201 1.3923000e+01 1.3923000e+01 0.
*
*** feed pump (c) inlet volume
5620000 cpmpin branch
5620001 1 0
5620101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5620200 0 2.4492000e+02 2.6673001e+02 1.1156000e+03 0.
5621101 **555**010000 **562**000000 1.5533 0. 0. 001000
5621201 1.3923000e+01 1.3923000e+01 0.
*
*** reactor feed pump (a) ***
* performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
5700000 fdpmp_a pump
* need true volume
5700101 1.5533 0. 30. 0. 0. 0. 00000
5700108 **560**010000 1.5533 0. 0. 001000
5700109 **575**000000 1.5533 4. 0. 001000
5700200 0 6.7017999e+02 2.6726001e+02 1.1173000e+03 0. 0.
5700201 0 1.3924000e+01 1.3924000e+01 0.
5700202 0 1.3907000e+01 1.3907000e+01 0.
5700301 0 -1 -3 -1 0 408 0
5700302 5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03

5700303 8279. 4239. 57.2 0.
5700304 0. 0. 0. 0.
* han
5701100 1 1
5701101 0. 1.197067
5701102 0.05 1.184067
5701103 0.1 1.173948
5701104 0.15 1.166099
5701105 0.2 1.159951
5701106 0.25 1.154979
5701107 0.3 1.150703
5701108 0.35 1.146687
5701109 0.4 1.142538
5701110 0.45 1.137910
5701111 0.5 1.132499
5701112 0.55 1.126046
5701113 0.6 1.118334
5701114 0.65 1.109195
5701115 0.7 1.098501
5701116 0.75 1.086169
5701117 0.8 1.072161
5701118 0.85 1.056483
5701119 0.9 1.039186
5701120 0.95 1.020363
5701121 1. 1.
* hvn
5701200 1 2
5701201 0.618 0. * extrapolated value
5701202 0.725 0.384958
5701203 0.75 0.447154
5701204 0.775 0.504118
5701205 0.8 0.557846
5701206 0.825 0.609998
5701207 0.85 0.661900
5701208 0.875 0.714540
5701209 0.9 0.768575
5701210 0.925 0.824324
5701211 0.95 0.881772
5701212 0.975 0.940568
5701213 1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5701300 1 3 0. 1.197067
5701400 1 4 0. 0.7 * jam

```
* ban
5701500 2 1
5701501     0. 0.482838
5701502   0.05 0.500041
5701503    0.1 0.520557
5701504   0.15 0.543522
5701505    0.2 0.568180
5701506   0.25 0.593886
5701507    0.3 0.620100
5701508   0.35 0.646396
5701509    0.4 0.672452
5701510   0.45 0.698057
5701511    0.5 0.723108
5701512   0.55 0.747612
5701513    0.6 0.771684
5701514   0.65 0.795547
5701515    0.7 0.819534
5701516   0.75 0.844086
5701517    0.8 0.869753
5701518   0.85 0.897194
5701519    0.9 0.927177
5701520   0.95 0.960578
5701521     1. 1.
* bvn
5701600 2 2
5701601   0.27 0. *jam
5701602  0.725 0.579497
5701603   0.75 0.613313
5701604  0.775 0.646402
5701605    0.8 0.679301
5701606  0.825 0.712545
5701607   0.85 0.746670
5701608  0.875 0.782212
5701609    0.9 0.819708
5701610  0.925 0.859692
5701611   0.95 0.902700
5701612  0.975 0.949269
5701613     1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5701700 2 3 0. 0.482838
5701800 2 4 0. 0.8 * jam
*
* velocity table
```

5706100 408 cntrlvar 756
5706101 0. 0. 10000. 10000.
*
*** reactor feed pump (b) ***
*   performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
5710000 fdpmp_b pump
* need true volume
5710101 1.5533 0. 30. 0. 0. 0. 00000
5710108 **561**010000 1.5533 0. 0. 001000
5710109 **576**000000 1.5533 4. 0. 001000
5710200 0 6.7017999e+02 2.6726001e+02 1.1173000e+03 0. 0.
5710201 0 1.3923000e+01 1.3923000e+01   0.
5710202 0 1.3906000e+01 1.3906000e+01   0.
5710301 **570** -1 -3 -1 0 408 0
5710302   5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03
5710303 8279. 4239. 57.2 0.
5710304 0. 0. 0. 0.
*
* velocity table
5716100 408 cntrlvar 757
5716101 0. 0. 10000. 10000.
*
*** reactor feed pump (c) ***
*   performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
5720000 fdpmp_c pump
* need true flow area and length
5720101 1.5533 0. 30. 0. 0. 0. 00000
5720108 **562**010000 1.5533 0. 0. 001000
5720109 **577**000000 1.5533 4. 0. 001000
5720200 0 6.7017999e+02 2.6726001e+02 1.1173000e+03 0. 0.
5720201 0 1.3923000e+01 1.3923000e+01   0.
5720202 0 1.3906000e+01 1.3906000e+01   0.
5720301 **570** -1 -3 -1 0 408 0
5720302   5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03
* moment of inertia per Bill Babb, GE
5720303 8279. 4239. 57.2 0.
5720304 0. 0. 0. 0.
*
* velocity table
5726100 408 cntrlvar 758
5726101 0. 0. 10000. 10000.
*
*** feed pump (a) outlet volume (with check valve function) ***
*   large loss coef. in reverse direction serves check valve function

5750000 apmpout branch
5750001 1 0
5750101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5750200 0 1.0966000e+03 2.6726999e+02 1.1075000e+03 0.
5751101 **575**010000 **588**000000 1.5533 0. 1.e99 001000
5751201 1.3886000e+01 1.3886000e+01 0.
*
*** feed pump (b) outlet volume (with check valve function) ***
* large loss coef. in reverse direction serves check valve function
5760000 bpmpout branch
5760001 1 0
5760101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5760200 0 1.0966000e+03 2.6726999e+02 1.1075000e+03 0.
5761101 **576**010000 **588**000000 1.5533 0. 1.e99 001000
5761201 1.3885000e+01 1.3885000e+01 0.
*
*** feed pump (c) outlet volume (with check valve function) ***
* large loss coef. in reverse direction serves check valve function
5770000 cpmpout branch
5770001 1 0
5770101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5770200 0 1.0966000e+03 2.6726999e+02 1.1075000e+03 0.
5771101 **577**010000 **588**000000 1.5533 0. 1.e99 001000
5771201 1.3885000e+01 1.3885000e+01 0.
*
*** min. recirc. valve (a) ***
* this is a trip type valve with choked flow logic enabled, and
* abrupt area change logic invoked. the area of this valve is
* best defined as the area of the orifice placed in min. recirc.
* piping. this area has been estimated from consideration of
* ref. [178]. it corresponds to a diameter of 2".
5800000 recirc_a valve
5800101 **575**010000 **581**000000 0.0014 6.4764 6.4764 000100
5800201 0 0. 0. 0.
5800300 mtrvlv *jam
5800301 475 478 1. 0. *jam
*
*** min. recirc. (a) sink ***
* fluid conditions of condensers (see comp. 500)
5810000 sink_a tmdpvol
5810101 0. 100. 1.e6 0. 0. 0.
5810102 0. 0. 00010
5810200 003
5810201 0. 0.9824 101.1

*
*** min. recirc. valve (b) ***
*   (see note of component 580)
5820000 recirc_b valve
5820101 **576**010000 **583**000000 0.0014 6.4764 6.4764 000100
5820201   0   0.   0.   0.
5820300 mtrvlv *jam
5820301 476 479 1. 0. *jam
*
*** min. recirc. (b) sink ***
*   fluid conditions of condensers (see comp. 500)
5830000 sink_b tmdpvol
5830101 0. 100. 1.e6 0. 0. 0.
5830102 0. 0. 00010
5830200 003
5830201 0. 0.9824 101.1
*
*** min. recirc. valve (c) ***
*   (see note of component 580)
5840000 recirc_c valve
5840101 **577**010000 **585**000000 0.0014 6.4764 6.4764 000100
5840201   0   0.   0.   0.
5840300 mtrvlv *jam
5840301 477 480 1. 0. *jam
*
*
*** min. recirc. (c) sink ***
*   fluid conditions of condensers (see comp. 500)
5850000 sink_c tmdpvol
5850101 0. 100. 1.e6 0. 0. 0.
5850102 0. 0. 00010
5850200 003
5850201 0. 0.9824 101.1
*
*** piping from feed pumps to heaters 2 ***
*   geometry per ref. [216]
*
5880000 pmp_htr2 branch
5880001 **4**   0
5880101 4.6599 220.14 0. 0. -7.2 -27.75 0.00015 1.4063 01000
5880200   0 1.1017000e+03 2.6726999e+02 1.1074000e+03 0.
5881101 **588**010000 **590**000000 0. 0. 0. 001000
5882101 **588**010000 **591**000000 0. 0. 0. 001000
5883101 588010000 592000000 0. 0. 0. 001000

```
5884101 559010000 588000000 0.3491 8.229 1.e+99 001000
5881201     7.5832000e+00  7.5832000e+00   0.
5882201     7.5832000e+00  7.5832000e+00   0.
5883201     7.5832000e+00  7.5832000e+00   0.
5884201     0.   0.    0.
*
*
* component 590 - RFW Heater A2 Tubes
5900000  'HTRA2-p'      pipe
*
*       nv
5900001  10
*
*       varea         vn
5900101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
5900201  2.8872        9
*
*       vlength       vn
5900301  5.4974        1       *
5900302  3.0000        2       *volume center = lower level tap
5900303  3.0000        3       *volume center = upper level tap
5900304  8.8763        7       *remaining 35.5' total tube length
5900305  3.0000        8       *volume center = lower level tap
5900306  3.0000        9       *volume center = upper level tap
5900307  5.4974        10       *
*
*       volume        vn
5900401  0.0          10
*
*       incl          vn
5900601  90.0         5
5900602  -90.0        10
*
*       roughness     dhyd   vn
5900801  1.5e-4       0.0439  10      *.527" ID
*
*       kf    kr     jn
5900901  0.0    0.0    9
*
*       pvbfe         vn
5901001  00000        10
*
```

```
*       fvcahs        jn
5901101  001000        9
*
*       ebt   press.   temp.                    vn
5901201  3     1110.0   301.969 0.    0.     0.     1
5901202  3     1107.4   303.527 0.    0.     0.     2
5901203  3     1105.5   309.131 0.    0.     0.     3
5901204  3     1101.9   319.624 0.    0.     0.     4
5901205  3     1096.4   325.800 0.    0.     0.     5
5901206  3     1094.5   329.305 0.    0.     0.     6
5901207  3     1096.0   331.281 0.    0.     0.     7
5901208  3     1097.0   331.801 0.    0.     0.     8
5901209  3     1097.5   331.601 0.    0.     0.     9
5901210  3     1098.3   330.416 0.    0.     0.     10
*
*       vel/flow
5901300  1
*
*       liq-flo       vap-flo        int     jn
5901301  1232.9        0.0            0.     9
*
*
* component 591 - RFW Heater B2 Tubes
5910000  'HTRB2-p'      pipe
*
*       nv
5910001  10
*
*       varea         vn
5910101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
5910201  2.8872        9
*
*       vlength       vn
5910301  5.4974        1       *
5910302  3.0000        2       *volume center = lower level tap
5910303  3.0000        3       *volume center = upper level tap
5910304  8.8763        7       *remaining 35.5' total tube length
5910305  3.0000        8       *volume center = lower level tap
5910306  3.0000        9       *volume center = upper level tap
5910307  5.4974        10       *
*
*       volume        vn
5910401  0.0           10
```

```
*
*       incl          vn
5910601  90.0          5
5910602  -90.0         10
*
*       roughness     dhyd    vn
5910801  1.5e-4       0.0439  10     *.527" ID
*
*       kf    kr    jn
5910901  0.0    0.0    9
*
*       pvbfe         vn
5911001  00000        10
*
*       fvcahs        jn
5911101  001000        9
*
*       ebt   press.   temp.                    vn
5911201  3    1110.0   301.969 0.    0.    0.    1
5911202  3    1107.4   303.527 0.    0.    0.    2
5911203  3    1105.5   309.131 0.    0.    0.    3
5911204  3    1101.9   319.624 0.    0.    0.    4
5911205  3    1096.4   325.800 0.    0.    0.    5
5911206  3    1094.5   329.305 0.    0.    0.    6
5911207  3    1096.0   331.281 0.    0.    0.    7
5911208  3    1097.0   331.801 0.    0.    0.    8
5911209  3    1097.5   331.601 0.    0.    0.    9
5911210  3    1098.3   330.416 0.    0.    0.    10
*
*       vel/flow
5911300  1
*
*       liq-flo       vap-flo        int    jn
5911301  1232.9       0.0            0.     9
*
*
* component 592 - RFW Heater C2 Tubes
*
5920000  'HTRC2-p'     pipe
*
*       nv
5920001  10
*
*       varea         vn
5920101  2.8872        10     *1906 tubes, 5/8" OD, .049" wall, 18BWG
```

```
*
*       jarea         jn
5920201  2.8872        9
*
*       vlength       vn
5920301  5.4974        1      *
5920302  3.0000        2      *volume center = lower level tap
5920303  3.0000        3      *volume center = upper level tap
5920304  8.8763        7      *remaining 35.5' total tube length
5920305  3.0000        8      *volume center = lower level tap
5920306  3.0000        9      *volume center = upper level tap
5920307  5.4974        10      *
*
*       volume        vn
5920401  0.0          10
*
*       incl          vn
5920601  90.0          5
5920602  -90.0         10
*
*       roughness     dhyd   vn
5920801  1.5e-4        0.0439  10      *.527" ID
*
*       kf    kr    jn
5920901  0.0    0.0    9
*
*       pvbfe         vn
5921001  00000         10
*
*       fvcahs        jn
5921101  001000        9
*
*       ebt   press.   temp.                  vn
5921201  3    1110.0   301.969 0.    0.    0.    1
5921202  3    1107.4   303.527 0.    0.    0.    2
5921203  3    1105.5   309.131 0.    0.    0.    3
5921204  3    1101.9   319.624 0.    0.    0.    4
5921205  3    1096.4   325.800 0.    0.    0.    5
5921206  3    1094.5   329.305 0.    0.    0.    6
5921207  3    1096.0   331.281 0.    0.    0.    7
5921208  3    1097.0   331.801 0.    0.    0.    8
5921209  3    1097.5   331.601 0.    0.    0.    9
5921210  3    1098.3   330.416 0.    0.    0.    10
*
*       vel/flow
```

5921300 1
*
*** liq-flo vap-flo int jn**
5921301 1232.9 0.0 0. 9
*
*
*** piping from heater A2 to heater A1 ***
* geometry per ref. [215 & 216]
5950000 'htrA2_1' pipe
5950001 1
5950101 1.755 1
5950301 2. 1
5950401 0. 1
5950501 0. 1
5950601 0. 1
5950701 0. 1
5950801 0.00015 1.4948 1
5951001 01000 1
5951201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03 0. .0 1
*
***** piping from heater B2 to heater B1 *****
*** geometry per ref. [215 & 216]**
5960000 'htrB2_1' pipe
5960001 1
5960101 1.755 1
5960301 2. 1
5960401 0. 1
5960501 0. 1
5960601 0. 1
5960701 0. 1
5960801 0.00015 1.4948 1
5961001 01000 1
5961201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03 0. .0 1
*
***** piping from heater C2 to heater C1 *****
*** geometry per ref. [215 & 216]**
5970000 'htrC2_1' pipe
5970001 1
5970101 1.755 1
5970301 2. 1
5970401 0. 1
5970501 0. 1
5970601 0. 1
5970701 0. 1

```
5970801 0.00015 1.4948 1
5971001 01000 1
5971201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03  0.  .0  1
*
*
* component 600 - RFW Heater A1 Tubes
6000000  'HTRA1-p'      pipe
*
*       nv
6000001  10
*
*       varea         vn
6000101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
6000201  2.8872        9
*
*       vlength       vn
6000301  1.3307        1       *
6000302  2.6667        2       *volume center = lower level tap
6000303  2.6667        3       *volume center = upper level tap
6000304  10.4596       7       *remaining 41.8' total tube length
6000305  2.6667        8       *volume center = lower level tap
6000306  2.6667        9       *volume center = upper level tap
6000307  1.3307        10      *
*
*       volume        vn
6000401  0.0           10
*
*       incl          vn
6000601  90.0          5
6000602  -90.0         10
*
*       roughness     dhyd   vn
6000801  1.0e-7        0.0439  10      *.527" ID
*
*       kf    kr     jn
6000901  0.0   0.0    9
*
*       pvbfe         vn
6001001  00000         10
*
*       fvcahs        jn
6001101  001000        9
*
```

```
*       ebt   press.   temp.                    vn
6001201  3     1089.5   331.600 0.     0.     0.     1
6001202  3     1088.5   335.810 0.     0.     0.     2
6001203  3     1087.1   340.290 0.     0.     0.     3
6001204  3     1083.6   352.648 0.     0.     0.     4
6001205  3     1078.1   362.143 0.     0.     0.     5
6001206  3     1076.6   368.635 0.     0.     0.     6
6001207  3     1079.1   372.725 0.     0.     0.     7
6001208  3     1080.7   373.688 0.     0.     0.     8
6001209  3     1081.4   373.683 0.     0.     0.     9
6001210  3     1081.9   373.013 0.     0.     0.     10
*
*       vel/flow
6001300  1
*
*       liq-flo       vap-flo       int    jn
6001301  1232.9        0.0           0.     9
*
*
* component 601 - RFW Heater B1 Tubes
6010000  'HTRB1-p'     pipe
*
*       nv
6010001  10
*
*       varea         vn
6010101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
6010201  2.8872        9
*
*       vlength       vn
6010301  1.3307        1      *
6010302  2.6667        2      *volume center = lower level tap
6010303  2.6667        3      *volume center = upper level tap
6010304  10.4596       7       *remaining 41.8' total tube length
6010305  2.6667        8      *volume center = lower level tap
6010306  2.6667        9      *volume center = upper level tap
6010307  1.3307        10      *
*
*       volume        vn
6010401  0.0           10
*
*       incl          vn
6010601  90.0          5
```

```
6010602  -90.0         10
*
*       roughness     dhyd    vn
6010801  1.0e-7       0.0439  10     *.527" ID
*
*       kf    kr    jn
6010901  0.0   0.0    9
*
*       pvbfe        vn
6011001  00000        10
*
*       fvcahs       jn
6011101  001000       9
*
*       ebt  press.   temp.                vn
6011201  3    1089.5   331.600 0.   0.    0.    1
6011202  3    1088.5   335.815 0.   0.    0.    2
6011203  3    1087.1   340.290 0.   0.    0.    3
6011204  3    1083.6   352.648 0.   0.    0.    4
6011205  3    1078.1   362.143 0.   0.    0.    5
6011206  3    1076.6   368.635 0.   0.    0.    6
6011207  3    1079.1   372.725 0.   0.    0.    7
6011208  3    1080.7   373.688 0.   0.    0.    8
6011209  3    1081.4   373.683 0.   0.    0.    9
6011210  3    1081.9   373.013 0.   0.    0.    10
*
*       vel/flow
6011300  1
*
*       liq-flo      vap-flo       int    jn
6011301  1232.9       0.0           0.     9
*
*
* component 602 - RFW Heater C1 Tubes
6020000  'HTRC1-p'     pipe
*
*       nv
6020001  10
*
*       varea        vn
6020101  2.8872       10     *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea        jn
6020201  2.8872       9
*
```

```
*       vlength      vn
6020301  1.3307        1       *
6020302  2.6667        2       *volume center = lower level tap
6020303  2.6667        3       *volume center = upper level tap
6020304  10.4596       7        *remaining 41.8' total tube length
6020305  2.6667        8       *volume center = lower level tap
6020306  2.6667        9       *volume center = upper level tap
6020307  1.3307        10      *
*
*       volume       vn
6020401  0.0          10
*
*       incl         vn
6020601  90.0         5
6020602  -90.0        10
*
*       roughness     dhyd   vn
6020801  1.0e-7        0.0439  10     *.527" ID
*
*       kf    kr     jn
6020901  0.0    0.0    9
*
*       pvbfe        vn
6021001  00000        10
*
*       fvcahs       jn
6021101  001000       9
*
*       ebt   press.   temp.                   vn
6021201  3     1089.5   331.600 0.    0.     0.     1
6021202  3     1088.5   335.815 0.    0.     0.     2
6021203  3     1087.1   340.290 0.    0.     0.     3
6021204  3     1083.6   352.648 0.    0.     0.     4
6021205  3     1078.1   362.143 0.    0.     0.     5
6021206  3     1076.6   368.635 0.    0.     0.     6
6021207  3     1079.1   372.725 0.    0.     0.     7
6021208  3     1080.7   373.688 0.    0.     0.     8
6021209  3     1081.4   373.683 0.    0.     0.     9
6021210  3     1081.9   373.013 0.    0.     0.     10
*
*       vel/flow
6021300  1
*
*       liq-flo       vap-flo       int    jn
6021301  1232.9        0.0           0.     9
```

```
*
*
*** piping from heaters 1 to reactor ***
*   geometry per ref. [215]
6050000 htr1_rx branch
6050001 4       0
6050101 5.0724 255.58 0. 0. 6.1 27.21 0.00015 1.7970 01000
6050200   0 1.0818000e+03 3.4728000e+02 1.1080000e+03  0.
6051101 600010000 605000000 0. 0. 0. 001000
6052101 601010000 605000000 0. 0. 0. 001000
6053101 602010000 605000000 0. 0. 0. 001000
6054101 605010000 150000000 5.0724 49. 0. 001000
*                        /     \
*         loss coef. specified to effect the flow losses attributable to
*         the feedwater sparger - see calc. of app. d.
*
6051201     7.9503999e+00  7.9503999e+00   0.
6052201     7.9503999e+00  7.9503999e+00   0.
6053201     7.9503999e+00  7.9503999e+00   0.
6054201     1.3383000e+01  1.3383000e+01   0.
*
*** miscellaneous junctures ***
*   no flow losses or area restrictions
6100000 misc_jun mtpljun
6100001 24 1
*
*     from      to       juna  kf  kr  fvcahs        incr1   incr2      jn
6100011 520010000 525000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 1
6100021 521010000 526000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 2
6100031 522010000 527000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 3
6100041 525010000 530000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 4
6100051 526010000 531000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 5
6100061 527010000 532000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 6
6100071 530010000 535000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 7
6100081 531010000 536000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 8
6100091 532010000 537000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 9
6100101 535010000 540000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 10
6100111 536010000 541000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 11
6100121 537010000 542000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 12
6100131 540010000 545000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 13
6100141 541010000 546000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 14
6100151 542010000 547000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 15
6100161 545010000 550000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 16
6100171 546010000 551000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 17
```

```
6100181 547010000 552000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 18
6100191 590010000 595000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 19
6100201 591010000 596000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 20
6100211 592010000 597000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 21
6100221 595010000 600000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 22
6100231 596010000 601000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 23
6100241 597010000 602000000 0.   0.  0.  001000 1. 1. 1. 0      0      0 24
*
*     liq-flo    vap-flo    jn
6101011 1244.8     0.        1
6101021 1244.8     0.        2
6101031 1244.8     0.        3
6101041 1244.8     0.        4
6101051 1244.8     0.        5
6101061 1244.8     0.        6
6101071 1244.8     0.        7
6101081 1244.8     0.        8
6101091 1244.8     0.        9
6101101 1244.8     0.        10
6101111 1244.8     0.        11
6101121 1244.8     0.        12
6101131 1244.8     0.        13
6101141 1244.8     0.        14
6101151 1244.8     0.        15
6101161 1244.8     0.        16
6101171 1244.8     0.        17
6101181 1244.8     0.        18
6101191 1244.8     0.        19
6101201 1244.8     0.        20
6101211 1244.8     0.        21
6101221 1244.8     0.        22
6101231 1244.8     0.        23
6101241 1244.8     0.        24
*
*
*-------------------------------------------------------------------------
* Train A Feedwater Heaters - Shellside
*-------------------------------------------------------------------------
*
* component 701 - RFW HTR A1 Steam Supply
7010000 'STM-src1'     tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd     fe
7010101 5.0     10.0    0.0     0.0     90.0    10.0    0.0     0.0     10
```

```
*
*     ebt    trip    variable
7010200 002     0      cntrlvar 010    *RX Power, %                      *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.
7010201   0.0    7.545  0.9107         *extrapolated                    *prb 01-26-96 10:38pm
7010202  25.0   55.019  0.9022                                         *prb 01-26-96 10:38pm
7010203  50.0   110.02  0.8907                                         *prb 01-26-96 10:38pm
7010204  75.0   153.73  0.8837                                         *prb 01-26-96 10:38pm
7010205  90.0   186.86  0.8791                                         *prb 01-26-96 10:38pm
7010206 100.0   209.01  0.8765                                          *prb 01-26-96 10:38pm
*
*
* component 702 - RFW HTR A2 Steam Supply
7020000 'STM-src2'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7020101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable
7020200 002     0      cntrlvar 010    *RX Power, %                      *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                         *prb 01-26-96 11:55pm
7020201   0.0    3.43   0.9607         *extrapolated                    *prb 01-26-96 11:55pm
7020202  25.0    31.30  0.9587                                         *prb 01-26-96 11:55pm
7020203  50.0    61.70  0.9533                                         *prb 01-26-96 11:55pm
7020204  75.0    88.31  0.9530                                         *prb 01-26-96 11:55pm
7020205  90.0   107.20  0.9508                                         *prb 01-26-96 11:55pm
7020206 100.0   119.81  0.9495                                          *prb 01-26-96 11:55pm
*
*
* component 703 - RFW HTR A3 Steam Supply
7030000 'STM-src3'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable
7030200 002     0      cntrlvar 010    *RX Power, %                      *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                         *prb 01-26-96 11:55pm
7030201   0.0    1.99   0.9421         *extrapolated                    *prb 01-26-96 11:55pm
7030202  25.0   19.80   0.9389                                         *prb 01-26-96 11:55pm
7030203  50.0   38.70   0.9316                                         *prb 01-26-96 11:55pm
7030204  75.0   55.97   0.9305                                         *prb 01-26-96 11:55pm
```

```
7030205  90.0   67.71   0.9276                                  *prb 01-26-96 11:55pm
7030206 100.0   75.51   0.9259                                  *prb 01-26-96 11:55pm
*
*
* component 704 - RFW HTR A4 Steam Supply #1
7040000 'STMsrc4A'     tmdpvol
*
*     area   length  vol    azmth   incl   elev   rough   hyd    fe
7040101 2.8229  10.0    0.0     0.0     0.0    0.0    0.0     0.0    10
*
*     ebt    trip    variable
7040200 002     0      cntrlvar 010    *RX Power, %                   *prb 01-27-96 10:08am
*                                                         *prb 01-27-96 10:08am
*     %pwr    press   qual.                                    *prb 01-27-96 10:08am
7040201   0.0    0.75   0.6576        *extrapolated                  *prb 01-27-96 10:08am
7040202  25.0    7.66   0.7094                                  *prb 01-27-96 10:08am
7040203  50.0   14.80   0.8077                                  *prb 01-27-96 10:08am
7040204  75.0   21.59   0.8363                                  *prb 01-27-96 10:08am
7040205  90.0   26.05   0.8437                                  *prb 01-27-96 10:08am
7040206 100.0   29.00   0.8482                                  *prb 01-27-96 10:08am
*
*
* component 705 - RFW HTR A4 Steam Supply #2
7050000 'STMsrc4B'     tmdpvol
*
*     area   length  vol    azmth   incl   elev   rough   hyd    fe
7050101 2.8229  10.0    0.0     0.0     0.0    0.0    0.0     0.0    10
*
*     ebt    trip    variable
7050200 002     0      cntrlvar 010    *RX Power, %                   *prb 01-27-96 10:08am
*                                                         *prb 01-27-96 10:08am
*     %pwr    press   qual.                                    *prb 01-27-96 10:08am
7050201   0.0   1.127   0.3577        *extrapolated                  *prb 01-27-96 10:08am
7050202  25.0   12.30   0.4394                                  *prb 01-27-96 10:08am
7050203  50.0   24.00   0.5701                                  *prb 01-27-96 10:08am
7050204  75.0   34.91   0.6273                                  *prb 01-27-96 10:08am
7050205  90.0   42.24   0.6434                                  *prb 01-27-96 10:08am
7050206 100.0   47.12   0.6485                                  *prb 01-27-96 10:08am
*
*
* component 706 - RFW HTR A5 Steam Supply #1 (From "B" LP Turbine, point MR5)
7060000 'STMsrc5A'     tmdpvol
*
*     area   length  vol    azmth   incl   elev   rough   hyd    fe
7060101 9.0164  10.0    0.0     0.0     0.0    0.0    0.0     0.0    10
```

```
*
*     ebt    trip    variable
7060200 002     0      cntrlvar 010    *RX Power, %                       *prb 01-27-96 12:31pm
*                                                         *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                        *prb 01-27-96 12:31pm
7060201   0.0   0.30    0.064         *extrapolated                     *prb 01-27-96 12:31pm
7060202  25.0   4.59    0.1630                                       *prb 01-27-96 12:31pm
7060203  50.0   8.88    0.2620                                       *prb 01-27-96 12:31pm
7060204  75.0   13.01   0.5389                                       *prb 01-27-96 12:31pm
7060205  90.0   15.71   0.5008                                       *prb 01-27-96 12:31pm
7060206 100.0   17.49   0.4806                                       *prb 01-27-96 12:31pm
*
*
* component 707 - RFW HTR A5 Steam Supply #2 (From "C" LP Turbine, point #5)
7070000 'STMsrc5B'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable
7070200 002     0      cntrlvar 010    *RX Power, %                       *prb 01-27-96 12:31pm
*                                                         *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                        *prb 01-27-96 12:31pm
7070201   0.0   0.45    0.2807        *extrapolated                     *prb 01-27-96 12:31pm
7070202  25.0   2.69    0.4153                                       *prb 01-27-96 12:31pm
7070203  50.0   5.05    0.5633                                       *prb 01-27-96 12:31pm
7070204  75.0   7.23    0.6912                                       *prb 01-27-96 12:31pm
7070205  90.0   8.66    0.7368                                       *prb 01-27-96 12:31pm
7070206 100.0   9.60    0.7545                                       *prb 01-27-96 12:31pm
*
*
* component 708 - Moisture Separator
7080000 'Mois-Sep'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7080101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable                                      *prb 01-26-96 11:47pm
7080200 001     0      cntrlvar 010    *RX Power, %                       *prb 01-26-96 11:47pm
*
*     %pwr    temp    qual.                                        *prb 01-26-96 11:47pm
7080201   0.0   253.12  0.0           *extrapolated                     *prb 01-26-96 11:47pm
7080202  25.0   286.00  0.0                                          *prb 01-26-96 11:47pm
7080203  50.0   333.40  0.0                                          *prb 01-26-96 11:47pm
7080204  75.0   359.02  0.0                                          *prb 01-26-96 11:47pm
```

```
7080205  90.0   374.74  0.0                                  *prb 01-26-96 11:47pm
7080206 100.0   384.07  0.0                                  *prb 01-26-96 11:47pm
*
*
* component 709: Moisture Separator Drain to HTR A2
7090000  'MS-drain'    tmdpjun
7090101  708000000     731000000     1.3963
*
*          trip    variable                                  *prb 01-26-96 11:47pm
*7090200  1     0      cntrlvar 010    *RX Power, %                 *prb 01-26-96 11:47pm
7090200  1      632    cntrlvar 010    *RX Power, %                 *jam 7-27-96
*
*      %pwr   liq.flow    .                                  *prb 01-26-96 11:47pm
7090201    0.0  0.0         0.0          0.0                  *prb 01-26-96 11:47pm
7090202   25.0  22.4352      0.0          0.0       *242,300/3 lb/hr      *prb 01-26-96 11:47pm
7090203   50.0  54.9444      0.0          0.0       *593,400/3 lb/hr      *prb 01-26-96 11:47pm
7090204   75.0  82.8714      0.0          0.0       *895,011/3 lb/hr      *prb 01-26-96 11:47pm
7090205   90.0  105.3094     0.0          0.0       *1,137,342/3 lb/hr    *prb 01-26-96 11:47pm
7090206  100.0  120.7569     0.0          0.0       *1,304,175/3 lb/hr    *prb 01-26-96
*
* component 710 - RFW Heater A1 steam supply vlv - jam 7-27-96
7100000 a1stmvlv       valve    *jam 7-27-96
*     from          to           juna    kf     kr     fvcahs
7100101 701000000      720000000      1.3417  15.7355  15.7355 000000        *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7100201 0    60.166       118.13           0.0                    *jam 7-26-96
7100300 trpvlv                                             *jam 7-26-96
7100301 632                                                *jam 7-26-96
*
* component 720 - RFW Heater A1 Steam Dome (top of vertical shell)
7200000 'HTRA1-s1'      branch
*
*     #juns   vel/flow
*7200001 2      0
7200001 1      0                                          *jam 7-27-96
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7200101 12.34   13.7904 0.     0.      -90.0 -13.7904  1.5e-4  0.0772  00100
*
*     ebt    press   Uf        Uv        voidv
7200200 000     198.29  354.09       1113.5     0.99410
*
*     from          to           juna    kf     kr     fvcahs
*7201101 701000000      720000000      1.3417  15.7355 15.7355 000000       *jam 7-27-96
*7202101 720010000      721000000      0.      0.      0.      101000       *jam 7-27-96
```

```
7201101 720010000      721000000      0.      0.      0.      101000        *jam 7-27-96
*
*      jun_Dh         flood   gas-int slope
*7201110 0.0            0.0     1.0     1.0                              *jam 7-27-96
*7202110 0.0772          0.0     1.0     1.0                              *jam 7-27-96
7201110 0.0772          0.0     1.0     1.0
*
*      liq_vel     vap_vel          vel.int.
*7201201 60.166      118.13          0.                                  *jam 7-27-96
*7202201 7.3903      8.4137          0.                                  *jam 7-27-96
7201201 7.3903      8.4137          0.                                   *jam 7-27-96
*
*
* component 721 - RFW Heater A1 Shellside middle volumes
7210000 'HTRA1-s2'      pipe
*
*      nv
7210001 3
*
*      flowa          vn
7210101 12.34          3      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                             *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
7210301 10.4596        1
7210302 2.6667         3      *same as corresponding primary tube length
*
*      volume         vn
7210401 0.0            3
*
*      incl           vn
7210601 -90.0          3
*
*      roughness      dhyd   vn
7210801 1.5e-4         0.0772  3
*
*      kf     kr     jn
7210901 0.0     0.0     2
*
*      pvbfe          vn
7211001 00100          3
*
*      fvcahs         jn
7211101 101000         2
*
```

```
*      ebt    press.  Uf        Uv       voidv            VN
7211201 0      198.33  354.09      1113.5    0.99189       0.    1
7211202 0      198.36  354.05      1113.5    0.96348       0.    2
7211203 0      198.89  336.85      1113.6    2.33801e-02    0.    3
*
*      vel/flow
7211300 0
*
*      liq-flo    vap-flo    vel.int      jn
7211301 11.168      2.4853     0.          1
7211302 3.0088      5.32454e-02 0.          2
*
*      jun_Dh       flood        gas-int       slope   jn
7211401 0.0772        0.0          1.0          1.0     2
*
*
* component 722 - RFW Heater A1 Tubesheet Shellside (bottom of vertical shell)
7220000 'HTRA1-s3'     branch
*
*      #juns   vel/flow
7220001 1      0
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7220101 12.34   1.3307  0.     0.     -90.0 -1.3307   1.5e-4  0.0772  00100
*
*      ebt    press.  Uf        Uv       voidv
7220200 000     199.30  338.19      1113.6    0.0
*
*      from          to          juna    kf     kr     fvcahs
7221101 721010000      722000000      0.     0.0    0.     101000
*
*      jun_Dh       flood   gas-int slope
7221110 0.0772        0.0     1.0     1.0
*
*      liq_vel      vap_vel        vel.int.
7221201 0.11251      -1.1900         0.
*
*
* component 723 - RFW Heater A1 Drain Piping
7230000 'HTRA1drn'     branch
*
*      #juns   vel/flow
7230001 1      0
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
```

```
7230101 0.3474  10.0    0.      0.      82.6  9.9167    1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
7230200 000     199.30  338.19       1113.6     0.0
*
*      from           to            juna    kf      kr      fvcahs
7231101 722010000       723000000       0.3474  0.0     0.      000100
*
*      liq_vel       vap_vel          vel.int.
7231201 3.7345        3.7345           0.
*
*
* component 725 - RFW HTRA1 Drain Valve
7250000  'LCV6-1'       valve
*
*       from       to         juna      kf        kr        fvcahs
7250101  723010000  731000000   0.0873    39.0223   39.0223   000000
*
7250201  0          15.463        15.465   0.     *  819,483/3 lb/hr
*
7250300  srvvlv
*
7250301  0324  * valve position demand from htr A1 level control system
*
7250400  1.0        288.0        * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                              4" linear double-seated full-port
7250401  0.0        0.0001      0.0001  * Assume linear Cv vs stroke for globe
7250402  1.0        1.0         1.0      * valve
*
* component 711 - RFW Heater A2 steam supply vlv - jam 7-27-96
7110000 a2stmvlv        valve    *jam 7-27-96
*      from           to            juna    kf      kr      fvcahs
7110101 702000000       730000000       0.7854  14.1087  14.1087 000000          *jam 7-27-96
*           liq_vel      vap_vel           vel.int.
7110201 0    74.200       202.58            0.0                          *jam 7-26-96
7110300 trpvlv                                                    *jam 7-26-96
7110301 632                                                       *jam 7-26-96
*
* component 730 - RFW Heater A2 Steam Dome (top of vertical shell)
7300000 'HTRA2-s1'      branch
*
*      #juns   vel/flow
*7300001 2       0                                               *jam 9-27-96
7300001 1       0                                                *jam 9-27-96
*
```

```
*     area   length  vol    theta   phi   elev     rough   hyd     pvbfe
7300101 12.34   10.2904 0.     0.      -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt    press   Uf         Uv        voidv
7300200 000     109.21  304.89       1106.3     0.99832
*
*     from          to           juna    kf     kr     fvcahs
*7301101 702000000      730000000      0.7854  14.1087 14.1087 000001        *jam 9-27-96
*7302101 730010000      731000000      12.34   0.     0.     101000        *jam 9-27-96
7301101 730010000      731000000      12.34   0.     0.     101000        *jam 9-27-96
*
*     jun_Dh         flood   gas-int slope
*7301110 0.0           0.0     1.0     1.0                            *jam 9-27-96
*7302110 0.0772         0.0     1.0     1.0                            *jam 9-27-96
7301110 0.0772         0.0     1.0     1.0                            *jam 9-27-96
*
*     liq_vel     vap_vel          vel.int.
*7301201 74.200      202.58           0.                            *jam 9-27-96
*7302201 12.027      7.9267           0.                            *jam 9-27-96
7301201 12.027      7.9267           0.                            *jam 9-27-96
*
*
* component 731 - RFW Heater A2 drain junction volume
7310000 'HTRA2-s2'     branch
*
*     #juns   vel/flow
7310001 1      0
*
*     area   length  vol    theta   phi   elev     rough   hyd     pvbfe
7310101 12.34   8.8763  0.     0.     -90.0 -8.8763   1.5e-4  0.0772  00100
*
*     ebt    press   Uf         Uv        voidv
7310200 000     109.23  305.04       1106.4     0.97393
*
*     from          to           juna    kf     kr     fvcahs
7311101 731010000      732000000      12.34   0.     0.     101000
*
*     jun_Dh         flood   gas-int slope
7311110 0.0772         0.0     1.0     1.0
*
*     liq_vel     vap_vel          vel.int.
7311201 10.895      3.4280           0.
*
*
* component 732 - RFW Heater A2 Shellside middle volumes
```

```
7320000 'HTRA2-s2'      pipe
*
*      nv
7320001 2
*
*      flowa          vn
7320101 12.34          2      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                            *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
7320301 3.0000         2      *same as corresponding primary tube length
*
*      volume         vn
7320401 0.0            2
*
*      incl           vn
7320601 -90.0          2
*
*      roughness      dhyd   vn
7320801 1.5e-4         0.0772  2
*
*      kf     kr     jn
7320901 0.0    0.0    1
*
*      pvbfe          vn
7321001 00100          2
*
*      fvcahs         jn
7321101 101000         1
*
*      ebt    press.  Uf          Uv        voidv              VN
7321201 000    109.25  304.86      1106.4    0.91724        0.     1
7321202 000    109.87  298.86      1106.4    5.89169e-02    0.     2
*
*      vel/flow
7321300 0
*
*      liq-flo    vap-flo    vel.int       jn
7321301 4.2183     0.30784    0.            1
*
*      jun_Dh         flood          gas-int        slope   jn
7321401 0.0772         0.0            1.0            1.0     1
*
*
* component 733 - RFW Heater A2 Tubesheet Shellside (bottom of vertical shell)
```

```
7330000 'HTRA2-s3'     branch
*
*     #juns   vel/flow
7330001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7330101 12.34   5.4974  0.      0.      -90.0 -5.4974   1.5e-4  0.0772  00100
*
*     ebt     press.  Uf          Uv        voidv
7330200 000     111.52  291.80      1106.6     0.0
*
*     from           to            juna    kf     kr     fvcahs
7331101 732010000      733000000      12.34   0.0     0.     101000
*
*     jun_Dh         flood   gas-int slope
7331110 0.0772         0.0     1.0     1.0
*
*     liq_vel      vap_vel         vel.int.
7331201 0.42029     -0.82167          0.
*
*
* component 734 - RFW Heater A2 Drain Piping
7340000 'HTRA2drn'     branch
*
*     #juns   vel/flow
7340001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7340101 0.5475  25.0    0.      0.      65.0  22.6667   1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
7340200 000     199.30  338.19      1113.6     0.0
*
*     from           to            juna    kf     kr     fvcahs
7341101 733010000      734000000      0.5475  0.0     0.     000100
*
*     liq_vel     vap_vel          vel.int.
7341201 8.2628      7.7109           0.
*
*
* component 735 - RFW HTRA2 Drain Valve
7350000  'LCV6-4A'     valve
*
*      from       to         juna     kf       kr       fvcahs
7350101  734010000  741000000   0.3491    22.8653   22.8653   000000
```

```
*
7350201  1         228.5294     0.0      0.     *2,468,117/3 lb/hr
*
7350300  srvvlv
*
7350301  0349  * valve position demand based from htr A2 level control
*
7350400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                             8" linear double-seated full-port
7350401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
7350402  1.0       1.0        1.0     * valve
*
*
* component 737 - RFW HTRA2 Bypass Valve                              *prb 01-18-96
10:16am
7370000  'LCV6-4B'      valve                                  *prb 01-18-96 10:16am
*                                                    *prb 01-18-96 10:16am
*      from       to         juna      kf       kr       fvcahs          *prb 01-18-96 10:16am
*7370101  734010000  738000000   0.3491    0.0       0.0       000000          *prb 01-18-96
10:16am
7370101  734010000  738000000   0.3491    22.8653   22.8653   000000          *jam 7-26-96
*                                                    *prb 01-18-96 10:16am
7370201  1         0.0         0.0      0.0                      *prb 01-18-96 10:16am
*                                                    *prb 01-18-96 10:16am
7370300  srvvlv                                             *prb 01-18-96 10:16am
*                                                    *prb 01-18-96 10:16am
7370301  0355  * valve position demand                               *prb 01-18-96 10:16am
*                                                    *prb 01-18-96 10:16am
7370400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb
01-18-96 10:16am
*                             8" linear double-seated full-port    *prb 01-18-96 10:16am
7370401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-18-96
10:16am
7370402  1.0       1.0        1.0     * valve                          *prb 01-18-96 10:16am


* component 738 - RFW bank 2 bypass drain piping to condenser               *prb
01-18-96 10:28am
7380000 'HTR2byp'      branch                                    *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      #juns   vel/flow                                    *prb 01-18-96 10:28am
7380001 1      0                                          *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      area    length  vol     theta   phi   elev     rough   hyd     pvbfe   *prb 01-18-96
10:28am
```

```
*7380101 1.0472  50.0    0.     0.     -17.72 -37.887   1.5e-4  0.6667  00000   *prb 01-23-96
01:02pm
7380101 1.0472  10.0    0.     0.    -90.00 -10.000   1.5e-4  0.6667  00000   *jam 7-28-96
*                                                    *prb 01-18-96 10:28am
*      ebt     press.  temp                                  *prb 01-18-96 10:28am
7380200 003     1.0     101.14                                 *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      from           to           juna    kf     kr     fvcahs        *prb 01-18-96 10:28am
*7381101 738010000       969010000       1.0472  0.0     0.0     000000        *prb 01-18-96
10:28am
7381101 738010000       971000000       1.0472  0.0     0.0     001000        *jam  7-28-96
*                                                    *prb 01-18-96 10:28am
*      liq_vel      vap_vel           vel.int.                       *prb 01-18-96 10:28am
7381201 0.0          0.0              0.                          *prb 01-18-96 10:28am
*
* component 712 - RFW Heater A3 steam supply vlv - jam 7-27-96
7120000 a3stmvlv        valve    *jam 7-27-96
*      from           to           juna    kf     kr     fvcahs
7120101 703000000       740000000       3.1416  23.4899  23.4899 000000        *jam 7-27-96
*           liq_vel      vap_vel           vel.int.
7120201 0    7.7263       124.84            0.0                        *jam 7-26-96
7120300 trpvlv                                                *jam 7-26-96
7120301 632                                                   *jam 7-26-96
*
* component 740 - RFW Heater A3 Steam Dome (top of vertical shell)
7400000 'HTRA3-s1'      branch
*
*      #juns   vel/flow
*7400001 2       0                                            *jam 7-26-96
7400001 1       0                                            *jam 7-26-96
*
*      area    length  vol    theta   phi   elev      rough   hyd     pvbfe
7400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
7400200 000     69.300  271.84       1099.9     0.99613
*
*      from           to           juna    kf     kr     fvcahs
*7401101 703000000       740000000       3.1416  23.4899 23.4899 000000        *jam 7-26-96
*7402101 740010000       741000000       13.5335 0.      0.      101000        *jam 7-26-96
7401101 740010000       741000000       13.5335 0.      0.      101000        *jam 7-26-96
*
*      jun_Dh           flood    gas-int slope
*7401110 0.0             0.0     1.0     1.0                            *jam 7-26-96
*7402110 0.0864          0.0     1.0     1.0                            *jam 7-26-96
```

```
7401110 0.0864         0.0    1.0    1.0                              *jam 7-26-96
*
*      liq_vel     vap_vel          vel.int.
*7401201 7.7263      124.84          0.                                *jam 7-26-96
*7402201 8.9171      19.266          0.                                *jam 7-26-96
7401201 8.9171      19.266          0.                                *jam 7-26-96
*
*
* component 741 - RFW Heater A3 drain junction volume
7410000 'HTRA3-s2'     branch
*
*      #juns   vel/flow
7410001 1      0
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7410101 13.5335 11.1133 0.     0.     -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
7410200 000     69.309  271.88      1100.0    0.96083
*
*      from           to            juna    kf     kr     fvcahs
7411101 741010000      742000000      13.5335 0.     0.     101000
*
*      jun_Dh         flood   gas-int slope
7411110 0.0864         0.0    1.0    1.0
*
*      liq_vel     vap_vel          vel.int.
7411201 9.3922      5.8524          0.
*
*
* component 742 - RFW Heater A3 Shellside middle & lower volumes
7420000 'HTRA3-s3'     pipe
*
*      nv
7420001 4
*
*      flowa         vn
7420101 13.5335        1
7420102 6.7667         4      *volumes 2-4 share space with subcooling zone
*
*      flowl         vn
7420301 3.0000         2      *same as corresponding primary tube length
7420302 7.0534         4      *same as corresponding primary tube length
*
*      volume        vn
```

```
7420401 0.0          4
*
*    incl          vn
7420601 -90.0        4
*
*    roughness     dhyd   vn
7420801 1.5e-4       0.0864  4
*
*    kf    kr    jn
7420901 0.0    0.0    3
*
*    pvbfe         vn
7421001 00100        4
*
*    fvcahs        jn
7421101 101000       3
*
*    ebt    press.  Uf         Uv        voidv              VN
7421201 000    69.322  271.84     1100.0    0.98918        0.    1
7421202 000    69.529  271.38     1099.9    0.16248        0.    2
7421203 000    72.030  269.21     1100.5    2.68060e-06    0.    3
7421204 000    74.835  267.04     1101.0    8.83757e-06    0.    4
*
*    vel/flow
7421300 0
*
*    liq-flo    vap-flo        vel.int      jn
7421301  70.794     0.44862        0.           1
7421302 0.75643    -0.90429        0.           2
7421303 0.63162     0.77799        0.           3
*
*    jun_Dh        flood        gas-int       slope   jn
7421401 0.0864        0.0          1.0          1.0    3
*
*
* component 743 - RFW Heater A3 Subcooling Zone
7430000 'HTRA3-s4'     pipe
*
*    nv
7430001 3
*
*    flowa         vn
7430101 6.7667        3
*
*    flowl         vn
```

```
7430301 3.0000        1       *same as corresponding primary tube length
7430302 7.0534        3       *same as corresponding primary tube length
*
*     volume        vn
7430401 0.0          3
*
*     incl          vn
7430601 -90.0        3
*
*     roughness     dhyd   vn
7430801 1.5e-4       0.0864  3
*
*     kf     kr     jn
7430901 0.0    0.0    2
*
*     pvbfe         vn
7431001 00100        3
*
*     fvcahs        jn
7431101 101000       2
*
*     ebt    press.  Uf        Uv       voidv             VN
7431201 000    69.415  233.60    1100.1   8.99481e-02   0.    1
7431202 000    71.404  226.39    1100.4   1.57683e-07   0.    2
7431203 000    74.264  242.61    1100.9   3.17648e-06   0.    3
*
*     vel/flow
7431300 0
*
*     liq-flo     vap-flo         vel.int       jn
7431301 3.53376e-02  -1.6814         0.          1
7431302 3.03089e-02  3.099473e-02     0.          2
*
*     jun_Dh        flood         gas-int       slope   jn
7431401 0.0864        0.0           1.0           1.0    2
*
*
* component 744 - RFW Heater A3 Drain Piping
7440000 'HTRA3drn'     branch
*
*     #juns   vel/flow
7440001 1      1
*
*     area    length  vol    theta   phi   elev     rough   hyd    pvbfe
7440101 0.5475  5.0     0.     0.     0.    0.      1.5e-4  0.0    00000
```

```
*
*     ebt    press.  Uf         Uv       voidv
7440200 000     199.30  338.19      1113.6     0.0
*
*     from          to          juna   kf     kr     fvcahs
7441101 743010000      744000000      0.5475  0.0     0.     000100
*
*     liq_vel     vap_vel         vel.int.
7441201 228.5294     0.0             0.
*
*
* component 745 - RFW HTRA3 Drain Valve
7450000  'LCV6-7'      valve
*
*      from      to        juna     kf      kr      fvcahs
7450101  744010000  752000000   0.3491    7.4816    7.4816    000000
*
7450201  0         12.689      44.886   0.    *2,468,117/3 lb/hr target
*
7450300  srvvlv
*
7450301  0379  * valve position demand based on htr A3 level error
*
7450400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
7450401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
7450402  1.0       1.0        1.0     * valve
*
*
7470000 'HTRA3jun' mtpljun
7470001 2      0
*
*     from     to      juna   kf  kr  fvcahs       incr1   incr2   jn
7470011 742020004 743010003 .1      5.  5.  001000 1. 1. 1. 0      0     0 1
7470021 742040004 743030003 1.      5.  5.  001000 1. 1. 1. 0      0     0 2
*
*     liq-flo    vap-flo     jn
7471011 4.0946       4.0946     1
7471021 0.0         0.0       2
*
* component 713 - RFW Heater A4 steam supply vlv - jam 7-27-96
7130000 a4stvlv1       valve    *jam 7-27-96
*     from          to          juna   kf     kr     fvcahs
7130101 705000000      750000000      2.8229  6197.85  6197.85 000000         *jam 7-27-96
*         liq_vel     vap_vel         vel.int.
```

```
7130201 0    0.83437      24.814            0.0                          *jam 7-26-96
7130300 trpvlv                                                 *jam 7-26-96
7130301 632                                                    *jam 7-26-96
*
*
* component 750 - RFW Heater A4 (top of shell nearest tubesheet)
7500000 'HTRA4-s1'     branch
*
*     #juns   vel/flow
*7500001 2      0                                              *jam 7-26-96
7500001 1      0                                              *jam 7-26-96
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
7500200 000     27.276  213.37       1086.4     0.99962
*
*     from          to           juna    kf      kr      fvcahs
*7501101 705000000      750000000      2.8229  6197.85 6197.85 000000         *jam 7-27-96
*7502101 750010000      751000000      9.7832  0.      0.      001003         *jam 7-27-96
7501101 750010000      751000000      9.7832  0.      0.      001003         *jam 7-27-96
*
*     jun_Dh          flood   gas-int slope
*7501110 0.0            0.0     1.0     1.0                          *jam 7-27-96
*7502110 0.1309         0.0     1.0     1.0                          *jam 7-27-96
7501110 0.1309         0.0     1.0     1.0                          *jam 7-27-96
*
*     liq_vel      vap_vel          vel.int.
*7501201 0.83437      24.814          0.                           *jam 7-27-96
*7502201  9.1016      8.7249          0.                           *jam 7-27-96
7501201  9.1016      8.7249          0.                           *jam 7-27-96
*
* component 714 - RFW Heater A4 steam supply vlv - jam 7-27-96
7140000 a4stvlv2       valve    *jam 7-27-96
*     from          to           juna    kf      kr      fvcahs
7140101 704000000      751000000      2.8229  4.4554   4.4554  000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7140201 0    41.854       271.59            0.0                          *jam 7-26-96
7140300 trpvlv                                                 *jam 7-26-96
7140301 632                                                    *jam 7-26-96
*
*
* component 751 - RFW Heater A4 (top of shell furthest from tubesheet)
```

```
7510000 'HTRA4-s2'     branch
*
*      #juns   vel/flow
*7510001 2      0                                          *jam 7-27-96
7510001 1      0                                          *jam 7-27-96
*
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
7510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv        voidv
7510200 000     27.276  213.38      1086.4     0.99996
*
*      from           to            juna     kf      kr      fvcahs
*7511101 704000000      751000000      2.8229   4.4554  4.4554  000000       *jam 7-27-96
*7512101 751010000      752000000      153.4359 0.      0.      101000       *jam 7-27-96
7511101 751010000      752000000      153.4359 0.      0.      101000       *jam 7-27-96
*
*      jun_Dh         flood   gas-int slope
*7511110 0.0            0.0     1.0     1.0                            *jam 7-27-96
*7512110 0.1309         0.0     1.0     1.0                            *jam 7-27-96
7511110 0.1309         0.0     1.0     1.0                            *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*7511201 41.854      271.59           0.                               *jam 7-27-96
*7512201 38.784      4.5911           0.                               *jam 7-27-96
7511201 38.784      4.5911           0.                               *jam 7-27-96
*
*
* component 752 - RFW Heater A4 (bottom of shell furthest from tubesheet)
7520000 'HTRA4-s3'     branch
*
*      #juns   vel/flow
7520001 0      0
*
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
7520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv        voidv
7520200 000     27.292  209.34      1086.4     0.52487
*
*
* component 753 - RFW Heater A4 Subcooling Zone
7530000 'HTRA4-s4'     branch
*
*      #juns   vel/flow
```

```
7530001 1      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7530101 9.7832  15.6667 0.0      0.     0.0   0.0       1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv         voidv
7530200 000     26.746  170.92       1086.2     2.46992e-02
*
*     from           to            juna     kf      kr      fvcahs
7531101 752010000       753000000       1.7671   5.0     5.0     001000
*
*     jun_Dh          flood   gas-int slope
7531110 0.1309          0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
7531201 6.4784       37.792            0.
*
*
* component 754 - RFW Heater A4 Drain Piping
7540000 'HTRA4drn'      branch
*
*     #juns   vel/flow
7540001 1      0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
7540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv         voidv
7540200 000     26.326  174.57       1085.9     7.05438e-04
*
*     from           to            juna    kf      kr      fvcahs
7541101 753010000       754000000       1.6230  0.0     0.      000100
*
*     liq_vel      vap_vel           vel.int.
7541201 3.1304       4.5777            0.
*
*
* component 755 - RFW HTRA4 Drain Valve
7550000  'LCV6-11A'     valve
*
*      from       to         juna      kf        kr       fvcahs
7550101  754010000  760010003   0.7854    23.7848   23.7848   000000
*
7550201  0          7.5514       7.5514   0.     *3,184,100/3 lb/hr target
*
```

```
7550300  srvvlv
*
7550301  0399  * valve position demand based on htr A4 level error
*
7550400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                             12" linear double-seated full-port
7550401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
7550402  1.0       1.0         1.0     * valve
*
*
* component 757 - RFW HTRA4 Bypass Valve                          *prb 01-24-96
10:22am
7570000  'LCV6-11B'     valve                                *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
*      from       to        juna      kf       kr       fvcahs          *prb 01-24-96 10:22am
*7570101  754010000  758000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
7570101  754010000  758000000   0.7854    23.7848   23.7848   000000          *jam 7-26-96
*                                                    *prb 01-24-96 10:22am
7570201  1         0.0         0.0      0.0                   *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
7570300  srvvlv                                           *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
7570301  0405  * valve position demand                          *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
7570400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-24-96 10:22am
*                             12" linear double-seated full-port   *prb 01-24-96 10:22am
7570401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
7570402  1.0       1.0         1.0     * valve                         *prb 01-24-96 10:22am
*
*
* component 758 - RFW bank 4 bypass drain piping to condenser               *prb
01-24-96 10:22am
7580000 'HTR4byp'      branch                                *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
*      #juns   vel/flow                                   *prb 01-24-96 10:22am
7580001 1       0                                        *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe   *prb 01-24-96
10:22am
7580101 2.3562  25.0    0.      0.     -27.0  -11.40625 1.5e-4  1.0     00000   *prb 01-24-96
10:22am
*                                                    *prb 01-24-96 10:22am
```

```
*      ebt     press.  temp                                        *prb 01-24-96 10:22am
7580200 003     1.0     101.14                                       *prb 01-24-96 10:22am
*                                                          *prb 01-24-96 10:22am
*      from          to           juna    kf      kr      fvcahs        *prb 01-24-96 10:22am
*7581101 758010000       969010000       2.3562  0.0     0.0     000000         *prb 01-24-96
10:22am
7581101 758010000       969010000       2.3562  0.0     0.0     001000         *jam  7-26-96
*                                                          *prb 01-24-96 10:22am
*      liq_vel      vap_vel           vel.int.                          *prb 01-24-96 10:22am
7581201 0.0          0.0               0.                            *prb 01-24-96 10:22am
*
*
* component 760 - RFW Heater A5 Flash Tank
7600000 'FL-TankA'      pipe
*
*      nv
7600001 4
*
*      flowa          vn
7600101 16.4988        4
*
*      flowl          vn
7600301 1.4583         1
7600302 2.9583         2
7600303 2.500          3
7600304 5.2188         4
*
*      volume         vn
7600401 0.0            4
*
*      incl           vn
7600601 -90.0          4
*
*      roughness      dhyd    vn
7600801 0.0            0.0     4
*
*      kf      kr      jn
7600901 0.0     0.0     3
*
*      pvbfe          vn
7601001 00010          4
*
*      fvcahs         jn
7601101 101000         3
*
```

```
*      ebt     press.  Uf          Uv        voidv              VN
7601201 000     9.6940  160.59      1071.8    0.98351       0.     1
7601202 000     9.6954  159.92      1071.8    0.99883       0.     2
7601203 000     9.9628  160.43      1072.2    0.53140       0.     3
7601204 000     12.394  159.48      1075.2    0.00000e+00     0.     4
*
*      vel/flow
7601300 0
*
*      liq-flo    vap-flo          vel.int       jn
7601301  19.581      0.27746          0.           1
7601302  282.58      0.63630          0.           2
7601303 0.63560      -4.2606          0.           3
*
*      jun_Dh         flood          gas-int        slope   jn
7601401 0.0           0.0           1.0           1.0     3
*
*
* component 761 - RFW Heater A5 Drain Piping
7610000 'HTRA5drn'      branch
*
*      #juns   vel/flow
7610001 1       0
*
*      area    length  vol     theta   phi    elev      rough   hyd     pvbfe
7610101 2.9483  10.0    0.      0.      0.0    0.0       1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
7610200 000     13.552  159.14      1076.4    0.0
*
*      from           to            juna    kf      kr      fvcahs
7611101 760010000       761000000       2.9483  0.0     0.      000100
*
*      liq_vel      vap_vel          vel.int.
7611201 1.6705       1.9099           0.
*
* component 715 - RFW Heater A5 steam supply vlv - jam 7-27-96
7150000 a5stvlv1        valve    *jam 7-27-96
*      from           to            juna    kf      kr      fvcahs
7150101 706000000       762000000       9.0164  6243.8   6243.8  000000          *jam 7-27-96
*           liq_vel      vap_vel          vel.int.
7150201 0    0.49198      22.264           0.0                        *jam 7-26-96
7150300 trpvlv                                                     *jam 7-26-96
7150301 632                                                        *jam 7-26-96
*
```

```
*
* component 762 - RFW Heater A5 (top of shell nearest tubesheet)
7620000 'HTRA5-s1'     branch
*
*     #juns   vel/flow
*7620001 3      0                                        *jam 7-27-96
7620001 2      0                                        *jam 7-27-96
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
7620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf         Uv        voidv
7620200 000     9.4593  158.61      1071.3     0.99998
*
*     from           to           juna    kf     kr      fvcahs
*7621101 706000000      762000000      9.0164  6243.8  6243.8  001000
*jam 7-27-96
*7622101 762010000      763000000      8.7069  0.      0.      001003
*jam 7-27-96
7621101 762010000      763000000      8.7069  0.      0.      001003
*jam 7-27-96
*7623101 760000000      762000000      0.7530  1.50    1.50    001000
*jam 7-27-96
7622101 760000000      762000000      0.7530  1.50    1.50    001000
*jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*7621110 2.3958         0.0     1.0     1.0                                *jam 7-27-96
*7622110 0.1128         0.0     1.0     1.0                                *jam 7-27-96
7621110 0.1128         0.0     1.0     1.0                                *jam 7-27-96
*7623110 0.0            0.0     1.0     1.0                                *jam 7-27-96
7622110 0.0            0.0     1.0     1.0                                *jam 7-27-96
*
*     liq_vel      vap_vel           vel.int.
*7621201 0.49198       22.264           0.                                 *jam 7-27-96
*7622201 -31.397      -26.477           0.                                 *jam 7-27-96
7621201 -31.397      -26.477           0.                                 *jam 7-27-96
*7623201 -30.730       237.56           0.                                 *jam 7-27-96
7622201 -30.730       237.56           0.                                 *jam 7-27-96
*
* component 716 - RFW Heater A5 steam supply vlv - jam 7-27-96
7160000 a5stvlv2       valve    *jam 7-27-96
*     from           to           juna    kf     kr      fvcahs
7160101 707000000      763000000      9.0164  2.9489   2.9489  000000         *jam 7-27-96
*         liq_vel      vap_vel           vel.int.
```

```
7160201 0    26.337       161.50            0.0                         *jam 7-26-96
7160300 trpvlv                                                 *jam 7-26-96
7160301 632                                                    *jam 7-26-96
*
*
* component 763 - RFW Heater A5 (top of shell furthest from tubesheet)
7630000 'HTRA5-s2'     branch
*
*     #juns   vel/flow
*7630001 2      0                                              *jam 7-27-96
7630001 1      0                                               *jam 7-27-96
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7630101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf         Uv        voidv
7630200 000     9.4589  158.60      1071.4     0.99992
*
*     from           to            juna     kf      kr      fvcahs
*7631101 707000000      763000000      9.0164    2.9489  2.9489  001000       *jam 9-27-96
*7632101 763010000      764000000      83.8342  0.      0.      001000       *jam 9-27-96
7631101 763010000      764000000      83.8342  0.      0.      001000       *jam 9-27-96
*
*     jun_Dh         flood   gas-int slope
*7631110 2.3958         0.0     1.0     1.0                          *jam 9-27-96
*7632110 0.1128         0.0     1.0     1.0                          *jam 9-27-96
7631110 0.1128         0.0     1.0     1.0                           *jam 9-27-96
*
*     liq_vel      vap_vel          vel.int.
*7631201 26.337       161.50           0.                           *jam 9-27-96
*7632201 34.542       8.5995           0.                           *jam 9-27-96
7631201 34.542       8.5995           0.                            *jam 9-27-96
*
*
* component 764 - RFW Heater A5 (bottom of shell furthest from tubesheet)
7640000 'HTRA5-s3'     branch
*
*     #juns   vel/flow
7640001 2      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf         Uv        voidv
7640200 000     9.6340  148.68      1071.7     0.39598
```

```
*
*     from          to           juna   kf     kr     fvcahs
7641101 764010004      765010003      8.7069  0.     0.     001000
7642101 764010000      766000000      0.8685   1.5    100.0   001001  * discourage reverse
flow
*
*     jun_Dh        flood   gas-int slope
7641110 0.1128        0.0     1.0     1.0
7642110 0.6651        0.0     1.0     1.0
*
*     liq_vel     vap_vel          vel.int.
7641201  3.4725      -8.5376          0.
7642201 0.47271      -9.3520          0.
*
*
* component 765 - RFW Heater A5 (bottom of shell nearest tubesheet)
7650000 'HTRA5-s4'     branch
*
*     #juns   vel/flow
7650001 2      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt    press   Uf         Uv       voidv
7650200 000     9.4996  134.05      1071.5     0.44943
*
*     from          to           juna    kf     kr     fvcahs
7651101 762010000      765000000      110.9722 0.0     0.0     001000
7652101 765010000      766000000      0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*     jun_Dh        flood   gas-int slope
7651110 0.1128        0.0     1.0     1.0
7652110 0.6651        0.0     1.0     1.0
*
*     liq_vel     vap_vel          vel.int.
7651201   37.265      5.8851         0.
7652201 -0.42722      -10.256         0.
*
*
* component 766 - RFW Heater A5 Collector
7660000 'Coll-A5'      branch
*
*     #juns   vel/flow
```

```
7660001 1       0
*
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
7660101 4.9087  0.0     145.2255 0.    0.0   0.0      1.5e-4  0.0     00000
*
*      ebt    press   Uf         Uv        voidv
7660200 000    9.9594  146.78      1072.2    0.10641
*
*      from           to            juna    kf     kr     fvcahs
7661101 766010002      760030003      4.9087   1.0     0.50    031000
*
*      jun_Dh         flood   gas-int slope
7661110 2.5            0.0     1.0     1.0
*
*      liq_vel     vap_vel          vel.int.
7661201 -0.18014     -1.3910          0.
*
*
* component 767 - RFW HTRA5 Drain Valve
*
7670000  'LCV6-14A'     valve
*
*       from      to        juna     kf       kr       fvcahs
7670101  761010000  969000000   0.7854    5.6209    5.6209    001000
*
7670201  0         9.4         9.4      0.     *3,184,100/3 lb/hr target
*
7670300  srvvlv
*
7670301  0429  * valve position demand based on htr A5 level error
*
7670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
7670401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
7670402  1.0       1.0         1.0     * valve
*
*
* component 768 - RFW HTRA5 Bypass Valve                              *prb 01-24-96
10:22am
7680000  'LCV6-14B'     valve                                  *prb 01-24-96 10:22am
*                                                 *prb 01-24-96 10:22am
*       from      to        juna     kf       kr       fvcahs          *prb 01-24-96 10:22am
*7680101  761010000  969000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
7680101  761010000  969000000   0.7854    0.0       5.6209    001000          *jam 7-26-96
```

```
*                                                   *prb 01-24-96 10:22am
7680201  1        0.0        0.0      0.0                    *prb 01-24-96 10:22am
*                                                   *prb 01-24-96 10:22am
7680300  srvvlv                                            *prb 01-24-96 10:22am
*                                                   *prb 01-24-96 10:22am
7680301  0435  * valve position demand                            *prb 01-24-96 10:22am
*                                                   *prb 01-24-96 10:22am
7680400  1.0       2180.0     * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-24-96 10:22am
*                            12" linear double-seated full-port   *prb 01-24-96 10:22am
7680401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
7680402  1.0       1.0        1.0     * valve                       *prb 01-24-96 10:22am
*
*
*-----------------------------------------------------------------------
* Train B Feedwater Heaters - Shellside
*-----------------------------------------------------------------------
*
* component 801 - RFW HTR B1 Steam Supply
8010000 'STM-src1'     tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd     fe
8010101 5.0     10.0    0.0     0.0     90.0    10.0    0.0     0.0     10
*
*     ebt    trip    variable
8010200 002     0      cntrlvar 010    *RX Power, %                     *prb 01-25-96 11:25pm
*
*     %pwr    press   qual.
8010201   0.0    7.545  0.9107        *extrapolated                  *prb 01-26-96 10:38pm
8010202  25.0   55.019  0.9022                                    *prb 01-26-96 10:38pm
8010203  50.0   110.02  0.8907                                    *prb 01-26-96 10:38pm
8010204  75.0   153.73  0.8837                                    *prb 01-26-96 10:38pm
8010205  90.0   186.86  0.8791                                    *prb 01-26-96 10:38pm
8010206 100.0   209.01  0.8765                                    *prb 01-26-96 10:38pm
*
*
* component 802 - RFW HTR B2 Steam Supply
8020000 'STM-src2'     tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd     fe
8020101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable
```

```
8020200 002    0     cntrlvar 010    *RX Power, %                   *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                        *prb 01-26-96 11:55pm
8020201   0.0    3.43   0.9607        *extrapolated                    *prb 01-26-96 11:55pm
8020202  25.0    31.30  0.9587                                     *prb 01-26-96 11:55pm
8020203  50.0    61.70  0.9533                                     *prb 01-26-96 11:55pm
8020204  75.0    88.31  0.9530                                     *prb 01-26-96 11:55pm
8020205  90.0   107.20  0.9508                                     *prb 01-26-96 11:55pm
8020206 100.0   119.81  0.9495                                     *prb 01-26-96 11:55pm
*
*
* component 803 - RFW HTR B3 Steam Supply
8030000 'STM-src3'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8030200 002    0     cntrlvar 010    *RX Power, %                   *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                        *prb 01-26-96 11:55pm
8030201   0.0    1.99   0.9421        *extrapolated                    *prb 01-26-96 11:55pm
8030202  25.0   19.80   0.9389                                     *prb 01-26-96 11:55pm
8030203  50.0   38.70   0.9316                                     *prb 01-26-96 11:55pm
8030204  75.0   55.97   0.9305                                     *prb 01-26-96 11:55pm
8030205  90.0   67.71   0.9276                                     *prb 01-26-96 11:55pm
8030206 100.0   75.51   0.9259                                     *prb 01-26-96 11:55pm
*
*
* component 804 - RFW HTR B4 Steam Supply #1
8040000 'STMsrc4A'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8040101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8040200 002    0     cntrlvar 010    *RX Power, %                   *prb 01-27-96 10:08am
*                                        *prb 01-27-96 10:08am
*     %pwr    press   qual.                                        *prb 01-27-96 10:08am
8040201   0.0    0.75   0.6576        *extrapolated                    *prb 01-27-96 10:08am
8040202  25.0    7.66   0.7094                                     *prb 01-27-96 10:08am
8040203  50.0   14.80   0.8077                                     *prb 01-27-96 10:08am
8040204  75.0   21.59   0.8363                                     *prb 01-27-96 10:08am
8040205  90.0   26.05   0.8437                                     *prb 01-27-96 10:08am
8040206 100.0   29.00   0.8482                                     *prb 01-27-96 10:08am
```

```
*
*
* component 805 - RFW HTR B4 Steam Supply #2
8050000 'STMsrc4B'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8050101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8050200 002     0       cntrlvar 010    *RX Power, %                *prb 01-27-96 10:08am
*                                                           *prb 01-27-96 10:08am
*     %pwr    press   qual.                                 *prb 01-27-96 10:08am
8050201   0.0   1.127   0.3577      *extrapolated           *prb 01-27-96 10:08am
8050202  25.0   12.30   0.4394                              *prb 01-27-96 10:08am
8050203  50.0   24.00   0.5701                              *prb 01-27-96 10:08am
8050204  75.0   34.91   0.6273                              *prb 01-27-96 10:08am
8050205  90.0   42.24   0.6434                              *prb 01-27-96 10:08am
8050206 100.0   47.12   0.6485                              *prb 01-27-96 10:08am
*
*
* component 806 - RFW HTR B5 Steam Supply #1 (From "B" LP Turbine, point MR5)
8060000 'STMsrc5A'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8060101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8060200 002     0       cntrlvar 010    *RX Power, %                *prb 01-27-96 12:31pm
*                                                           *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                 *prb 01-27-96 12:31pm
8060201   0.0   0.30    0.064       *extrapolated           *prb 01-27-96 12:31pm
8060202  25.0   4.59    0.1630                              *prb 01-27-96 12:31pm
8060203  50.0   8.88    0.2620                              *prb 01-27-96 12:31pm
8060204  75.0   13.01   0.5389                              *prb 01-27-96 12:31pm
8060205  90.0   15.71   0.5008                              *prb 01-27-96 12:31pm
8060206 100.0   17.49   0.4806                              *prb 01-27-96 12:31pm
*
*
* component 807 - RFW HTR B5 Steam Supply #2 (From "C" LP Turbine, point #5)
8070000 'STMsrc5B'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
```

```
8070200 002    0      cntrlvar 010    *RX Power, %                      *prb 01-27-96 12:31pm
*                                                       *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                     *prb 01-27-96 12:31pm
8070201   0.0   0.45    0.2807        *extrapolated                    *prb 01-27-96 12:31pm
8070202  25.0   2.69    0.4153                                  *prb 01-27-96 12:31pm
8070203  50.0   5.05    0.5633                                  *prb 01-27-96 12:31pm
8070204  75.0   7.23    0.6912                                  *prb 01-27-96 12:31pm
8070205  90.0   8.66    0.7368                                  *prb 01-27-96 12:31pm
8070206 100.0   9.60    0.7545                                  *prb 01-27-96 12:31pm
*
*
* component 808 - Moisture Separator
8080000 'Mois-Sep'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8080101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable                                  *prb 01-26-96 11:47pm
8080200 001    0      cntrlvar 010    *RX Power, %                      *prb 01-26-96 11:47pm
*
*     %pwr    temp    qual.                                     *prb 01-26-96 11:47pm
8080201   0.0   253.12  0.0          *extrapolated                     *prb 01-26-96 11:47pm
8080202  25.0   286.00  0.0                                     *prb 01-26-96 11:47pm
8080203  50.0   333.40  0.0                                     *prb 01-26-96 11:47pm
8080204  75.0   359.02  0.0                                     *prb 01-26-96 11:47pm
8080205  90.0   374.74  0.0                                     *prb 01-26-96 11:47pm
8080206 100.0   384.07  0.0                                     *prb 01-26-96 11:47pm
*
*
* component 809: Moisture Separator Drain to HTR B2
8090000  'MS-drain'     tmdpjun
8090101  808000000      831000000       1.3963
*
*            trip    variable                                   *prb 01-26-96 11:47pm
*8090200  1      0      cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:47pm
8090200  1      633    cntrlvar 010    *RX Power, %                    *jam 7-27-96
*
*      %pwr   liq.flow    .                                     *prb 01-26-96 11:47pm
8090201    0.0  0.0          0.0           0.0                  *prb 01-26-96 11:47pm
8090202   25.0  22.4352      0.0           0.0       *242,300/3 lb/hr       *prb 01-26-96 11:47pm
8090203   50.0  54.9444      0.0           0.0       *593,400/3 lb/hr       *prb 01-26-96 11:47pm
8090204   75.0  82.8714      0.0           0.0       *895,011/3 lb/hr       *prb 01-26-96 11:47pm
8090205   90.0  105.3094     0.0           0.0       *1,137,342/3 lb/hr     *prb 01-26-96 11:47pm
8090206  100.0  120.7569     0.0           0.0       *1,304,175/3 lb/hr     *prb 01-26-96 11:47pm
*
```

```
*
* component 810 - RFW Heater A1 steam supply vlv - jam 7-27-96
8100000 b1stmvlv       valve    *jam 7-27-96
*      from          to          juna    kf     kr     fvcahs
8100101 801000000      820000000      1.3417  15.7355  15.7355 000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
8100201 0    60.166      118.13           0.0                         *jam 7-26-96
8100300 trpvlv                                                  *jam 7-26-96
8100301 633                                                     *jam 7-26-96
*
* component 820 - RFW Heater A1 Steam Dome (top of vertical shell)
8200000 'HTRB1-s1'     branch
*
*      #juns   vel/flow
*8200001 2       0
8200001 1       0                                               *jam 7-27-96
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
8200101 12.34   13.7904 0.      0.      -90.0 -13.7904  1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv        voidv
8200200 000     198.29  354.09      1113.5     0.99410
*
*      from          to          juna    kf     kr     fvcahs
*8201101 801000000      820000000      1.3417  15.7355 15.7355 000000       *jam 7-27-96
*8202101 820010000      821000000      0.      0.      0.      101000       *jam 7-27-96
8201101 820010000      821000000      0.      0.      0.      101000       *jam 7-27-96
*
*      jun_Dh         flood   gas-int slope
*8201110 0.0            0.0     1.0     1.0                          *jam 7-27-96
*8202110 0.0772         0.0     1.0     1.0                          *jam 7-27-96
8201110 0.0772         0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
*8201201 60.166       118.13           0.                          *jam 7-27-96
*8202201 7.3903       8.4137           0.                          *jam 7-27-96
8201201 7.3903       8.4137           0.                          *jam 7-27-96
*
* component 821 - RFW Heater B1 Shellside middle volumes
8210000 'HTRB1-s2'     pipe
*
*      nv
8210001 3
*
*      flowa          vn
```

```
8210101 12.34          3      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                           *tube area = (2)(1906 tubes)(tube area)
*
*     flowl         vn
8210301 10.4596        1
8210302 2.6667         3      *same as corresponding primary tube length
*
*     volume        vn
8210401 0.0            3
*
*     incl          vn
8210601 -90.0          3
*
*     roughness      dhyd   vn
8210801 1.5e-4         0.0772  3
*
*     kf     kr     jn
8210901 0.0     0.0     2
*
*     pvbfe         vn
8211001 00100          3
*
*     fvcahs        jn
8211101 101000         2
*
*     ebt    press.  Uf         Uv        voidv              VN
8211201 0      198.33  354.09      1113.5     0.99189        0.     1
8211202 0      198.36  354.05      1113.5     0.96348        0.     2
8211203 0      198.89  336.85      1113.6     2.33801e-02    0.     3
*
*     vel/flow
8211300 0
*
*     liq-flo    vap-flo    vel.int       jn
8211301 11.168       2.4853      0.           1
8211302 3.0088       5.32454e-02 0.           2
*
*     jun_Dh        flood         gas-int       slope   jn
8211401 0.0772         0.0           1.0           1.0     2
*
*
* component 822 - RFW Heater B1 Tubesheet Shellside (bottom of vertical shell)
8220000 'HTRB1-s3'     branch
*
*     #juns   vel/flow
```

```
8220001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8220101 12.34   1.3307  0.      0.      -90.0 -1.3307   1.5e-4  0.0772  00100
*
*      ebt     press.  Uf          Uv        voidv
8220200 000     199.30  338.19      1113.6     0.0
*
*      from            to             juna    kf      kr      fvcahs
8221101 821010000       822000000       0.      0.0     0.      101000
*
*      jun_Dh          flood   gas-int slope
8221110 0.0772          0.0     1.0     1.0
*
*      liq_vel       vap_vel          vel.int.
8221201 0.11251      -1.1900           0.
*
*
* component 823 - RFW Heater B1 Drain Piping
8230000 'HTRB1drn'      branch
*
*      #juns   vel/flow
8230001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8230101 0.3474  10.0    0.      0.      82.6  9.9167    1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
8230200 000     199.30  338.19      1113.6     0.0
*
*      from            to             juna    kf      kr      fvcahs
8231101 822010000       823000000       0.3474  0.0     0.      000100
*
*      liq_vel       vap_vel          vel.int.
8231201 3.7345        3.7345           0.
*
*
* component 825 - RFW HTRB1 Drain Valve
8250000  'LCV6-19'      valve
*
*       from       to         juna      kf        kr        fvcahs
8250101  823010000  831000000   0.0873    39.0223   39.0223   000000
*
8250201  0          15.463       15.465   0.     *  819,483/3 lb/hr
*
```

```
8250300  srvvlv
*
8250301  0450  * valve position demand from htr B1 level control system
*
8250400  1.0       288.0      * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                             4" linear double-seated full-port
8250401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
8250402  1.0       1.0        1.0     * valve
*
* component 811 - RFW Heater B2 steam supply vlv - jam 7-27-96
8110000 b2stmvlv       valve    *jam 7-27-96
*     from          to           juna    kf      kr      fvcahs
8110101 802000000      830000000      0.7854  14.1087  14.1087 000000         *jam 7-27-96
*        liq_vel     vap_vel          vel.int.
8110201 0   74.200      202.58           0.0                      *jam 7-26-96
8110300 trpvlv                                                *jam 7-26-96
8110301 633                                                   *jam 7-26-96
*
* component 830 - RFW Heater A2 Steam Dome (top of vertical shell)
8300000 'HTRB2-s1'     branch
*
*     #juns   vel/flow
*8300001 2      0                                             *jam 9-27-96
8300001 1      0                                              *jam 9-27-96
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
8300101 12.34   10.2904 0.     0.      -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt     press   Uf         Uv        voidv
8300200 000     109.21  304.89      1106.3     0.99832
*
*     from          to           juna    kf      kr      fvcahs
*8301101 802000000      830000000      0.7854  14.1087 14.1087 000001        *jam 9-27-96
*8302101 830010000      831000000      12.34   0.      0.      101000        *jam 9-27-96
8301101 830010000      831000000      12.34   0.      0.      101000         *jam 9-27-96
*
*     jun_Dh          flood   gas-int slope
*8301110 0.0            0.0     1.0     1.0                        *jam 9-27-96
*8302110 0.0772         0.0     1.0     1.0                        *jam 9-27-96
8301110 0.0772         0.0     1.0     1.0                         *jam 9-27-96
*
*     liq_vel     vap_vel          vel.int.
*8301201 74.200      202.58           0.                           *jam 9-27-96
*8302201 12.027      7.9267           0.                           *jam 9-27-96
8301201 12.027      7.9267           0.                            *jam 9-27-96
```

```
*
*
* component 831 - RFW Heater B2 drain junction volume
8310000 'HTRB2-s2'     branch
*
*     #juns   vel/flow
8310001 1      0
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8310101 12.34   8.8763  0.      0.      -90.0 -8.8763   1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
8310200 000     109.23  305.04      1106.4     0.97393
*
*     from            to            juna    kf      kr      fvcahs
8311101 831010000      832000000      12.34   0.      0.      101000
*
*     jun_Dh          flood   gas-int slope
8311110 0.0772          0.0     1.0     1.0
*
*     liq_vel      vap_vel            vel.int.
8311201 10.895       3.4280             0.
*
*
* component 832 - RFW Heater B2 Shellside middle volumes
8320000 'HTRB2-s2'     pipe
*
*     nv
8320001 2
*
*     flowa          vn
8320101 12.34          2      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                             *tube area = (2)(1906 tubes)(tube area)
*
*     flowl          vn
8320301 3.0000         2      *same as corresponding primary tube length
*
*     volume         vn
8320401 0.0            2
*
*     incl           vn
8320601 -90.0          2
*
*     roughness       dhyd    vn
8320801 1.5e-4          0.0772  2
```

```
*
*     kf     kr     jn
8320901 0.0     0.0     1
*
*     pvbfe         vn
8321001 00100         2
*
*     fvcahs        jn
8321101 101000        1
*
*     ebt    press.  Uf         Uv       voidv              VN
8321201 000     109.25  304.86      1106.4    0.91724       0.     1
8321202 000     109.87  298.86      1106.4    5.89169e-02    0.     2
*
*     vel/flow
8321300 0
*
*     liq-flo    vap-flo    vel.int       jn
8321301 4.2183      0.30784     0.           1
*
*     jun_Dh         flood          gas-int        slope   jn
8321401 0.0772         0.0           1.0           1.0     1
*
*
* component 833 - RFW Heater B2 Tubesheet Shellside (bottom of vertical shell)
8330000 'HTRB2-s3'      branch
*
*     #juns   vel/flow
8330001 1       0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
8330101 12.34   5.4974  0.      0.      -90.0 -5.4974   1.5e-4  0.0772  00100
*
*     ebt    press.  Uf         Uv       voidv
8330200 000     111.52  291.80      1106.6     0.0
*
*     from          to           juna    kf     kr     fvcahs
8331101 832010000       833000000       12.34   0.0     0.     101000
*
*     jun_Dh         flood   gas-int slope
8331110 0.0772         0.0     1.0     1.0
*
*     liq_vel      vap_vel         vel.int.
8331201 0.42029     -0.82167           0.
*
```

```
*
* component 834 - RFW Heater B2 Drain Piping
8340000 'HTRB2drn'     branch
*
*     #juns   vel/flow
8340001 1      0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
8340101 0.5475  25.0    0.      0.      65.0  22.6667  1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
8340200 000     199.30  338.19      1113.6    0.0
*
*     from           to            juna    kf     kr      fvcahs
8341101 833010000      834000000      0.5475  0.0     0.      000100
*
*     liq_vel     vap_vel          vel.int.
8341201 8.2628      7.7109           0.
*
*
* component 835 - RFW HTRB2 Drain Valve
8350000  'LCV6-22A'     valve
*
*      from       to         juna      kf       kr       fvcahs
8350101  834010000  841000000   0.3491    22.8653   22.8653   000000
*
8350201  1          228.5294     0.0      0.     *2,468,117/3 lb/hr
*
8350300  srvvlv
*
8350301  0458  * valve position demand based from htr B2 level control          *prb
01-24-96 10:40am
*
8350400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
8350401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
8350402  1.0       1.0         1.0     * valve
*
*
* component 837 - RFW HTRB2 Bypass Valve                                  *prb 01-23-96
01:05pm
8370000  'LCV6-4B'      valve                                  *prb 01-23-96 01:05pm
*                                                      *prb 01-23-96 01:05pm
*      from       to         juna      kf       kr       fvcahs          *prb 01-23-96 01:05pm
```

```
*8370101  834010000  738000000   0.3491    0.0       0.0       000000          *prb 01-23-96
01:05pm
8370101  834010000  738000000   0.3491    22.8653   22.8653   000000          *prb 01-23-96
01:05pm
*                                                    *prb 01-23-96 01:05pm
8370201  1         0.0         0.0      0.0                 *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
8370300  srvvlv                                            *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
8370301  0460  * valve position demand                           *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
8370400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb
01-23-96 01:05pm
*                            8" linear double-seated full-port    *prb 01-23-96 01:05pm
8370401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-23-96
01:05pm
8370402  1.0       1.0        1.0     * valve                          *prb 01-23-96 01:05pm
*
* component 812 - RFW Heater B3 steam supply vlv - jam 7-27-96
8120000 b3stmvlv       valve    *jam 7-27-96
*      from           to            juna    kf      kr      fvcahs
8120101 803000000       840000000       3.1416  23.4899  23.4899 000000         *jam 7-27-96
*          liq_vel      vap_vel           vel.int.
8120201 0    7.7263       124.84            0.0                        *jam 7-26-96
8120300 trpvlv                                                 *jam 7-26-96
8120301 633                                                   *jam 7-26-96
*
* component 840 - RFW Heater A3 Steam Dome (top of vertical shell)
8400000 'HTRB3-s1'      branch
*
*      #juns   vel/flow
*8400001 2       0                                          *jam 7-26-96
8400001 1       0                                          *jam 7-26-96
*
*      area    length  vol     theta   phi   elev     rough   hyd     pvbfe
8400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv         voidv
8400200 000     69.300  271.84       1099.9     0.99613
*
*      from           to            juna    kf      kr      fvcahs
*8401101 803000000       840000000       3.1416  23.4899 23.4899 000000        *jam 7-26-96
*8402101 840010000       841000000       13.5335 0.      0.      101000        *jam 7-26-96
8401101 840010000       841000000       13.5335 0.      0.      101000        *jam 7-26-96
*
```

```
*      jun_Dh          flood   gas-int slope
*8401110 0.0            0.0     1.0     1.0                              *jam 7-26-96
*8402110 0.0864         0.0     1.0     1.0                              *jam 7-26-96
8401110 0.0864          0.0     1.0     1.0                              *jam 7-26-96
*
*      liq_vel     vap_vel          vel.int.
*8401201 7.7263      124.84           0.                                 *jam 7-26-96
*8402201 8.9171      19.266           0.                                 *jam 7-26-96
8401201 8.9171       19.266           0.                                 *jam 7-26-96
*
*
* component 841 - RFW Heater B3 drain junction volume
8410000 'HTRB3-s2'     branch
*
*      #juns   vel/flow
8410001 1       0
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
8410101 13.5335 11.1133 0.      0.      -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
8410200 000     69.309  271.88       1100.0     0.96083
*
*      from           to            juna    kf      kr      fvcahs
8411101 841010000       842000000       13.5335 0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
8411110 0.0864          0.0     1.0     1.0
*
*      liq_vel     vap_vel          vel.int.
8411201 9.3922       5.8524           0.
*
*
* component 842 - RFW Heater B3 Shellside middle & lower volumes
8420000 'HTRB3-s3'     pipe
*
*      nv
8420001 4
*
*      flowa          vn
8420101 13.5335        1
8420102 6.7667         4      *volumes 2-4 share space with subcooling zone
*
*      flowl          vn
8420301 3.0000         2      *same as corresponding primary tube length
```

```
8420302 7.0534        4       *same as corresponding primary tube length
*
*      volume        vn
8420401 0.0           4
*
*      incl          vn
8420601 -90.0         4
*
*      roughness      dhyd   vn
8420801 1.5e-4        0.0864  4
*
*      kf     kr     jn
8420901 0.0    0.0    3
*
*      pvbfe         vn
8421001 00100         4
*
*      fvcahs        jn
8421101 101000        3
*
*      ebt    press.  Uf         Uv        voidv              VN
8421201 000    69.322  271.84     1100.0    0.98918        0.    1
8421202 000    69.529  271.38     1099.9    0.16248        0.    2
8421203 000    72.030  269.21     1100.5    2.68060e-06    0.    3
8421204 000    74.835  267.04     1101.0    8.83757e-06    0.    4
*
*      vel/flow
8421300 0
*
*      liq-flo    vap-flo          vel.int       jn
8421301  70.794     0.44862          0.           1
8421302 0.75643    -0.90429          0.           2
8421303 0.63162     0.77799          0.           3
*
*      jun_Dh        flood         gas-int       slope   jn
8421401 0.0864        0.0           1.0           1.0     3
*
*
* component 843 - RFW Heater B3 Subcooling Zone
8430000 'HTRB3-s4'     pipe
*
*      nv
8430001 3
*
*      flowa         vn
```

```
8430101 6.7667       3
*
*     flowl       vn
8430301 3.0000       1     *same as corresponding primary tube length
8430302 7.0534       3     *same as corresponding primary tube length
*
*     volume      vn
8430401 0.0          3
*
*     incl        vn
8430601 -90.0        3
*
*     roughness     dhyd   vn
8430801 1.5e-4        0.0864  3
*
*     kf    kr    jn
8430901 0.0    0.0    2
*
*     pvbfe       vn
8431001 00100        3
*
*     fvcahs      jn
8431101 101000       2
*
*     ebt    press.  Uf        Uv       voidv             VN
8431201 000    69.415  233.60     1100.1    8.99481e-02    0.    1
8431202 000    71.404  226.39     1100.4    1.57683e-07    0.    2
8431203 000    74.264  242.61     1100.9    3.17648e-06    0.    3
*
*     vel/flow
8431300 0
*
*     liq-flo     vap-flo         vel.int       jn
8431301 3.53376e-02  -1.6814          0.          1
8431302 3.03089e-02  3.099473e-02      0.          2
*
*     jun_Dh        flood         gas-int       slope   jn
8431401 0.0864        0.0           1.0           1.0    2
*
*
* component 844 - RFW Heater B3 Drain Piping
8440000 'HTRB3drn'     branch
*
*     #juns   vel/flow
8440001 1      1
```

```
*
*     area   length  vol    theta  phi  elev    rough  hyd    pvbfe
8440101 0.5475  5.0    0.     0.     0.   0.      1.5e-4  0.0    00000
*
*     ebt    press.  Uf         Uv       voidv
8440200 000     199.30  338.19      1113.6    0.0
*
*     from           to            juna   kf     kr     fvcahs
8441101 843010000      844000000      0.5475  0.0    0.     000100
*
*     liq_vel     vap_vel          vel.int.
8441201 228.5294     0.0             0.
*
*
* component 845 - RFW HTRB3 Drain Valve
8450000  'LCV6-23'     valve
*
*      from      to        juna     kf      kr      fvcahs
8450101  844010000  852000000   0.3491    7.4816    7.4816    000000
*
8450201  0         12.689      44.886   0.    *2,468,117/3 lb/hr target
*
8450300  srvvlv
*
8450301  0472  * valve position demand based on htr B3 level error
*
8450400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
8450401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
8450402  1.0       1.0        1.0     * valve
*
*
8470000 'HTRB3jun' mtpljun
8470001 2      0
*
*     from      to       juna   kf  kr  fvcahs       incr1   incr2   jn
8470011 842020004 843010003 .1      5.  5.  001000 1. 1. 1. 0      0     0 1
8470021 842040004 843030003 1.      5.  5.  001000 1. 1. 1. 0      0     0 2
*
*     liq-flo    vap-flo     jn
8471011 4.0946       4.0946     1
8471021 0.0          0.0        2
*
* component 813 - RFW Heater B4 steam supply vlv - jam 7-27-96
8130000 b4stvlv1       valve    *jam 7-27-96
```

```
*     from          to           juna    kf     kr     fvcahs
8130101 805000000      850000000      2.8229  6197.85  6197.85 000000        *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
8130201 0    0.83437      24.814           0.0                         *jam 7-26-96
8130300 trpvlv                                                   *jam 7-26-96
8130301 633                                                      *jam 7-26-96
*
*
* component 850 - RFW Heater A4 (top of shell nearest tubesheet)
8500000 'HTRB4-s1'     branch
*
*     #juns   vel/flow
*8500001 2      0                                                *jam 7-26-96
8500001 1      0                                                *jam 7-26-96
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
8500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
8500200 000     27.276  213.37       1086.4     0.99962
*
*     from          to           juna    kf     kr     fvcahs
*8501101 805000000      850000000      2.8229  6197.85 6197.85 000000        *jam 7-27-96
*8502101 850010000      851000000      9.7832  0.      0.      001003        *jam 7-27-96
8501101 850010000      851000000      9.7832  0.      0.      001003        *jam 7-27-96
*
*     jun_Dh          flood   gas-int slope
*8501110 0.0            0.0     1.0     1.0                          *jam 7-27-96
*8502110 0.1309          0.0     1.0     1.0                          *jam 7-27-96
8501110 0.1309          0.0     1.0     1.0                          *jam 7-27-96
*
*     liq_vel      vap_vel          vel.int.
*8501201 0.83437       24.814           0.                           *jam 7-27-96
*8502201  9.1016       8.7249           0.                           *jam 7-27-96
8501201  9.1016       8.7249           0.                           *jam 7-27-96
*
* component 814 - RFW Heater B4 steam supply vlv - jam 7-27-96
8140000 b4stvlv2       valve    *jam 7-27-96
*     from          to           juna    kf     kr     fvcahs
8140101 804000000      851000000      2.8229  4.4554   4.4554  000000        *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
8140201 0    41.854       271.59           0.0                         *jam 7-26-96
8140300 trpvlv                                                   *jam 7-26-96
8140301 633                                                      *jam 7-26-96
*
```

```
*
* component 851 - RFW Heater A4 (top of shell furthest from tubesheet)
8510000 'HTRB4-s2'     branch
*
*     #juns   vel/flow
*8510001 2      0                                          *jam 7-27-96
8510001 1      0                                          *jam 7-27-96
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
8510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
8510200 000     27.276  213.38       1086.4     0.99996
*
*     from           to            juna     kf      kr      fvcahs
*8511101 804000000      851000000      2.8229    4.4554  4.4554  000000       *jam 7-27-96
*8512101 851010000      852000000      153.4359 0.      0.      101000       *jam 7-27-96
8511101 851010000      852000000      153.4359 0.      0.      101000       *jam 7-27-96
*
*     jun_Dh          flood   gas-int slope
*8511110 0.0            0.0     1.0     1.0                                *jam 7-27-96
*8512110 0.1309          0.0     1.0     1.0                               *jam 7-27-96
8511110 0.1309          0.0     1.0     1.0                               *jam 7-27-96
*
*     liq_vel      vap_vel           vel.int.
*8511201 41.854       271.59            0.                                *jam 7-27-96
*8512201 38.784       4.5911            0.                                *jam 7-27-96
8511201 38.784       4.5911            0.                                *jam 7-27-96
*
*
* component 852 - RFW Heater B4 (bottom of shell furthest from tubesheet)
8520000 'HTRB4-s3'     branch
*
*     #juns   vel/flow
8520001 0      0
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
8520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
8520200 000     27.292  209.34       1086.4     0.52487
*
*
* component 853 - RFW Heater B4 Subcooling Zone
8530000 'HTRB4-s4'     branch
```

```
*
*     #juns   vel/flow
8530001 1       0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
8530101 9.7832  15.6667 0.0      0.     0.0   0.0       1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
8530200 000     26.746  170.92       1086.2     2.46992e-02
*
*     from            to            juna    kf      kr      fvcahs
8531101 852010000       853000000       1.7671   5.0     5.0     001000
*
*     jun_Dh          flood   gas-int slope
8531110 0.1309          0.0     1.0     1.0
*
*     liq_vel     vap_vel           vel.int.
8531201 6.4784       37.792             0.
*
*
* component 854 - RFW Heater B4 Drain Piping
8540000 'HTRB4drn'     branch
*
*     #juns   vel/flow
8540001 1       0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
8540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
8540200 000     26.326  174.57       1085.9     7.05438e-04
*
*     from            to            juna   kf      kr      fvcahs
8541101 853010000       854000000       1.6230  0.0     0.      000100
*
*     liq_vel     vap_vel           vel.int.
8541201 3.1304       4.5777             0.
*
*
* component 855 - RFW HTRB4 Drain Valve
8550000  'LCV6-29A'    valve
*
*      from       to         juna      kf       kr       fvcahs
8550101  854010000  860010003   0.7854    23.7848   23.7848   000000
*
```

```
8550201  0         7.5514       7.5514   0.     *3,184,100/3 lb/hr target
*
8550300  srvvlv
*
8550301  0482  * valve position demand based on htr B4 level error
*
8550400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
8550401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
8550402  1.0       1.0         1.0     * valve
*
*
* component 857 - RFW HTRB4 Bypass Valve                              *prb 01-24-96
10:22am
8570000  'LCV6-29B'     valve                                    *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
*      from       to         juna      kf        kr       fvcahs          *prb 01-24-96 10:22am
*8570101  854010000  758000000  0.7854    0.0       0.0       000000           *prb 01-24-96
10:22am
8570101  854010000  758000000   0.7854    23.7848   23.7848   000000           *jam 7-26-96
*                                                        *prb 01-24-96 10:22am
8570201  1         0.0         0.0      0.0                         *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570300  srvvlv                                                *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570301  0460  * valve position demand                                *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-24-96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
8570401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
8570402  1.0       1.0         1.0     * valve                          *prb 01-24-96 10:22am
*
*
* component 860 - RFW Heater B5 Flash Tank
8600000 'FL-TankB'      pipe
*
*      nv
8600001 4
*
*      flowa          vn
8600101 16.4988         4
*
*      flowl          vn
```

```
8600301 1.4583        1
8600302 2.9583        2
8600303 2.500         3
8600304 5.2188        4
*
*     volume        vn
8600401 0.0           4
*
*     incl          vn
8600601 -90.0         4
*
*     roughness      dhyd   vn
8600801 0.0           0.0    4
*
*     kf     kr     jn
8600901 0.0    0.0    3
*
*     pvbfe         vn
8601001 00010         4
*
*     fvcahs        jn
8601101 101000        3
*
*     ebt    press.  Uf         Uv        voidv              VN
8601201 000    9.6940  160.59     1071.8    0.98351       0.    1
8601202 000    9.6954  159.92     1071.8    0.99883       0.    2
8601203 000    9.9628  160.43     1072.2    0.53140       0.    3
8601204 000    12.394  159.48     1075.2    0.00000e+00   0.    4
*
*     vel/flow
8601300 0
*
*     liq-flo    vap-flo          vel.int       jn
8601301  19.581     0.27746          0.           1
8601302  282.58     0.63630          0.           2
8601303 0.63560     -4.2606          0.           3
*
*     jun_Dh        flood         gas-int       slope   jn
8601401 0.0           0.0           1.0           1.0    3
*
*
* component 861 - RFW Heater B5 Drain Piping
8610000 'HTRB5drn'     branch
*
*     #juns   vel/flow
```

```
8610001 1       0
*
*      area    length  vol     theta   phi    elev      rough   hyd     pvbfe
8610101 2.9483  10.0    0.      0.      0.0    0.0       1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv          voidv
8610200 000     13.552  159.14      1076.4      0.0
*
*      from            to              juna    kf      kr      fvcahs
8611101 860010000       861000000       2.9483  0.0     0.      000100
*
*      liq_vel     vap_vel         vel.int.
8611201 1.6705      1.9099          0.
*
* component 815 - RFW Heater B5 steam supply vlv - jam 7-27-96
8150000 b5stvlv1        valve    *jam 7-27-96
*      from            to              juna    kf      kr      fvcahs
8150101 806000000       862000000       9.0164  6243.8   6243.8  000000         *jam 7-27-96
*           liq_vel     vap_vel         vel.int.
8150201 0    0.49198      22.264          0.0                          *jam 7-26-96
8150300 trpvlv                                                      *jam 7-26-96
8150301 633                                                        *jam 7-26-96
*
*
* component 862 - RFW Heater B5 (top of shell nearest tubesheet)
8620000 'HTRB5-s1'      branch
*
*      #juns   vel/flow
*8620001 3       0                                                  *jam 7-27-96
8620001 2       0                                                  *jam 7-27-96
*
*      area    length  vol       theta  phi    elev      rough   hyd     pvbfe
8620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv          voidv
8620200 000     9.4593  158.61      1071.3      0.99998
*
*      from            to              juna    kf      kr      fvcahs
*8621101 806000000       862000000       9.0164  6243.8  6243.8  001000
*jam 7-27-96
*8622101 862010000       863000000       8.7069  0.      0.      001003
*jam 7-27-96
8621101 862010000       863000000       8.7069  0.      0.      001003
*jam 7-27-96
```

```
*8623101 860000000     862000000     0.7530  1.50   1.50   001000
*jam 7-27-96
8622101 860000000     862000000     0.7530  1.50   1.50   001000
*jam 7-27-96
*
*      jun_Dh        flood   gas-int slope
*8621110 2.3958        0.0     1.0     1.0                                    *jam 7-27-96
*8622110 0.1128        0.0     1.0     1.0                                    *jam 7-27-96
8621110 0.1128        0.0     1.0     1.0                                     *jam 7-27-96
*8623110 0.0           0.0     1.0     1.0                                    *jam 7-27-96
8622110 0.0           0.0     1.0     1.0                                     *jam 7-27-96
*
*      liq_vel     vap_vel        vel.int.
*8621201 0.49198      22.264         0.                                       *jam 7-27-96
*8622201 -31.397     -26.477         0.                                       *jam 7-27-96
8621201 -31.397     -26.477         0.                                        *jam 7-27-96
*8623201 -30.730      237.56         0.                                       *jam 7-27-96
8622201 -30.730      237.56         0.                                        *jam 7-27-96
*
* component 816 - RFW Heater B5 steam supply vlv - jam 7-27-96
8160000 b5stvlv2      valve    *jam 7-27-96
*      from          to          juna    kf     kr     fvcahs
8160101 807000000     863000000     9.0164  2.9489   2.9489  000000       *jam 7-27-96
*          liq_vel     vap_vel        vel.int.
8160201 0   26.337      161.50          0.0                  *jam 7-26-96
8160300 trpvlv                                          *jam 7-26-96
8160301 633                                             *jam 7-26-96
*
*
* component 863 - RFW Heater B5 (top of shell furthest from tubesheet)
8630000 'HTRB5-s2'     branch
*
*      #juns   vel/flow
*8630001 2      0                                        *jam 7-27-96
8630001 1      0                                        *jam 7-27-96
*
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
8630101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf         Uv       voidv
8630200 000     9.4589  158.60      1071.4     0.99992
*
*      from          to          juna    kf     kr     fvcahs
*8631101 807000000     863000000     9.0164   2.9489  2.9489  001000      *jam 9-27-96
*8632101 863010000     864000000     83.8342  0.      0.      001000      *jam 9-27-96
```

```
8631101 863010000       864000000       83.8342  0.     0.     001000       *jam 9-27-96
*
*     jun_Dh         flood   gas-int slope
*8631110 2.3958         0.0     1.0     1.0                              *jam 9-27-96
*8632110 0.1128         0.0     1.0     1.0                              *jam 9-27-96
8631110 0.1128         0.0     1.0     1.0                              *jam 9-27-96
*
*     liq_vel     vap_vel          vel.int.
*8631201 26.337      161.50           0.                                *jam 9-27-96
*8632201 34.542      8.5995           0.                                *jam 9-27-96
8631201 34.542      8.5995           0.                                *jam 9-27-96
*
*
* component 864 - RFW Heater B5 (bottom of shell furthest from tubesheet)
8640000 'HTRB5-s3'     branch
*
*     #juns   vel/flow
8640001 2      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
8640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
8640200 000     9.6340  148.68       1071.7     0.39598
*
*     from           to            juna    kf      kr      fvcahs
8641101 864010004       865010003       8.7069  0.     0.     001000
8642101 864010000       866000000       0.8685   1.5    100.0   001001  * discourage reverse
flow
*
*     jun_Dh         flood   gas-int slope
8641110 0.1128         0.0     1.0     1.0
8642110 0.6651         0.0     1.0     1.0
*
*     liq_vel     vap_vel          vel.int.
8641201  3.4725     -8.5376           0.
8642201 0.47271     -9.3520           0.
*
*
* component 865 - RFW Heater B5 (bottom of shell nearest tubesheet)
8650000 'HTRB5-s4'     branch
*
*     #juns   vel/flow
8650001 2      0
*
```

```
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
8650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt    press   Uf          Uv        voidv
8650200 000     9.4996  134.05      1071.5     0.44943
*
*      from           to            juna     kf      kr      fvcahs
8651101 862010000      865000000      110.9722 0.0     0.0     001000
8652101 865010000      866000000      0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*      jun_Dh         flood   gas-int slope
8651110 0.1128         0.0     1.0     1.0
8652110 0.6651         0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
8651201   37.265       5.8851          0.
8652201 -0.42722      -10.256          0.
*
*
* component 866 - RFW Heater B5 Collector
8660000 'Coll-B5'      branch
*
*      #juns   vel/flow
8660001 1       0
*
*      area    length  vol      theta  phi   elev     rough   hyd     pvbfe
8660101 4.9087  0.0     145.2255 0.     0.0   0.0       1.5e-4  0.0     00000
*
*      ebt    press   Uf          Uv        voidv
8660200 000     9.9594  146.78      1072.2     0.10641
*
*      from           to            juna     kf      kr      fvcahs
8661101 866010002      860030003      4.9087   1.0     0.50    031000
*
*      jun_Dh         flood   gas-int slope
8661110 2.5            0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
8661201 -0.18014      -1.3910          0.
*
*
* component 867 - RFW HTRB5 Drain Valve
*
8670000  'LCV6-32A'     valve
```

```
*
*      from       to        juna     kf       kr       fvcahs
8670101  861010000  969000000   0.7854    5.6209    5.6209    001000
*
8670201  0         9.4         9.4      0.     *3,184,100/3 lb/hr target
*
8670300  srvvlv
*
8670301  0493  * valve position demand based on htr B5 level error
*
8670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
8670401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
8670402  1.0       1.0        1.0     * valve
*
*
* component 868 - RFW HTRB5 Bypass Valve                         *prb 01-24-96
10:22am
8680000  'LCV6-32B'     valve                              *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
*      from       to        juna     kf       kr       fvcahs         *prb 01-24-96 10:22am
*8680101  861010000  969000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
8680101  861010000  969000000   0.7854    0.0       5.6209    001000          *jam 7-26-96
*                                                  *prb 01-24-96 10:22am
8680201  1         0.0         0.0      0.0                    *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
8680300  srvvlv                                            *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
8680301  0495  * valve position demand                          *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
8680400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-24-96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
8680401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
8680402  1.0       1.0        1.0     * valve                      *prb 01-24-96 10:22am
*
*
*-------------------------------------------------------------------------
* Train C Feedwater Heaters - Shellside
*-------------------------------------------------------------------------
*
* component 901 - RFW HTR C1 Steam Supply
```

```
9010000 'STM-src1'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9010101 5.0     10.0    0.0     0.0     90.0    10.0    0.0     0.0     10
*
*     ebt     trip    variable
9010200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-25-96 11:25pm
*
*     %pwr    press   qual.
9010201   0.0   7.545  0.9107        *extrapolated                     *prb 01-26-96 10:38pm
9010202  25.0   55.019  0.9022                                        *prb 01-26-96 10:38pm
9010203  50.0   110.02  0.8907                                        *prb 01-26-96 10:38pm
9010204  75.0   153.73  0.8837                                        *prb 01-26-96 10:38pm
9010205  90.0   186.86  0.8791                                        *prb 01-26-96 10:38pm
9010206 100.0   209.01  0.8765                                        *prb 01-26-96 10:38pm
*
*
* component 902 - RFW HTR C2 Steam Supply
9020000 'STM-src2'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9020101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9020200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                   *prb 01-26-96 11:55pm
9020201   0.0   3.43   0.9607        *extrapolated                     *prb 01-26-96 11:55pm
9020202  25.0    31.30  0.9587                                        *prb 01-26-96 11:55pm
9020203  50.0    61.70  0.9533                                        *prb 01-26-96 11:55pm
9020204  75.0    88.31  0.9530                                        *prb 01-26-96 11:55pm
9020205  90.0   107.20  0.9508                                        *prb 01-26-96 11:55pm
9020206 100.0   119.81  0.9495                                        *prb 01-26-96 11:55pm
*
*
* component 903 - RFW HTR C3 Steam Supply
9030000 'STM-src3'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9030200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                   *prb 01-26-96 11:55pm
```

```
9030201   0.0    1.99   0.9421         *extrapolated                 *prb 01-26-96 11:55pm
9030202  25.0   19.80   0.9389                                       *prb 01-26-96 11:55pm
9030203  50.0   38.70   0.9316                                       *prb 01-26-96 11:55pm
9030204  75.0   55.97   0.9305                                       *prb 01-26-96 11:55pm
9030205  90.0   67.71   0.9276                                       *prb 01-26-96 11:55pm
9030206 100.0   75.51   0.9259                                       *prb 01-26-96 11:55pm
*
*
* component 904 - RFW HTR C4 Steam Supply #1
9040000 'STMsrc4A'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9040101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9040200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                                      *prb 01-27-96 10:08am
*     %pwr    press   qual.                                            *prb 01-27-96 10:08am
9040201   0.0    0.75   0.6576         *extrapolated                 *prb 01-27-96 10:08am
9040202  25.0    7.66   0.7094                                       *prb 01-27-96 10:08am
9040203  50.0   14.80   0.8077                                       *prb 01-27-96 10:08am
9040204  75.0   21.59   0.8363                                       *prb 01-27-96 10:08am
9040205  90.0   26.05   0.8437                                       *prb 01-27-96 10:08am
9040206 100.0   29.00   0.8482                                       *prb 01-27-96 10:08am
*
*
* component 905 - RFW HTR C4 Steam Supply #2
9050000 'STMsrc4B'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9050101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9050200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                                      *prb 01-27-96 10:08am
*     %pwr    press   qual.                                            *prb 01-27-96 10:08am
9050201   0.0   1.127   0.3577         *extrapolated                 *prb 01-27-96 10:08am
9050202  25.0   12.30   0.4394                                       *prb 01-27-96 10:08am
9050203  50.0   24.00   0.5701                                       *prb 01-27-96 10:08am
9050204  75.0   34.91   0.6273                                       *prb 01-27-96 10:08am
9050205  90.0   42.24   0.6434                                       *prb 01-27-96 10:08am
9050206 100.0   47.12   0.6485                                       *prb 01-27-96 10:08am
*
*
* component 906 - RFW HTR C5 Steam Supply #1 (From "B" LP Turbine, point MR5)
```

```
9060000 'STMsrc5A'      tmdpvol
*
*      area    length  vol    azmth   incl    elev    rough   hyd     fe
9060101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
9060200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 12:31pm
*                                                       *prb 01-27-96 12:31pm
*      %pwr    press   qual.                                  *prb 01-27-96 12:31pm
9060201   0.0   0.30    0.064          *extrapolated                *prb 01-27-96 12:31pm
9060202  25.0   4.59    0.1630                                 *prb 01-27-96 12:31pm
9060203  50.0   8.88    0.2620                                 *prb 01-27-96 12:31pm
9060204  75.0   13.01   0.5389                                 *prb 01-27-96 12:31pm
9060205  90.0   15.71   0.5008                                 *prb 01-27-96 12:31pm
9060206 100.0   17.49   0.4806                                 *prb 01-27-96 12:31pm
*
*
* component 907 - RFW HTR C5 Steam Supply #2 (From "C" LP Turbine, point #5)
9070000 'STMsrc5B'      tmdpvol
*
*      area    length  vol    azmth   incl    elev    rough   hyd     fe
9070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
9070200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 12:31pm
*                                                       *prb 01-27-96 12:31pm
*      %pwr    press   qual.                                  *prb 01-27-96 12:31pm
9070201   0.0   0.45    0.2807         *extrapolated                *prb 01-27-96 12:31pm
9070202  25.0   2.69    0.4153                                 *prb 01-27-96 12:31pm
9070203  50.0   5.05    0.5633                                 *prb 01-27-96 12:31pm
9070204  75.0   7.23    0.6912                                 *prb 01-27-96 12:31pm
9070205  90.0   8.66    0.7368                                 *prb 01-27-96 12:31pm
9070206 100.0   9.60    0.7545                                 *prb 01-27-96 12:31pm
*
*
* component 908 - Moisture Separator
9080000 'Mois-Sep'      tmdpvol
*
*      area    length  vol    azmth   incl    elev    rough   hyd     fe
9080101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable                               *prb 01-26-96 11:47pm
9080200 001     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:47pm
*
*      %pwr    temp    qual.                                  *prb 01-26-96 11:47pm
```

```
9080201   0.0   253.12  0.0           *extrapolated                     *prb 01-26-96 11:47pm
9080202  25.0   286.00  0.0                                        *prb 01-26-96 11:47pm
9080203  50.0   333.40  0.0                                        *prb 01-26-96 11:47pm
9080204  75.0   359.02  0.0                                        *prb 01-26-96 11:47pm
9080205  90.0   374.74  0.0                                        *prb 01-26-96 11:47pm
9080206 100.0   384.07  0.0                                        *prb 01-26-96 11:47pm
*
*
* component 909: Moisture Separator Drain to HTR C2
9090000  'MS-drain'    tmdpjun
9090101  908000000     931000000      1.3963
*
*            trip    variable                                   *prb 01-26-96 11:47pm
*9090200  1     0      cntrlvar 010    *RX Power, %                       *prb 01-26-96 11:47pm
9090200  1      634    cntrlvar 010    *RX Power, %                       *jam 7-27-96
*
*       %pwr   liq.flow    .                                       *prb 01-26-96 11:47pm
9090201    0.0  0.0          0.0          0.0                        *prb 01-26-96 11:47pm
9090202   25.0  22.4352      0.0          0.0       *242,300/3 lb/hr       *prb 01-26-96 11:47pm
9090203   50.0  54.9444      0.0          0.0       *593,400/3 lb/hr       *prb 01-26-96 11:47pm
9090204   75.0  82.8714      0.0          0.0       *895,011/3 lb/hr       *prb 01-26-96 11:47pm
9090205   90.0  105.3094     0.0          0.0       *1,137,342/3 lb/hr     *prb 01-26-96 11:47pm
9090206  100.0  120.7569     0.0          0.0       *1,304,175/3 lb/hr     *prb 01-26-96 11:47pm
*
* component 910 - RFW Heater C1 steam supply vlv - jam 7-27-96
9100000 c1stmvlv       valve    *jam 7-27-96
*      from           to            juna    kf      kr      fvcahs
9100101 901000000      920000000      1.3417  15.7355  15.7355 000000        *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9100201 0    60.166      118.13           0.0                      *jam 7-26-96
9100300 trpvlv                                              *jam 7-26-96
9100301 634                                                 *jam 7-26-96
*
* component 920 - RFW Heater C1 Steam Dome (top of vertical shell)
9200000 'HTRC1-s1'     branch
*
*      #juns   vel/flow
*9200001 2       0
9200001 1       0                                          *jam 7-27-96
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9200101 12.34   13.7904 0.      0.      -90.0 -13.7904  1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv         voidv
9200200 000     198.29  354.09      1113.5     0.99410
```

```
*
*     from          to           juna   kf     kr     fvcahs
*9201101 901000000      920000000      1.3417  15.7355 15.7355 000000      *jam 7-27-96
*9202101 920010000      921000000      0.     0.     0.     101000      *jam 7-27-96
9201101 920010000      921000000      0.     0.     0.     101000      *jam 7-27-96
*
*     jun_Dh        flood   gas-int slope
*9201110 0.0           0.0     1.0     1.0                          *jam 7-27-96
*9202110 0.0772        0.0     1.0     1.0                          *jam 7-27-96
9201110 0.0772        0.0     1.0     1.0
*
*     liq_vel     vap_vel         vel.int.
*9201201 60.166      118.13          0.                           *jam 7-27-96
*9202201 7.3903      8.4137          0.                           *jam 7-27-96
9201201 7.3903      8.4137          0.                           *jam 7-27-96
*
*
* component 921 - RFW Heater C1 Shellside middle volumes
9210000 'HTRC1-s2'     pipe
*
*     nv
9210001 3
*
*     flowa         vn
9210101 12.34         3      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                         *tube area = (2)(1906 tubes)(tube area)
*
*     flowl         vn
9210301 10.4596        1
9210302 2.6667         3      *same as corresponding primary tube length
*
*     volume        vn
9210401 0.0           3
*
*     incl          vn
9210601 -90.0         3
*
*     roughness      dhyd   vn
9210801 1.5e-4        0.0772  3
*
*     kf     kr     jn
9210901 0.0     0.0     2
*
*     pvbfe         vn
9211001 00100         3
```

```
*
*     fvcahs        jn
9211101 101000        2
*
*     ebt    press.  Uf          Uv       voidv              VN
9211201 0      198.33  354.09      1113.5     0.99189        0.     1
9211202 0      198.36  354.05      1113.5     0.96348        0.     2
9211203 0      198.89  336.85      1113.6     2.33801e-02    0.     3
*
*     vel/flow
9211300 0
*
*     liq-flo    vap-flo    vel.int       jn
9211301 11.168      2.4853     0.            1
9211302 3.0088      5.32454e-02 0.           2
*
*     jun_Dh        flood          gas-int       slope   jn
9211401 0.0772         0.0            1.0            1.0     2
*
*
* component 922 - RFW Heater C1 Tubesheet Shellside (bottom of vertical shell)
9220000 'HTRC1-s3'     branch
*
*     #juns   vel/flow
9220001 1      0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
9220101 12.34   1.3307  0.      0.      -90.0 -1.3307   1.5e-4  0.0772  00100
*
*     ebt    press.  Uf          Uv       voidv
9220200 000     199.30  338.19      1113.6     0.0
*
*     from          to            juna    kf     kr     fvcahs
9221101 921010000      922000000      0.      0.0     0.     101000
*
*     jun_Dh        flood   gas-int slope
9221110 0.0772         0.0     1.0     1.0
*
*     liq_vel      vap_vel          vel.int.
9221201 0.11251      -1.1900           0.
*
*
* component 923 - RFW Heater C1 Drain Piping
9230000 'HTRC1drn'     branch
*
```

```
*     #juns   vel/flow
9230001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9230101 0.3474  10.0    0.     0.     82.6  9.9167   1.5e-4  0.0     00000
*
*     ebt     press.  Uf        Uv        voidv
9230200 000     199.30  338.19     1113.6    0.0
*
*     from          to           juna   kf     kr     fvcahs
9231101 922010000      923000000      0.3474  0.0    0.     000100
*
*     liq_vel      vap_vel        vel.int.
9231201 3.7345       3.7345          0.
*
*
* component 925 - RFW HTRC1 Drain Valve
9250000  'LCV6-37'     valve
*
*      from      to        juna      kf       kr       fvcahs
9250101  923010000  931000000   0.0873    39.0223   39.0223   000000
*
9250201  0         15.463      15.465   0.    *  819,483/3 lb/hr
*
9250300  srvvlv
*
9250301  0950  * valve position demand from htr C1 level control system
*
9250400  1.0       288.0       * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                             4" linear double-seated full-port
9250401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9250402  1.0       1.0        1.0     * valve
*
* component 911 - RFW Heater C2 steam supply vlv - jam 7-27-96
9110000 c2stmvlv       valve    *jam 7-27-96
*     from          to           juna   kf     kr     fvcahs
9110101 902000000      930000000      0.7854  14.1087  14.1087 000000         *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9110201 0    74.200      202.58           0.0                         *jam 7-26-96
9110300 trpvlv                                                   *jam 7-26-96
9110301 634                                                     *jam 7-26-96
*
* component 930 - RFW Heater C2 Steam Dome (top of vertical shell)
9300000 'HTRC2-s1'     branch
*
```

```
*     #juns   vel/flow
*9300001 2      0                                    *jam 9-27-96
9300001 1      0                                    *jam 9-27-96
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9300101 12.34   10.2904 0.     0.     -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
9300200 000     109.21  304.89       1106.3     0.99832
*
*     from            to             juna    kf      kr      fvcahs
*9301101 902000000       930000000       0.7854  14.1087 14.1087 000001        *jam 9-27-96
*9302101 930010000       931000000       12.34   0.      0.      101000        *jam 9-27-96
9301101 930010000       931000000       12.34   0.      0.      101000        *jam 9-27-96
*
*     jun_Dh          flood   gas-int slope
*9301110 0.0            0.0     1.0     1.0                          *jam 9-27-96
*9302110 0.0772         0.0     1.0     1.0                          *jam 9-27-96
9301110 0.0772         0.0     1.0     1.0                          *jam 9-27-96
*
*     liq_vel      vap_vel          vel.int.
*9301201 74.200       202.58           0.                           *jam 9-27-96
*9302201 12.027       7.9267           0.                           *jam 9-27-96
9301201 12.027       7.9267           0.                           *jam 9-27-96
*
*
* component 931 - RFW Heater C2 drain junction volume
9310000 'HTRC2-s2'      branch
*
*     #juns   vel/flow
9310001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9310101 12.34   8.8763  0.     0.     -90.0 -8.8763   1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
9310200 000     109.23  305.04       1106.4     0.97393
*
*     from            to             juna    kf      kr      fvcahs
9311101 931010000       932000000       12.34   0.      0.      101000
*
*     jun_Dh          flood   gas-int slope
9311110 0.0772         0.0     1.0     1.0
*
*     liq_vel      vap_vel          vel.int.
```

```
9311201 10.895      3.4280          0.
*
*
* component 932 - RFW Heater C2 Shellside middle volumes
9320000 'HTRC2-s2'     pipe
*
*     nv
9320001 2
*
*     flowa         vn
9320101 12.34         2      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                          *tube area = (2)(1906 tubes)(tube area)
*
*     flowl         vn
9320301 3.0000        2      *same as corresponding primary tube length
*
*     volume        vn
9320401 0.0           2
*
*     incl          vn
9320601 -90.0         2
*
*     roughness     dhyd   vn
9320801 1.5e-4        0.0772  2
*
*     kf     kr     jn
9320901 0.0    0.0    1
*
*     pvbfe         vn
9321001 00100         2
*
*     fvcahs        jn
9321101 101000        1
*
*     ebt    press.  Uf         Uv       voidv              VN
9321201 000    109.25  304.86     1106.4    0.91724        0.    1
9321202 000    109.87  298.86     1106.4    5.89169e-02    0.    2
*
*     vel/flow
9321300 0
*
*     liq-flo    vap-flo    vel.int      jn
9321301 4.2183     0.30784    0.           1
*
*     jun_Dh        flood         gas-int       slope   jn
```

```
9321401 0.0772     0.0      1.0      1.0   1
*
*
* component 933 - RFW Heater C2 Tubesheet Shellside (bottom of vertical shell)
9330000 'HTRC2-s3'    branch
*
*    #juns   vel/flow
9330001 1     0
*
*    area   length  vol    theta   phi   elev     rough   hyd    pvbfe
9330101 12.34  5.4974  0.     0.     -90.0 -5.4974  1.5e-4  0.0772  00100
*
*    ebt    press.  Uf       Uv       voidv
9330200 000    111.52  291.80      1106.6    0.0
*
*    from         to          juna   kf    kr    fvcahs
9331101 932010000      933000000      12.34  0.0    0.    101000
*
*    jun_Dh        flood   gas-int slope
9331110 0.0772      0.0    1.0    1.0
*
*    liq_vel     vap_vel        vel.int.
9331201 0.42029    -0.82167         0.
*
*
* component 934 - RFW Heater C2 Drain Piping
9340000 'HTRC2drn'    branch
*
*    #juns   vel/flow
9340001 1     0
*
*    area   length  vol    theta   phi   elev     rough   hyd    pvbfe
9340101 0.5475  25.0    0.     0.     65.0  22.6667  1.5e-4  0.0    00000
*
*    ebt    press.  Uf       Uv       voidv
9340200 000    199.30  338.19      1113.6    0.0
*
*    from         to          juna   kf    kr    fvcahs
9341101 933010000      934000000      0.5475  0.0    0.    000100
*
*    liq_vel     vap_vel        vel.int.
9341201 8.2628      7.7109          0.
*
*
* component 935 - RFW HTRC2 Drain Valve
```

```
9350000  'LCV6-40A'     valve
*
*      from       to         juna      kf        kr        fvcahs
9350101  934010000  941000000   0.3491    22.8653   22.8653   000000
*
9350201  1          228.5294     0.0      0.     *2,468,117/3 lb/hr
*
9350300  srvvlv
*
9350301  0958  * valve position demand based from htr C2 level control
*
9350400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
9350401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
9350402  1.0       1.0         1.0     * valve
*
*
* component 937 - RFW HTRB2 Bypass Valve                              *prb 01-23-96
01:05pm
9370000  'LCV6-4B'      valve                                *prb 01-23-96 01:05pm
*                                                      *prb 01-23-96 01:05pm
*      from       to         juna      kf        kr        fvcahs          *prb 01-23-96 01:05pm
*9370101  934010000  738000000   0.3491    0.0       0.0       000000          *prb 01-23-96
01:05pm
9370101  934010000  738000000   0.3491    22.8653   22.8653   000000          *jam 7-26-96
*                                                      *prb 01-23-96 01:05pm
9370201  1          0.0          0.0      0.0                         *prb 01-23-96 01:05pm
*                                                      *prb 01-23-96 01:05pm
9370300  srvvlv                                              *prb 01-23-96 01:05pm
*                                                      *prb 01-23-96 01:05pm
9370301  0960  * valve position demand                              *prb 01-23-96 01:05pm
*                                                      *prb 01-23-96 01:05pm
9370400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb
01-23-96 01:05pm
*                              8" linear double-seated full-port    *prb 01-23-96 01:05pm
9370401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-23-96
01:05pm
9370402  1.0       1.0         1.0     * valve                      *prb 01-23-96 01:05pm
*
* component 912 - RFW Heater C3 steam supply vlv - jam 7-27-96
9120000 c3stmvlv        valve    *jam 7-27-96
*      from            to             juna    kf      kr      fvcahs
9120101 903000000       940000000       3.1416  23.4899  23.4899 000000         *jam 7-27-96
*          liq_vel      vap_vel           vel.int.
9120201 0    7.7263       124.84            0.0                          *jam 7-26-96
```

```
9120300 trpvlv                                          *jam 7-26-96
9120301 634                                             *jam 7-26-96
*
* component 940 - RFW Heater C3 Steam Dome (top of vertical shell)
9400000 'HTRC3-s1'     branch
*
*      #juns   vel/flow
*9400001 2      0                                       *jam 7-26-96
9400001 1      0                                        *jam 7-26-96
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
9400200 000     69.300  271.84       1099.9     0.99613
*
*      from          to           juna    kf      kr      fvcahs
*9401101 903000000      940000000      3.1416  23.4899 23.4899 000000       *jam 7-26-96
*9402101 940010000      941000000      13.5335 0.      0.      101000       *jam 7-26-96
9401101 940010000      941000000      13.5335 0.      0.      101000       *jam 7-26-96
*
*      jun_Dh         flood   gas-int slope
*9401110 0.0            0.0     1.0     1.0                     *jam 7-26-96
*9402110 0.0864         0.0     1.0     1.0                     *jam 7-26-96
9401110 0.0864         0.0     1.0     1.0                     *jam 7-26-96
*
*      liq_vel      vap_vel          vel.int.
*9401201 7.7263       124.84           0.                      *jam 7-26-96
*9402201 8.9171       19.266           0.                      *jam 7-26-96
9401201 8.9171       19.266           0.                      *jam 7-26-96
*
*
* component 941 - RFW Heater C3 drain junction volume
9410000 'HTRC3-s2'     branch
*
*      #juns   vel/flow
9410001 1      0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9410101 13.5335 11.1133 0.      0.      -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
9410200 000     69.309  271.88       1100.0     0.96083
*
*      from          to           juna    kf      kr      fvcahs
```

```
9411101 941010000      942000000      13.5335 0.      0.      101000
*
*      jun_Dh         flood   gas-int slope
9411110 0.0864         0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
9411201 9.3922       5.8524           0.
*
*
* component 942 - RFW Heater C3 Shellside middle & lower volumes
9420000 'HTRC3-s3'      pipe
*
*      nv
9420001 4
*
*      flowa          vn
9420101 13.5335        1
9420102 6.7667         4      *volumes 2-4 share space with subcooling zone
*
*      flowl          vn
9420301 3.0000         2      *same as corresponding primary tube length
9420302 7.0534         4      *same as corresponding primary tube length
*
*      volume         vn
9420401 0.0            4
*
*      incl           vn
9420601 -90.0          4
*
*      roughness      dhyd   vn
9420801 1.5e-4         0.0864  4
*
*      kf     kr     jn
9420901 0.0    0.0    3
*
*      pvbfe          vn
9421001 00100          4
*
*      fvcahs         jn
9421101 101000         3
*
*      ebt    press.  Uf         Uv        voidv               VN
9421201 000    69.322  271.84     1100.0    0.98918        0.    1
9421202 000    69.529  271.38     1099.9    0.16248        0.    2
9421203 000    72.030  269.21     1100.5    2.68060e-06    0.    3
```

```
9421204 000     74.835  267.04      1101.0     8.83757e-06     0.     4
*
*     vel/flow
9421300 0
*
*     liq-flo     vap-flo          vel.int       jn
9421301  70.794      0.44862          0.            1
9421302 0.75643     -0.90429          0.            2
9421303 0.63162      0.77799          0.            3
*
*     jun_Dh        flood          gas-int        slope   jn
9421401 0.0864         0.0           1.0           1.0     3
*
*
* component 943 - RFW Heater C3 Subcooling Zone
9430000 'HTRC3-s4'      pipe
*
*     nv
9430001 3
*
*     flowa         vn
9430101 6.7667         3
*
*     flowl         vn
9430301 3.0000         1       *same as corresponding primary tube length
9430302 7.0534         3       *same as corresponding primary tube length
*
*     volume        vn
9430401 0.0           3
*
*     incl          vn
9430601 -90.0         3
*
*     roughness      dhyd   vn
9430801 1.5e-4         0.0864  3
*
*     kf     kr     jn
9430901 0.0     0.0     2
*
*     pvbfe         vn
9431001 00100         3
*
*     fvcahs        jn
9431101 101000        2
*
```

```
*      ebt    press.  Uf         Uv        voidv               VN
9431201 000    69.415  233.60     1100.1    8.99481e-02    0.     1
9431202 000    71.404  226.39     1100.4    1.57683e-07    0.     2
9431203 000    74.264  242.61     1100.9    3.17648e-06    0.     3
*
*      vel/flow
9431300 0
*
*      liq-flo     vap-flo          vel.int       jn
9431301 3.53376e-02  -1.6814          0.           1
9431302 3.03089e-02  3.099473e-02      0.           2
*
*      jun_Dh        flood         gas-int       slope   jn
9431401 0.0864         0.0           1.0           1.0     2
*
*
* component 944 - RFW Heater C3 Drain Piping
9440000 'HTRC3drn'     branch
*
*      #juns   vel/flow
9440001 1      1
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9440101 0.5475  5.0     0.     0.     0.    0.       1.5e-4  0.0     00000
*
*      ebt    press.  Uf         Uv        voidv
9440200 000    199.30  338.19     1113.6    0.0
*
*      from          to           juna    kf     kr     fvcahs
9441101 943010000      944000000      0.5475  0.0     0.     000100
*
*      liq_vel     vap_vel          vel.int.
9441201 228.5294     0.0              0.
*
*
* component 945 - RFW HTRC3 Drain Valve
9450000  'LCV6-43'     valve
*
*       from       to         juna     kf       kr       fvcahs
9450101  944010000  952000000   0.3491    7.4816    7.4816    000000
*
9450201  0         12.689       44.886   0.     *2,468,117/3 lb/hr target
*
9450300  srvvlv
*
```

```
9450301  0972  * valve position demand based on htr C3 level error
*
9450400  1.0       950.0      * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                            8" linear double-seated full-port
9450401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9450402  1.0       1.0        1.0     * valve
*
*
9470000 'HTRC3jun' mtpljun
9470001 2      0
*
*     from      to       juna    kf  kr  fvcahs        incr1   incr2   jn
9470011 942020004 943010003 .1      5.  5.  001000 1. 1. 1. 0       0     0 1
9470021 942040004 943030003 1.      5.  5.  001000 1. 1. 1. 0       0     0 2
*
*     liq-flo    vap-flo    jn
9471011 4.0946       4.0946     1
9471021 0.0          0.0        2
*
* component 913 - RFW Heater C4 steam supply vlv - jam 7-27-96
9130000 c4stvlv1       valve    *jam 7-27-96
*     from           to            juna    kf     kr     fvcahs
9130101 905000000       950000000      2.8229  6197.85  6197.85 000000         *jam 7-27-96
*         liq_vel     vap_vel          vel.int.
9130201 0    0.83437      24.814           0.0                          *jam 7-26-96
9130300 trpvlv                                                     *jam 7-26-96
9130301 634                                                      *jam 7-26-96
*
*
* component 950 - RFW Heater C4 (top of shell nearest tubesheet)
9500000 'HTRC4-s1'      branch
*
*     #juns   vel/flow
*9500001 2      0                                                  *jam 7-26-96
9500001 1      0                                                *jam 7-26-96
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
9500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
9500200 000     27.276  213.37       1086.4     0.99962
*
*     from           to            juna    kf     kr     fvcahs
*9501101 905000000       950000000       2.8229  6197.85 6197.85 000000         *jam 7-27-96
*9502101 950010000       951000000       9.7832  0.      0.      001003         *jam 7-27-96
```

```
9501101 950010000      951000000      9.7832  0.     0.     001003        *jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*9501110 0.0           0.0     1.0     1.0                             *jam 7-27-96
*9502110 0.1309         0.0     1.0     1.0                             *jam 7-27-96
9501110 0.1309         0.0     1.0     1.0                             *jam 7-27-96
*
*     liq_vel     vap_vel          vel.int.
*9501201 0.83437      24.814          0.                               *jam 7-27-96
*9502201  9.1016      8.7249          0.                               *jam 7-27-96
9501201  9.1016      8.7249          0.                               *jam 7-27-96
*
* component 914 - RFW Heater C4 steam supply vlv - jam 7-27-96
9140000 c4stvlv2       valve    *jam 7-27-96
*     from          to           juna    kf     kr     fvcahs
9140101 904000000      951000000      2.8229  4.4554   4.4554  000000        *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9140201 0    41.854      271.59           0.0                           *jam 7-26-96
9140300 trpvlv                                                     *jam 7-26-96
9140301 634                                                        *jam 7-26-96
*
*
* component 951 - RFW Heater C4 (top of shell furthest from tubesheet)
9510000 'HTRC4-s2'     branch
*
*     #juns   vel/flow
*9510001 2      0                                                  *jam 7-27-96
9510001 1      0                                                  *jam 7-27-96
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
9510200 000     27.276  213.38       1086.4     0.99996
*
*     from          to           juna    kf     kr     fvcahs
*9511101 904000000      951000000      2.8229   4.4554  4.4554  000000       *jam 7-27-96
*9512101 951010000      952000000      153.4359 0.      0.      101000       *jam 7-27-96
9511101 951010000      952000000      153.4359 0.      0.      101000       *jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*9511110 0.0           0.0     1.0     1.0                             *jam 7-27-96
*9512110 0.1309         0.0     1.0     1.0                             *jam 7-27-96
9511110 0.1309         0.0     1.0     1.0                             *jam 7-27-96
*
```

```
*     liq_vel     vap_vel          vel.int.
*9511201 41.854      271.59          0.                         *jam 7-27-96
*9512201 38.784      4.5911          0.                         *jam 7-27-96
9511201 38.784      4.5911          0.                          *jam 7-27-96
*
*
* component 952 - RFW Heater C4 (bottom of shell furthest from tubesheet)
9520000 'HTRC4-s3'     branch
*
*     #juns   vel/flow
9520001 0      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
9520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
9520200 000     27.292  209.34      1086.4     0.52487
*
*
* component 953 - RFW Heater C4 Subcooling Zone
9530000 'HTRC4-s4'     branch
*
*     #juns   vel/flow
9530001 1      0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
9530101 9.7832  15.6667 0.0      0.     0.0   0.0      1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
9530200 000     26.746  170.92      1086.2     2.46992e-02
*
*     from            to             juna     kf      kr      fvcahs
9531101 952010000      953000000      1.7671   5.0     5.0     001000
*
*     jun_Dh          flood   gas-int slope
9531110 0.1309          0.0     1.0     1.0
*
*     liq_vel     vap_vel          vel.int.
9531201 6.4784      37.792           0.
*
*
* component 954 - RFW Heater C4 Drain Piping
9540000 'HTRC4drn'     branch
*
*     #juns   vel/flow
```

```
9540001 1       0
*
*      area    length  vol     theta   phi   elev     rough   hyd     pvbfe
9540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
9540200 000     26.326  174.57      1085.9     7.05438e-04
*
*      from           to            juna    kf     kr     fvcahs
9541101 953010000       954000000       1.6230  0.0     0.      000100
*
*      liq_vel      vap_vel           vel.int.
9541201 3.1304       4.5777            0.
*
*
* component 955 - RFW HTRC4 Drain Valve
9550000  'LCV6-47A'     valve
*
*       from       to         juna      kf       kr       fvcahs
9550101  954010000  960010003   0.7854    23.7848   23.7848   000000
*
9550201  0          7.5514       7.5514   0.     *3,184,100/3 lb/hr target
*
9550300  srvvlv
*
9550301  0982  * valve position demand based on htr C4 level error
*
9550400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                               12" linear double-seated full-port
9550401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9550402  1.0       1.0        1.0     * valve
*
*
* component 957 - RFW HTRC4 Bypass Valve                              *prb 01-24-96
10:22am
9570000  'LCV6-47B'     valve                                  *prb 01-24-96 10:22am
*                                                      *prb 01-24-96 10:22am
*       from       to         juna      kf       kr       fvcahs          *prb 01-24-96 10:22am
*9570101  954010000  758000000   0.7854    0.0       0.0       000000           *prb 01-24-96
10:22am
9570101  954010000  758000000   0.7854    23.7848   23.7848   000000           *jam 7-26-96
*                                                      *prb 01-24-96 10:22am
9570201  1          0.0         0.0      0.0                          *prb 01-24-96 10:22am
*                                                      *prb 01-24-96 10:22am
9570300  srvvlv                                                *prb 01-24-96 10:22am
```

```
*                                                    *prb 01-24-96 10:22am
9570301  0984  * valve position demand                         *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
9570400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-24-96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
9570401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
9570402  1.0       1.0        1.0     * valve                          *prb 01-24-96 10:22am
*
*
* component 960 - RFW Heater C5 Flash Tank
9600000 'FL-TankC'      pipe
*
*     nv
9600001 4
*
*     flowa          vn
9600101 16.4988         4
*
*     flowl          vn
9600301 1.4583         1
9600302 2.9583         2
9600303 2.500          3
9600304 5.2188         4
*
*     volume         vn
9600401 0.0            4
*
*     incl           vn
9600601 -90.0          4
*
*     roughness      dhyd    vn
9600801 0.0            0.0     4
*
*     kf     kr     jn
9600901 0.0     0.0     3
*
*     pvbfe          vn
9601001 00010          4
*
*     fvcahs         jn
9601101 101000         3
*
*     ebt    press.  Uf          Uv        voidv              VN
```

```
9601201 000    9.6940  160.59      1071.8    0.98351       0.     1
9601202 000    9.6954  159.92      1071.8    0.99883       0.     2
9601203 000    9.9628  160.43      1072.2    0.53140       0.     3
9601204 000    12.394  159.48      1075.2    0.00000e+00    0.     4
*
*     vel/flow
9601300 0
*
*     liq-flo    vap-flo         vel.int       jn
9601301  19.581     0.27746         0.           1
9601302  282.58     0.63630         0.           2
9601303 0.63560     -4.2606         0.           3
*
*     jun_Dh        flood         gas-int       slope   jn
9601401 0.0           0.0           1.0           1.0     3
*
*
* component 961 - RFW Heater C5 Drain Piping
9610000 'HTRC5drn'     branch
*
*     #juns   vel/flow
9610001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd    pvbfe
9610101 2.9483  10.0    0.     0.      0.0   0.0      1.5e-4  0.0    00000
*
*     ebt    press.  Uf          Uv        voidv
9610200 000    13.552  159.14      1076.4    0.0
*
*     from          to            juna   kf     kr     fvcahs
9611101 960010000      961000000      2.9483  0.0    0.     000100
*
*     liq_vel     vap_vel          vel.int.
9611201 1.6705      1.9099           0.
*
* component 915 - RFW Heater C5 steam supply vlv - jam 7-27-96
9150000 c5stvlv1       valve    *jam 7-27-96
*     from          to            juna   kf     kr     fvcahs
9150101 906000000      962000000     9.0164  6243.8   6243.8  000000         *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9150201 0    0.49198      22.264           0.0                          *jam 7-26-96
9150300 trpvlv                                                    *jam 7-26-96
9150301 634                                                       *jam 7-26-96
*
*
```

```
* component 962 - RFW Heater C5 (top of shell nearest tubesheet)
9620000 'HTRC5-s1'     branch
*
*     #juns   vel/flow
*9620001 3      0                                    *jam 7-27-96
9620001 2      0                                    *jam 7-27-96
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
9620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf         Uv        voidv
9620200 000     9.4593  158.61      1071.3     0.99998
*
*     from           to           juna    kf     kr     fvcahs
*9621101 906000000      962000000      9.0164  6243.8  6243.8  001000
*jam 7-27-96
*9622101 962010000      963000000      8.7069  0.      0.      001003
*jam 7-27-96
9621101 962010000      963000000      8.7069  0.      0.      001003
*jam 7-27-96
*9623101 960000000      962000000      0.7530  1.50    1.50    001000
*jam 7-27-96
9622101 960000000      962000000      0.7530  1.50    1.50    001000
*jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*9621110 2.3958         0.0     1.0     1.0                               *jam 7-27-96
*9622110 0.1128         0.0     1.0     1.0                               *jam 7-27-96
9621110 0.1128         0.0     1.0     1.0                               *jam 7-27-96
*9623110 0.0            0.0     1.0     1.0                               *jam 7-27-96
9622110 0.0            0.0     1.0     1.0                               *jam 7-27-96
*
*     liq_vel      vap_vel          vel.int.
*9621201 0.49198       22.264          0.                                 *jam 7-27-96
*9622201 -31.397       -26.477         0.                                 *jam 7-27-96
9621201 -31.397       -26.477         0.                                 *jam 7-27-96
*9623201 -30.730       237.56          0.                                 *jam 7-27-96
9622201 -30.730       237.56          0.                                 *jam 7-27-96
*
* component 916 - RFW Heater C5 steam supply vlv - jam 7-27-96
9160000 c5stvlv2       valve    *jam 7-27-96
*     from           to           juna    kf     kr     fvcahs
9160101 907000000      963000000      9.0164  2.9489   2.9489  000000        *jam 7-27-96
*         liq_vel      vap_vel          vel.int.
9160201 0    26.337       161.50           0.0                        *jam 7-26-96
```

```
9160300 trpvlv                                          *jam 7-26-96
9160301 634                                             *jam 7-26-96
*
*
* component 963 - RFW Heater C5 (top of shell furthest from tubesheet)
9630000 'HTRC5-s2'     branch
*
*      #juns   vel/flow
*9630001 2      0                                       *jam 7-27-96
9630001 1      0                                        *jam 7-27-96
*
*      area    length  vol     theta  phi   elev     rough   hyd     pvbfe
9630101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv        voidv
9630200 000     9.4589  158.60      1071.4     0.99992
*
*      from            to            juna     kf      kr      fvcahs
*9631101 907000000      963000000      9.0164   2.9489  2.9489  001000       *jam 9-27-96
*9632101 963010000      964000000      83.8342  0.      0.      001000       *jam 9-27-96
9631101 963010000      964000000      83.8342  0.      0.      001000       *jam 9-27-96
*
*      jun_Dh          flood   gas-int slope
*9631110 2.3958          0.0     1.0     1.0                          *jam 9-27-96
*9632110 0.1128          0.0     1.0     1.0                          *jam 9-27-96
9631110 0.1128          0.0     1.0     1.0                          *jam 9-27-96
*
*      liq_vel      vap_vel          vel.int.
*9631201 26.337       161.50           0.                             *jam 9-27-96
*9632201 34.542       8.5995           0.                             *jam 9-27-96
9631201 34.542       8.5995           0.                             *jam 9-27-96
*
*
* component 964 - RFW Heater C5 (bottom of shell furthest from tubesheet)
9640000 'HTRC5-s3'     branch
*
*      #juns   vel/flow
9640001 2      0
*
*      area    length  vol     theta  phi   elev     rough   hyd     pvbfe
9640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv        voidv
9640200 000     9.6340  148.68      1071.7     0.39598
*
```

```
*      from           to            juna    kf      kr      fvcahs
9641101 964010004       965010003       8.7069  0.      0.      001000
9642101 964010000       966000000       0.8685   1.5     100.0   001001  * discourage reverse
flow
*
*      jun_Dh          flood   gas-int slope
9641110 0.1128          0.0     1.0     1.0
9642110 0.6651          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
9641201  3.4725      -8.5376           0.
9642201 0.47271      -9.3520           0.
*
*
* component 965 - RFW Heater C5 (bottom of shell nearest tubesheet)
9650000 'HTRC5-s4'      branch
*
*      #juns   vel/flow
9650001 2       0
*
*      area    length  vol      theta  phi   elev      rough   hyd      pvbfe
9650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv        voidv
9650200 000     9.4996  134.05       1071.5     0.44943
*
*      from           to            juna    kf      kr      fvcahs
9651101 962010000       965000000       110.9722 0.0     0.0     001000
9652101 965010000       966000000       0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*      jun_Dh          flood   gas-int slope
9651110 0.1128          0.0     1.0     1.0
9652110 0.6651          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
9651201   37.265       5.8851          0.
9652201 -0.42722      -10.256          0.
*
*
* component 966 - RFW Heater C5 Collector
9660000 'Coll-C5'       branch
*
*      #juns   vel/flow
9660001 1       0
```

```
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
9660101 4.9087  0.0     145.2255 0.     0.0   0.0      1.5e-4  0.0     00000
*
*     ebt     press   Uf          Uv        voidv
9660200 000     9.9594  146.78       1072.2     0.10641
*
*     from           to           juna     kf      kr      fvcahs
9661101 966010002       960030003       4.9087   1.0      0.50    031000
*
*     jun_Dh          flood   gas-int slope
9661110 2.5             0.0      1.0      1.0
*
*     liq_vel      vap_vel           vel.int.
9661201 -0.18014       -1.3910           0.
*
*
* component 967 - RFW HTR C5 Drain Valve
*
9670000  'LCV6-50A'     valve
*
*      from       to         juna      kf        kr        fvcahs
9670101  961010000  969000000   0.7854    5.6209    5.6209    001000
*
9670201  0          9.4          9.4       0.     *3,184,100/3 lb/hr target
*
9670300  srvvlv
*
9670301  0993  * valve position demand based on htr C5 level error
*
9670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                               12" linear double-seated full-port
9670401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
9670402  1.0       1.0         1.0     * valve
*
*
* component 968 - RFW HTRC5 Bypass Valve                              *prb 01-25-96
09:19pm
9680000  'LCV6-50B'     valve                                   *prb 01-25-96 09:19pm
*                                                       *prb 01-25-96 09:19pm
*      from       to         juna      kf        kr        fvcahs          *prb 01-25-96 09:19pm
*9680101  961010000  969000000   0.7854    0.0       0.0       000000          *prb 01-25-96
09:19pm
9680101  961010000  969000000   0.7854    0.0       5.6209    001000          *jam 7-26-96
*                                                       *prb 01-25-96 09:19pm
```

```
9680201  1         0.0         0.0      0.0                         *prb 01-25-96 09:19pm
*                                                           *prb 01-25-96 09:19pm
9680300  srvvlv                                                *prb 01-25-96 09:19pm
*                                                           *prb 01-25-96 09:19pm
9680301  0995  * valve position demand                            *prb 01-25-96 09:19pm
*                                                           *prb 01-25-96 09:19pm
9680400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb
01-25-96 09:19pm
*                              12" linear double-seated full-port   *prb 01-25-96 09:19pm
9680401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-25-96
09:19pm
9680402  1.0       1.0        1.0     * valve                        *prb 01-25-96 09:19pm
*
*
* component 969 - RFW Heater sump header
9690000 'HTR-sump'     branch
*
*     #juns   vel/flow
9690001 1      1
*
*     area    length  vol     theta  phi   elev     rough   hyd    pvbfe
*9690101 5.0     10.0    0.0      0.     0.0   0.0      1.5e-4  0.0     00000
9690101 8.0     50.0    0.0      0.     0.0   0.0      1.5e-4  0.0     00000 *jam 7-28-96
*
*     ebt    press   temp
9690200 003     1.0     101.14
*
*     from          to           juna    kf     kr     fvcahs
9691101 969010000      970000000      0.0      1.0     0.50    001000
*
*     liq_vel     vap_vel          vel.int.
9691201 884.4722     0.0             0.
*
*
* component 970 - HTR sump / condenser
* ------------------------------------------
9700000 'HTR-cond'     tmdpvol
*
*     area    length  vol     azmth   incl    elev    rough   hyd     fe
*9700101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
9700101 8.0     50.0    0.0     0.0     0.0     0.0     0.0     0.0     10 *jam 7-28-96
*
*     ebt    trip    variable
9700200 003
*
```

```
*      time    press   temp.
9700201 0.0     0.9823  101.14
*
* component 971 - HTR sump / condenser                              *jam 7-28-96
* ----------------------------------------                          *jam 7-28-96
9710000 'HTR2cond'      tmdpvol                                     *jam 7-28-96
*                                                                   *jam 7-28-96
*      area    length  vol    azmth   incl    elev    rough   hyd     fe      *jam 7-28-96
9710101 1.0     50.0    0.0     0.0     0.0     0.0     0.0     0.0     10      *jam 7-28-96
*                                                                   *jam 7-28-96
*      ebt     trip    variable                                     *jam 7-28-96
9710200 003                                                         *jam 7-28-96
*                                                                   *jam 7-28-96
*      time    press   temp.                                        *jam 7-28-96
9710201 0.0     0.9823  101.14                                      *jam 7-28-96
*
*
*-------------------------------------------------------------------
* feedwater train heat structures
*-------------------------------------------------------------------
*
* heat structure geometry per vendor spec shts. included with app. d
*
*** drain cooler A tubes ***
15201000    1    2    2    0   2.84000e-02
15201100 0 1
15201101 1 0.0313
15201201 4 1
15201301 1. 1
15201400  -1
15201401 1.3759e+02 1.3950e+02
15201501 520010000 0 1 1 6.66e4 1
15201601          0 0 0 1 6.66e4 1
15201701 10816 1. 0. 0. 1
15201801 0. 10. 10. 0. 0. 0. 0. 1. 1
15201901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*** drain cooler B tubes ***
15211000    1    2    2    0   2.84000e-02
15211100 0 1
15211101 1 0.0313
15211201 4 1
15211301 1. 1
15211400  -1
```

```
15211401 1.3759e+02 1.3950e+02
15211501 521010000 0 1 1 6.66e4 1
15211601         0 0 0 1 6.66e4 1
15211701 10816 1. 0. 0. 1
15211801 0. 10. 10. 0. 0. 0. 0. 1. 1
15211901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*** drain cooler C tubes ***
15221000    1    2    2    0   2.84000e-02
15221100 0 1
15221101 1 0.0313
15221201 4 1
15221301 1. 1
15221400  -1
15221401 1.3759e+02 1.3950e+02
15221501 522010000 0 1 1 6.66e4 1
15221601         0 0 0 1 6.66e4 1
15221701 10816 1. 0. 0. 1
15221801 0. 10. 10. 0. 0. 0. 0. 1. 1
15221901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* heat structure 530-1  RFW Heater A5 Tubes
*       nh     np     geom   init   lt.coord
15301000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15301100 0            1
*
*       # intervals   rt.coord
15301101 2            0.0260
*
*       comp #        inter#(in)
15301201 004          2
*
*       rel. source   interval
15301301 1.           2
*
15301400 -1
*
*       mesh point temperatures
15301401 148.87      158.13      172.26
15301402 161.67      165.87      172.99
15301403 170.81      171.20      171.81
```

```
15301404 175.92     172.87     171.76
15301405 181.78     186.13     189.06
15301406 185.58     187.62     189.36
15301407 187.29     188.05     189.65
15301408 188.65     188.95     189.53
*
*       lt.boundary    incr    bdry    code    factor  hs#
15301501 530010000      0       1       1       12556.8 1   *(0.7) 17938.3
15301502 530020000      0       1       1       12556.8 2   *(0.7) 17938.3
15301503 530030000      0       1       1       12556.8 3   *(0.7) 17938.3
15301504 530040000      0       1       1       12556.8 4   *(0.7) 17938.3
15301505 530050000      0       1       1       12556.8 5   *(0.7) 17938.3
15301506 530060000      0       1       1       12556.8 6   *(0.7) 17938.3
15301507 530070000      0       1       1       12556.8 7   *(0.7) 17938.3
15301508 530080000      0       1       1       12556.8 8   *(0.7) 17938.3
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15301601 765010000      0       1       1       12556.8 1   *(0.7) 17938.3
15301602 765010000      0       1       1       12556.8 2   *(0.7) 17938.3
15301603 764010000      0       1       1       12556.8 3   *(0.7) 17938.3
15301604 764010000      0       1       1       12556.8 4   *(0.7) 17938.3
15301605 763010000      0       1       1       12556.8 5   *(0.7) 17938.3
15301606 763010000      0       1       1       12556.8 6   *(0.7) 17938.3
15301607 762010000      0       1       1       12556.8 7   *(0.7) 17938.3
15301608 762010000      0       1       1       12556.8 8   *(0.7) 17938.3
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15301701 0             0.0     0.0     0.0     8
*
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15301801 0.0      5.4844  100.0  100.0  100.0  0.0  0.0  1.0   1
15301802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   7
15301803 0.0      100.0   5.4844 100.0  100.0  0.0  0.0  1.0   8
*
15301901 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   8
*
*
* heat structure 531-1  RFW Heater B5 Tubes
*       nh     np     geom   init   lt.coord
15311000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15311100 0            1
*
```

```
*       # intervals   rt.coord
15311101 2            0.0260
*
*       comp #        inter#(in)
15311201 004          2
*
*       rel. source   interval
15311301 1.           2
*
15311400 -1
*
*       mesh point temperatures
15311401 152.71     158.09     163.24
15311402 153.75     159.06     164.11
15311403 162.74     168.34     173.74
15311404 168.95     173.40     177.69
15311405 176.29     179.73     182.98
15311406 181.27     183.49     185.58
15311407 184.14     185.46     186.70
15311408 185.89     186.61     187.28
*
*       lt.boundary   incr   bdry   code   factor  hs#
15311501 531010000    0      1      1      12556.8 1   *(0.7) 17938.3
15311502 531020000    0      1      1      12556.8 2   *(0.7) 17938.3
15311503 531030000    0      1      1      12556.8 3   *(0.7) 17938.3
15311504 531040000    0      1      1      12556.8 4   *(0.7) 17938.3
15311505 531050000    0      1      1      12556.8 5   *(0.7) 17938.3
15311506 531060000    0      1      1      12556.8 6   *(0.7) 17938.3
15311507 531070000    0      1      1      12556.8 7   *(0.7) 17938.3
15311508 531080000    0      1      1      12556.8 8   *(0.7) 17938.3
*
*
*       rt.boundary   incr   bdry   code   factor  hs#
15311601 865010000    0      1      1      12556.8 1   *(0.7) 17938.3
15311602 865010000    0      1      1      12556.8 2   *(0.7) 17938.3
15311603 864010000    0      1      1      12556.8 3   *(0.7) 17938.3
15311604 864010000    0      1      1      12556.8 4   *(0.7) 17938.3
15311605 863010000    0      1      1      12556.8 5   *(0.7) 17938.3
15311606 863010000    0      1      1      12556.8 6   *(0.7) 17938.3
15311607 862010000    0      1      1      12556.8 7   *(0.7) 17938.3
15311608 862010000    0      1      1      12556.8 8   *(0.7) 17938.3
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15311701 0            0.0     0.0     0.0     8
*
```

```
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15311801 0.0      5.4844  100.0  100.0  100.0  0.0  0.0  1.0   1
15311802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   7
15311803 0.0      100.0   5.4844 100.0  100.0  0.0  0.0  1.0   8
*
15311901 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   8
*
*
* heat structure 532-1  RFW Heater C5 Tubes
*       nh     np     geom   init   lt.coord
15321000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15321100 0            1
*
*       # intervals   rt.coord
15321101 2            0.0260
*
*       comp #        inter#(in)
15321201 004          2
*
*       rel. source   interval
15321301 1.           2
*
15321400 -1
*
*       mesh point temperatures
15321401 136.71      137.95      139.07
15321402 136.55      137.75      138.87
15321403 138.78      139.81      140.79
15321404 140.92      141.87      142.77
15321405 159.80      167.15      174.08
15321406 170.62      175.64      180.38
15321407 176.32      179.08      181.68
15321408 180.69      182.69      184.57
*
*       lt.boundary    incr    bdry    code    factor  hs#
15321501 532010000      0       1       1       12556.8 1   *(0.7) 17938.3
15321502 532020000      0       1       1       12556.8 2   *(0.7) 17938.3
15321503 532030000      0       1       1       12556.8 3   *(0.7) 17938.3
15321504 532040000      0       1       1       12556.8 4   *(0.7) 17938.3
15321505 532050000      0       1       1       12556.8 5   *(0.7) 17938.3
15321506 532060000      0       1       1       12556.8 6   *(0.7) 17938.3
15321507 532070000      0       1       1       12556.8 7   *(0.7) 17938.3
15321508 532080000      0       1       1       12556.8 8   *(0.7) 17938.3
```

```
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15321601 965010000     0       1       1       12556.8 1   *(0.7) 17938.3
15321602 965010000     0       1       1       12556.8 2   *(0.7) 17938.3
15321603 964010000     0       1       1       12556.8 3   *(0.7) 17938.3
15321604 964010000     0       1       1       12556.8 4   *(0.7) 17938.3
15321605 963010000     0       1       1       12556.8 5   *(0.7) 17938.3
15321606 963010000     0       1       1       12556.8 6   *(0.7) 17938.3
15321607 962010000     0       1       1       12556.8 7   *(0.7) 17938.3
15321608 962010000     0       1       1       12556.8 8   *(0.7) 17938.3
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15321701 0             0.0     0.0     0.0     8
*
*       hed     hlf     hlr     gslf    gslr    gkf   gkr  lbf   hs#
15321801 0.0     5.4844  100.0  100.0  100.0  0.0  0.0  1.0   1
15321802 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   7
15321803 0.0     100.0   5.4844 100.0  100.0  0.0  0.0  1.0   8
*
15321901 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   8
*
*
* heat structure 540-1  RFW Heater A4 Tubes
*       nh     np     geom   init   lt.coord
15401000 10    3      2      1      0.0231
*
*       mesh loc'n    format
15401100 0            1
*
*       # intervals   rt.coord
15401101 2            0.0260
*
*       comp #        inter#(in)
15401201 004          2
*
*       rel. source   interval
15401301 1.           2
*
15401400 -1
*
*       mesh point temperatures
15401401 196.10      198.57      200.90
15401402 196.69      198.94      201.05
15401403 214.70      221.16      227.25
```

```
15401404 225.70     230.12     234.28
15401405 232.97     235.92     238.70
15401406 238.11     240.19     242.15
15401407 240.94     242.10     243.09
15401408 242.41     243.03     243.55
15401409 243.10     243.41     243.71
15401410 243.58     243.77     243.95
*
*      lt.boundary   incr   bdry   code   factor  hs#
15401501 540010000     0      1      1      14906.7 1   *(1.5) 14906.7
15401502 540020000     0      1      1      13865.0 2   *(1.5) 13865.0
15401503 540030000     0      1      1      13865.0 3   *(1.0) 13865.0
15401504 540040000     0      1      1      13865.0 4   *(1.0) 13865.0
15401505 540050000     0      1      1      13865.0 5   *(1.0) 13865.0
15401506 540060000     0      1      1      13865.0 6   *(1.0) 13865.0
15401507 540070000     0      1      1      13865.0 7   *(1.0) 13865.0
15401508 540080000     0      1      1      13865.0 8   *(1.0) 13865.0
15401509 540090000     0      1      1      13865.0 9   *(1.0) 13865.0
15401510 540100000     0      1      1      14906.7 10  *(1.0) 13865.0
*
*
*      rt.boundary   incr   bdry   code   factor  hs#
15401601 753010000     0      1      1      14906.7 1   *(1.5) 14906.7
15401602 753010000     0      1      1      13865.0 2   *(1.5) 13865.0
15401603 752010000     0      1      1      13865.0 3   *(1.0) 13865.0
15401604 752010000     0      1      1      13865.0 4   *(1.0) 13865.0
15401605 752010000     0      1      1      13865.0 5   *(1.0) 13865.0
15401606 751010000     0      1      1      13865.0 6   *(1.0) 13865.0
15401607 751010000     0      1      1      13865.0 7   *(1.0) 13865.0
15401608 751010000     0      1      1      13865.0 8   *(1.0) 13865.0
15401609 750010000     0      1      1      13865.0 9   *(1.0) 13865.0
15401610 750010000     0      1      1      14906.7 10  *(1.0) 14906.7
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15401701 0            0.0     0.0     0.0     10
*
*      hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15401801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15401802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15401803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15401901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 541-1  RFW Heater B4 Tubes
```

```
*       nh     np     geom   init   lt.coord
15411000 10     3      2      1      0.0231
*
*       mesh loc'n    format
15411100 0           1
*
*       # intervals   rt.coord
15411101 2           0.0260
*
*       comp #       inter#(in)
15411201 004          2
*
*       rel. source   interval
15411301 1.           2
*
15411400 -1
*
*       mesh point temperatures
15411401 196.10      198.57      200.90
15411402 196.69      198.94      201.05
15411403 214.70      221.16      227.25
15411404 225.70      230.12      234.28
15411405 232.97      235.92      238.70
15411406 238.11      240.19      242.15
15411407 240.94      242.10      243.09
15411408 242.41      243.03      243.55
15411409 243.10      243.41      243.71
15411410 243.58      243.77      243.95
*
*       lt.boundary    incr    bdry    code    factor  hs#
15411501 541010000     0       1       1       14906.7 1   *(1.5) 14906.7
15411502 541020000     0       1       1       13865.0 2   *(1.5) 13865.0
15411503 541030000     0       1       1       13865.0 3   *(1.0) 13865.0
15411504 541040000     0       1       1       13865.0 4   *(1.0) 13865.0
15411505 541050000     0       1       1       13865.0 5   *(1.0) 13865.0
15411506 541060000     0       1       1       13865.0 6   *(1.0) 13865.0
15411507 541070000     0       1       1       13865.0 7   *(1.0) 13865.0
15411508 541080000     0       1       1       13865.0 8   *(1.0) 13865.0
15411509 541090000     0       1       1       13865.0 9   *(1.0) 13865.0
15411510 541100000     0       1       1       14906.7 10  *(1.0) 13865.0
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15411601 853010000     0       1       1       14906.7 1   *(1.5) 14906.7
15411602 853010000     0       1       1       13865.0 2   *(1.5) 13865.0
```

```
15411603 852010000     0      1      1      13865.0 3   *(1.0) 13865.0
15411604 852010000     0      1      1      13865.0 4   *(1.0) 13865.0
15411605 852010000     0      1      1      13865.0 5   *(1.0) 13865.0
15411606 851010000     0      1      1      13865.0 6   *(1.0) 13865.0
15411607 851010000     0      1      1      13865.0 7   *(1.0) 13865.0
15411608 851010000     0      1      1      13865.0 8   *(1.0) 13865.0
15411609 850010000     0      1      1      13865.0 9   *(1.0) 13865.0
15411610 850010000     0      1      1      14906.7 10  *(1.0) 14906.7
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15411701 0             0.0     0.0     0.0     10
*
*       hed      hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15411801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15411802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15411803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15411901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 542-1  RFW Heater C4 Tubes
*       nh     np     geom   init   lt.coord
15421000 10     3      2      1      0.0231
*
*       mesh loc'n    format
15421100 0            1
*
*       # intervals   rt.coord
15421101 2            0.0260
*
*       comp #        inter#(in)
15421201 004          2
*
*       rel. source   interval
15421301 1.           2
*
15421400 -1
*
*       mesh point temperatures
15421401 196.10      198.57      200.90
15421402 196.69      198.94      201.05
15421403 214.70      221.16      227.25
15421404 225.70      230.12      234.28
15421405 232.97      235.92      238.70
15421406 238.11      240.19      242.15
```

```
15421407 240.94     242.10     243.09
15421408 242.41     243.03     243.55
15421409 243.10     243.41     243.71
15421410 243.58     243.77     243.95
*
*      lt.boundary    incr    bdry    code    factor  hs#
15421501 542010000     0      1      1      14906.7 1   *(1.5) 14906.7
15421502 542020000     0      1      1      13865.0 2   *(1.5) 13865.0
15421503 542030000     0      1      1      13865.0 3   *(1.0) 13865.0
15421504 542040000     0      1      1      13865.0 4   *(1.0) 13865.0
15421505 542050000     0      1      1      13865.0 5   *(1.0) 13865.0
15421506 542060000     0      1      1      13865.0 6   *(1.0) 13865.0
15421507 542070000     0      1      1      13865.0 7   *(1.0) 13865.0
15421508 542080000     0      1      1      13865.0 8   *(1.0) 13865.0
15421509 542090000     0      1      1      13865.0 9   *(1.0) 13865.0
15421510 542100000     0      1      1      14906.7 10  *(1.0) 13865.0
*
*
*      rt.boundary    incr    bdry    code    factor  hs#
15421601 953010000     0      1      1      14906.7 1   *(1.5) 14906.7
15421602 953010000     0      1      1      13865.0 2   *(1.5) 13865.0
15421603 952010000     0      1      1      13865.0 3   *(1.0) 13865.0
15421604 952010000     0      1      1      13865.0 4   *(1.0) 13865.0
15421605 952010000     0      1      1      13865.0 5   *(1.0) 13865.0
15421606 951010000     0      1      1      13865.0 6   *(1.0) 13865.0
15421607 951010000     0      1      1      13865.0 7   *(1.0) 13865.0
15421608 951010000     0      1      1      13865.0 8   *(1.0) 13865.0
15421609 950010000     0      1      1      13865.0 9   *(1.0) 13865.0
15421610 950010000     0      1      1      14906.7 10  *(1.0) 14906.7
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15421701 0            0.0     0.0     0.0     10
*
*      hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15421801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15421802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15421803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15421901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 550-1  RFW Heater A3 Tubes
*      nh     np     geom   init   lt.coord
15501000 12     3      2      1      0.0231
*
```

```
*       mesh loc'n    format
15501100 0          1
*
*       # intervals   rt.coord
15501101 2          0.026
*
*       comp #       inter#(in)
15501201 004          2
*
*       rel. source   interval
15501301 1.          2
*
15501400 -1
*
*       mesh point temperatures
15501401 246.43     247.53     248.56
15501402 246.17     246.52     246.83
15501403 247.68     248.25     248.78
15501404 269.73     276.87     283.59
15501405 281.70     286.31     290.65
15501406 289.69     292.67     295.49
15501407 294.81     296.72     298.52
15501408 297.99     299.19     300.32
15501409 298.66     299.68     300.63
15501410 298.35     298.90     299.40
15501411 297.82     297.95     298.06
15501412 297.58     297.58     297.58
*
*       lt.boundary    incr    bdry    code    factor  hs#
15501501 550010000     0       1       1       21221.2 1   *(1.5) 14147.5
15501502 550020000     0       1       1       19721.3 2   *(1.5) 13147.5
15501503 550030000     0       1       1       8388.0  3   *(1.0) 5592.0
15501504 550040000     0       1       1       5592.0  4   *(1.0) 5592.0
15501505 550050000     0       1       1       20715.2 5   *(1.0) 20715.2
15501506 550060000     0       1       1       20715.2 6   *(1.0) 20715.2
15501507 550070000     0       1       1       20715.2 7   *(1.0) 20715.2
15501508 550080000     0       1       1       20715.2 8   *(1.0) 20715.2
15501509 550090000     0       1       1       5592.0  9   *(1.0) 5592.0
15501510 550100000     0       1       1       5592.0  10  *(1.0) 5592.0
15501511 550110000     0       1       1       13147.5 11  *(1.0) 13147.5
15501512 550120000     0       1       1       14147.5 12  *(1.0) 14147.5
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15501601 743030000     0       1       1       21221.2 1   *(1.5) 14147.5
```

```
15501602 743020000     0      1      1       19721.3 2   *(1.5) 13147.5
15501603 743010000     0      1      1       8388.0  3   *(1.0) 5592.0
15501604 742010000     0      1      1       5592.0  4   *(1.0) 5592.0
15501605 741010000     0      1      1       20715.2 5   *(1.0) 20715.2
15501606 740010000     0      1      1       20715.2 6   *(1.0) 20715.2
15501607 740010000     0      1      1       20715.2 7   *(1.0) 20715.2
15501608 741010000     0      1      1       20715.2 8   *(1.0) 20715.2
15501609 742010000     0      1      1       5592.0  9   *(1.0) 5592.0
15501610 742020000     0      1      1       5592.0  10  *(1.0) 5592.0
15501611 742030000     0      1      1       13147.5 11  *(1.0) 13147.5
15501612 742040000     0      1      1       14147.5 12  *(1.0) 14147.5
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15501701 0            0.0     0.0     0.0     12
*
*      hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15501801 0.0     4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15501802 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
15501803 0.0     100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15501901 0.0     100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 551-1  RFW Heater B3 Tubes
*      nh     np     geom   init   lt.coord
15511000 12    3      2      1      0.0231
*
*      mesh loc'n    format
15511100 0           1
*
*      # intervals   rt.coord
15511101 2           0.026
*
*      comp #        inter#(in)
15511201 004          2
*
*      rel. source   interval
15511301 1.          2
*
15511400 -1
*
*      mesh point temperatures
15511401 246.43      247.53      248.56
15511402 246.17      246.52      246.83
15511403 247.68      248.25      248.78
```

```
15511404 269.73     276.87     283.59
15511405 281.70     286.31     290.65
15511406 289.69     292.67     295.49
15511407 294.81     296.72     298.52
15511408 297.99     299.19     300.32
15511409 298.66     299.68     300.63
15511410 298.35     298.90     299.40
15511411 297.82     297.95     298.06
15511412 297.58     297.58     297.58
*
*      lt.boundary   incr   bdry   code   factor  hs#
15511501 551010000     0      1      1      21221.2 1   *(1.5) 14147.5
15511502 551020000     0      1      1      19721.3 2   *(1.5) 13147.5
15511503 551030000     0      1      1      8388.0  3   *(1.0) 5592.0
15511504 551040000     0      1      1      5592.0  4   *(1.0) 5592.0
15511505 551050000     0      1      1      20715.2 5   *(1.0) 20715.2
15511506 551060000     0      1      1      20715.2 6   *(1.0) 20715.2
15511507 551070000     0      1      1      20715.2 7   *(1.0) 20715.2
15511508 551080000     0      1      1      20715.2 8   *(1.0) 20715.2
15511509 551090000     0      1      1      5592.0  9   *(1.0) 5592.0
15511510 551100000     0      1      1      5592.0  10  *(1.0) 5592.0
15511511 551110000     0      1      1      13147.5 11  *(1.0) 13147.5
15511512 551120000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*
*      rt.boundary   incr   bdry   code   factor  hs#
15511601 843030000     0      1      1      21221.2 1   *(1.5) 14147.5
15511602 843020000     0      1      1      19721.3 2   *(1.5) 13147.5
15511603 843010000     0      1      1      8388.0  3   *(1.0) 5592.0
15511604 842010000     0      1      1      5592.0  4   *(1.0) 5592.0
15511605 841010000     0      1      1      20715.2 5   *(1.0) 20715.2
15511606 840010000     0      1      1      20715.2 6   *(1.0) 20715.2
15511607 840010000     0      1      1      20715.2 7   *(1.0) 20715.2
15511608 841010000     0      1      1      20715.2 8   *(1.0) 20715.2
15511609 842010000     0      1      1      5592.0  9   *(1.0) 5592.0
15511610 842020000     0      1      1      5592.0  10  *(1.0) 5592.0
15511611 842030000     0      1      1      13147.5 11  *(1.0) 13147.5
15511612 842040000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15511701 0             0.0     0.0     0.0     12
*
*      hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15511801 0.0      4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15511802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
```

```
15511803 0.0      100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15511901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 552-1  RFW Heater C3 Tubes
*       nh     np     geom   init   lt.coord
15521000 12     3      2      1      0.0231
*
*       mesh loc'n    format
15521100 0            1
*
*       # intervals   rt.coord
15521101 2            0.026
*
*       comp #        inter#(in)
15521201 004          2
*
*       rel. source   interval
15521301 1.           2
*
15521400 -1
*
*       mesh point temperatures
15521401 246.43      247.53      248.56
15521402 246.17      246.52      246.83
15521403 247.68      248.25      248.78
15521404 269.73      276.87      283.59
15521405 281.70      286.31      290.65
15521406 289.69      292.67      295.49
15521407 294.81      296.72      298.52
15521408 297.99      299.19      300.32
15521409 298.66      299.68      300.63
15521410 298.35      298.90      299.40
15521411 297.82      297.95      298.06
15521412 297.58      297.58      297.58
*
*       lt.boundary    incr    bdry    code    factor  hs#
15521501 552010000     0       1       1       21221.2 1   *(1.5) 14147.5
15521502 552020000     0       1       1       19721.3 2   *(1.5) 13147.5
15521503 552030000     0       1       1       8388.0  3   *(1.0) 5592.0
15521504 552040000     0       1       1       5592.0  4   *(1.0) 5592.0
15521505 552050000     0       1       1       20715.2 5   *(1.0) 20715.2
15521506 552060000     0       1       1       20715.2 6   *(1.0) 20715.2
15521507 552070000     0       1       1       20715.2 7   *(1.0) 20715.2
```

```
15521508 552080000     0      1      1       20715.2 8   *(1.0) 20715.2
15521509 552090000     0      1      1       5592.0  9   *(1.0) 5592.0
15521510 552100000     0      1      1       5592.0  10  *(1.0) 5592.0
15521511 552110000     0      1      1       13147.5 11  *(1.0) 13147.5
15521512 552120000     0      1      1       14147.5 12  *(1.0) 14147.5
*
*
*       rt.boundary   incr   bdry   code   factor  hs#
15521601 943030000     0      1      1       21221.2 1   *(1.5) 14147.5
15521602 943020000     0      1      1       19721.3 2   *(1.5) 13147.5
15521603 943010000     0      1      1       8388.0  3   *(1.0) 5592.0
15521604 942010000     0      1      1       5592.0  4   *(1.0) 5592.0
15521605 941010000     0      1      1       20715.2 5   *(1.0) 20715.2
15521606 940010000     0      1      1       20715.2 6   *(1.0) 20715.2
15521607 940010000     0      1      1       20715.2 7   *(1.0) 20715.2
15521608 941010000     0      1      1       20715.2 8   *(1.0) 20715.2
15521609 942010000     0      1      1       5592.0  9   *(1.0) 5592.0
15521610 942020000     0      1      1       5592.0  10  *(1.0) 5592.0
15521611 942030000     0      1      1       13147.5 11  *(1.0) 13147.5
15521612 942040000     0      1      1       14147.5 12  *(1.0) 14147.5
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15521701 0            0.0     0.0     0.0     12
*
*       hed     hlf     hlr     gslf   gslr   gkf  gkr  lbf   hs#
15521801 0.0      4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15521802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
15521803 0.0      100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15521901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 590-1  RFW Heater A2 Tubes
*       nh     np     geom   init   lt.coord
15901000 10     3      2      1      0.022
*
*       mesh loc'n    format
15901100 0            1
*
*       # intervals   rt.coord
15901101 2            0.026
*
*       comp #        inter#(in)
15901201 004          2
*
```

```
*       rel. source   interval
15901301 1.           2
*
15901400 -1
*
*       mesh point temperatures
15901401 303.62      304.79      305.86
15901402 306.11      307.75      309.25
15901403 318.82      324.86      330.41
15901404 328.06      331.84      335.32
15901405 333.40      335.65      337.72
15901406 336.33      337.62      338.81
15901407 337.88      338.59      339.25
15901408 338.29      338.84      339.35
15901409 337.26      337.13      337.02
15901410 335.67      335.19      334.76
*
*       lt.boundary    incr    bdry    code    factor  hs#
15901501 590010000      0       1       1       14896.8 1   *(1.5) 11917.5
15901502 590020000      0       1       1       7147.5  2   *(1.5) 5718.0
15901503 590030000      0       1       1       7147.5  3   *(1.5) 5718.0
15901504 590040000      0       1       1       21147.8 4   *(1.5) 16918.2
15901505 590050000      0       1       1       21147.8 5   *(1.5) 16918.2
15901506 590060000      0       1       1       21147.8 6   *(1.5) 16918.2
15901507 590070000      0       1       1       21147.8 7   *(1.5) 16918.2
15901508 590080000      0       1       1       7147.5  8   *(1.5) 5718.0
15901509 590090000      0       1       1       7147.5  9   *(1.5) 5718.0
15901510 590100000      0       1       1       14896.8 10  *(1.5) 11917.5
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15901601 733010000      0       1       1       14896.8 1   *(1.5) 11917.5
15901602 732020000      0       1       1       7147.5  2   *(1.5) 5718.0
15901603 732010000      0       1       1       7147.5  3   *(1.5) 5718.0
15901604 731010000      0       1       1       21147.8 4   *(1.5) 16918.2
15901605 730010000      0       1       1       21147.8 5   *(1.5) 16918.2
15901606 730010000      0       1       1       21147.8 6   *(1.5) 16918.2
15901607 731010000      0       1       1       21147.8 7   *(1.5) 16918.2
15901608 732010000      0       1       1       7147.5  8   *(1.5) 5718.0
15901609 732020000      0       1       1       7147.5  9   *(1.5) 5718.0
15901610 733010000      0       1       1       14896.8 10  *(1.5) 11917.5
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15901701 0            0.0     0.0     0.0     10
*
```

```
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15901801 0.0      3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15901802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15901803 0.0      100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15901901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 591-1  RFW Heater B2 Tubes
*       nh     np     geom   init   lt.coord
15911000 10    3      2      1      0.022
*
*       mesh loc'n    format
15911100 0            1
*
*       # intervals   rt.coord
15911101 2            0.026
*
*       comp #       inter#(in)
15911201 004          2
*
*       rel. source   interval
15911301 1.           2
*
15911400 -1
*
*       mesh point temperatures
15911401 303.62      304.79      305.86
15911402 306.11      307.75      309.25
15911403 318.82      324.86      330.41
15911404 328.06      331.84      335.32
15911405 333.40      335.65      337.72
15911406 336.33      337.62      338.81
15911407 337.88      338.59      339.25
15911408 338.29      338.84      339.35
15911409 337.26      337.13      337.02
15911410 335.67      335.19      334.76
*
*       lt.boundary    incr    bdry    code    factor  hs#
15911501 591010000      0       1       1       14896.8 1   *(1.5) 11917.5
15911502 591020000      0       1       1       7147.5  2   *(1.5) 5718.0
15911503 591030000      0       1       1       7147.5  3   *(1.5) 5718.0
15911504 591040000      0       1       1       21147.8 4   *(1.5) 16918.2
15911505 591050000      0       1       1       21147.8 5   *(1.5) 16918.2
15911506 591060000      0       1       1       21147.8 6   *(1.5) 16918.2
```

```
15911507 591070000     0     1     1     21147.8 7   *(1.5) 16918.2
15911508 591080000     0     1     1     7147.5  8   *(1.5) 5718.0
15911509 591090000     0     1     1     7147.5  9   *(1.5) 5718.0
15911510 591100000     0     1     1     14896.8 10  *(1.5) 11917.5
*
*
*      rt.boundary   incr   bdry   code   factor  hs#
15911601 833010000     0     1     1     14896.8 1   *(1.5) 11917.5
15911602 832020000     0     1     1     7147.5  2   *(1.5) 5718.0
15911603 832010000     0     1     1     7147.5  3   *(1.5) 5718.0
15911604 831010000     0     1     1     21147.8 4   *(1.5) 16918.2
15911605 830010000     0     1     1     21147.8 5   *(1.5) 16918.2
15911606 830010000     0     1     1     21147.8 6   *(1.5) 16918.2
15911607 831010000     0     1     1     21147.8 7   *(1.5) 16918.2
15911608 832010000     0     1     1     7147.5  8   *(1.5) 5718.0
15911609 832020000     0     1     1     7147.5  9   *(1.5) 5718.0
15911610 833010000     0     1     1     14896.8 10  *(1.5) 11917.5
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15911701 0             0.0     0.0     0.0     10
*
*      hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15911801 0.0      3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15911802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15911803 0.0      100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15911901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 592-1  RFW Heater C2 Tubes
*      nh    np    geom   init   lt.coord
15921000 10    3     2     1     0.022
*
*      mesh loc'n    format
15921100 0           1
*
*      # intervals   rt.coord
15921101 2           0.026
*
*      comp #       inter#(in)
15921201 004          2
*
*      rel. source   interval
15921301 1.          2
*
```

```
15921400 -1
*
*       mesh point temperatures
15921401 303.62      304.79      305.86
15921402 306.11      307.75      309.25
15921403 318.82      324.86      330.41
15921404 328.06      331.84      335.32
15921405 333.40      335.65      337.72
15921406 336.33      337.62      338.81
15921407 337.88      338.59      339.25
15921408 338.29      338.84      339.35
15921409 337.26      337.13      337.02
15921410 335.67      335.19      334.76
*
*       lt.boundary   incr   bdry   code   factor  hs#
15921501 592010000     0      1      1      14896.8 1   *(1.5) 11917.5
15921502 592020000     0      1      1      7147.5  2   *(1.5) 5718.0
15921503 592030000     0      1      1      7147.5  3   *(1.5) 5718.0
15921504 592040000     0      1      1      21147.8 4   *(1.5) 16918.2
15921505 592050000     0      1      1      21147.8 5   *(1.5) 16918.2
15921506 592060000     0      1      1      21147.8 6   *(1.5) 16918.2
15921507 592070000     0      1      1      21147.8 7   *(1.5) 16918.2
15921508 592080000     0      1      1      7147.5  8   *(1.5) 5718.0
15921509 592090000     0      1      1      7147.5  9   *(1.5) 5718.0
15921510 592100000     0      1      1      14896.8 10  *(1.5) 11917.5
*
*
*       rt.boundary   incr   bdry   code   factor  hs#
15921601 933010000     0      1      1      14896.8 1   *(1.5) 11917.5
15921602 932020000     0      1      1      7147.5  2   *(1.5) 5718.0
15921603 932010000     0      1      1      7147.5  3   *(1.5) 5718.0
15921604 931010000     0      1      1      21147.8 4   *(1.5) 16918.2
15921605 930010000     0      1      1      21147.8 5   *(1.5) 16918.2
15921606 930010000     0      1      1      21147.8 6   *(1.5) 16918.2
15921607 931010000     0      1      1      21147.8 7   *(1.5) 16918.2
15921608 932010000     0      1      1      7147.5  8   *(1.5) 5718.0
15921609 932020000     0      1      1      7147.5  9   *(1.5) 5718.0
15921610 933010000     0      1      1      14896.8 10  *(1.5) 11917.5
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15921701 0             0.0     0.0     0.0     10
*
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15921801 0.0      3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15921802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
```

```
15921803 0.0      100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15921901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 600-1  RFW Heater A1 Tubes
*       nh     np     geom   init   lt.coord
16001000 10     3      2      1      0.022
*
*       mesh loc'n    format
16001100 0            1
*
*       # intervals   rt.coord
16001101 2            0.026
*
*       comp #       inter#(in)
16001201 004           2
*
*       rel. source   interval
16001301 1.           2
*
16001400 -1
*
*       mesh point temperatures
16001401 334.73      337.01      339.10
16001402 342.92      348.65      353.94
16001403 350.65      358.47      365.67
16001404 361.40      366.91      372.00
16001405 370.28      374.50      378.38
16001406 375.68      378.54      381.17
16001407 378.82      380.63      382.30
16001408 379.67      381.32      382.84
16001409 377.60      377.59      377.59
16001410 374.79      373.19      371.71
*
*       lt.boundary    incr    bdry    code    factor  hs#
16001501 600010000     0       1       1       5963.7  1   *(1.5) 3975.8
16001502 600020000     0       1       1       7624.0  2   *(1.5) 5082.7
16001503 600030000     0       1       1       7624.0  3   *(1.5) 5082.7
16001504 600040000     0       1       1       29904.1 4   *(1.5) 19936.1
16001505 600050000     0       1       1       29904.1 5   *(1.5) 19936.1
16001506 600060000     0       1       1       29904.1 6   *(1.5) 19936.1
16001507 600070000     0       1       1       29904.1 7   *(1.5) 19936.1
16001508 600080000     0       1       1       7624.0  8   *(1.5) 5082.7
16001509 600090000     0       1       1       7624.0  9   *(1.5) 5082.7
```

```
16001510 600100000     0      1      1      5963.7  10  *(1.5) 3975.8
*
*
*      rt.boundary    incr    bdry    code    factor  hs#
16001601 722010000     0      1      1      5963.7  1   *(1.5) 3975.8
16001602 721030000     0      1      1      7624.0  2   *(1.5) 5082.7
16001603 721020000     0      1      1      7624.0  3   *(1.5) 5082.7
16001604 721010000     0      1      1      29904.1 4   *(1.5) 19936.1
16001605 720010000     0      1      1      29904.1 5   *(1.5) 19936.1
16001606 720010000     0      1      1      29904.1 6   *(1.5) 19936.1
16001607 721010000     0      1      1      29904.1 7   *(1.5) 19936.1
16001608 721020000     0      1      1      7624.0  8   *(1.5) 5082.7
16001609 721030000     0      1      1      7624.0  9   *(1.5) 5082.7
16001610 722010000     0      1      1      5963.7  10  *(1.5) 3975.8
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
16001701 0            0.0     0.0     0.0     10
*
*      hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
16001801 0.0     1.4206  100.0  100.0  100.0  0.0  0.0  1.0   01
16001802 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
16001803 0.0     100.0   1.4206 100.0  100.0  0.0  0.0  1.0   10
*
16001901 0.0     100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 601-1  RFW Heater B1 Tubes
*      nh    np    geom   init   lt.coord
16011000 10    3     2     1     0.022
*
*      mesh loc'n    format
16011100 0           1
*
*      # intervals   rt.coord
16011101 2           0.026
*
*      comp #       inter#(in)
16011201 004          2
*
*      rel. source   interval
16011301 1.          2
*
16011400 -1
*
*      mesh point temperatures
```

```
16011401 334.73     337.01     339.10
16011402 342.92     348.65     353.94
16011403 350.65     358.47     365.67
16011404 361.40     366.91     372.00
16011405 370.28     374.50     378.38
16011406 375.68     378.54     381.17
16011407 378.82     380.63     382.30
16011408 379.67     381.32     382.84
16011409 377.60     377.59     377.59
16011410 374.79     373.19     371.71
*
*     lt.boundary   incr   bdry   code   factor  hs#
16011501 601010000    0     1     1     5963.7  1   *(1.5) 3975.8
16011502 601020000    0     1     1     7624.0  2   *(1.5) 5082.7
16011503 601030000    0     1     1     7624.0  3   *(1.5) 5082.7
16011504 601040000    0     1     1     29904.1 4   *(1.5) 19936.1
16011505 601050000    0     1     1     29904.1 5   *(1.5) 19936.1
16011506 601060000    0     1     1     29904.1 6   *(1.5) 19936.1
16011507 601070000    0     1     1     29904.1 7   *(1.5) 19936.1
16011508 601080000    0     1     1     7624.0  8   *(1.5) 5082.7
16011509 601090000    0     1     1     7624.0  9   *(1.5) 5082.7
16011510 601100000    0     1     1     5963.7  10  *(1.5) 3975.8
*
*
*     rt.boundary   incr   bdry   code   factor  hs#
16011601 822010000    0     1     1     5963.7  1   *(1.5) 3975.8
16011602 821030000    0     1     1     7624.0  2   *(1.5) 5082.7
16011603 821020000    0     1     1     7624.0  3   *(1.5) 5082.7
16011604 821010000    0     1     1     29904.1 4   *(1.5) 19936.1
16011605 820010000    0     1     1     29904.1 5   *(1.5) 19936.1
16011606 820010000    0     1     1     29904.1 6   *(1.5) 19936.1
16011607 821010000    0     1     1     29904.1 7   *(1.5) 19936.1
16011608 821020000    0     1     1     7624.0  8   *(1.5) 5082.7
16011609 821030000    0     1     1     7624.0  9   *(1.5) 5082.7
16011610 822010000    0     1     1     5963.7  10  *(1.5) 3975.8
*
*     src.type     s.mult  dh-lt   dh-rt   hs#
16011701 0           0.0     0.0     0.0     10
*
*     hed    hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
16011801 0.0     1.4206  100.0  100.0  100.0  0.0  0.0  1.0   01
16011802 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
16011803 0.0     100.0   1.4206 100.0  100.0  0.0  0.0  1.0   10
*
16011901 0.0     100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
```

```
*
*
* heat structure 602-1  RFW Heater C1 Tubes
*       nh     np     geom   init   lt.coord
16021000 10     3      2      1      0.022
*
*       mesh loc'n    format
16021100 0            1
*
*       # intervals   rt.coord
16021101 2            0.026
*
*       comp #        inter#(in)
16021201 004          2
*
*       rel. source   interval
16021301 1.           2
*
16021400 -1
*
*       mesh point temperatures
16021401 334.73     337.01     339.10
16021402 342.92     348.65     353.94
16021403 350.65     358.47     365.67
16021404 361.40     366.91     372.00
16021405 370.28     374.50     378.38
16021406 375.68     378.54     381.17
16021407 378.82     380.63     382.30
16021408 379.67     381.32     382.84
16021409 377.60     377.59     377.59
16021410 374.79     373.19     371.71
*
*       lt.boundary    incr    bdry    code    factor  hs#
16021501 602010000     0       1       1       5963.7  1   *(1.5) 3975.8
16021502 602020000     0       1       1       7624.0  2   *(1.5) 5082.7
16021503 602030000     0       1       1       7624.0  3   *(1.5) 5082.7
16021504 602040000     0       1       1       29904.1 4   *(1.5) 19936.1
16021505 602050000     0       1       1       29904.1 5   *(1.5) 19936.1
16021506 602060000     0       1       1       29904.1 6   *(1.5) 19936.1
16021507 602070000     0       1       1       29904.1 7   *(1.5) 19936.1
16021508 602080000     0       1       1       7624.0  8   *(1.5) 5082.7
16021509 602090000     0       1       1       7624.0  9   *(1.5) 5082.7
16021510 602100000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*
```

```
*       rt.boundary    incr    bdry    code    factor  hs#
16021601 922010000     0       1       1       5963.7  1   *(1.5) 3975.8
16021602 921030000     0       1       1       7624.0  2   *(1.5) 5082.7
16021603 921020000     0       1       1       7624.0  3   *(1.5) 5082.7
16021604 921010000     0       1       1       29904.1 4   *(1.5) 19936.1
16021605 920010000     0       1       1       29904.1 5   *(1.5) 19936.1
16021606 920010000     0       1       1       29904.1 6   *(1.5) 19936.1
16021607 921010000     0       1       1       29904.1 7   *(1.5) 19936.1
16021608 921020000     0       1       1       7624.0  8   *(1.5) 5082.7
16021609 921030000     0       1       1       7624.0  9   *(1.5) 5082.7
16021610 922010000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
16021701 0            0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf    gslr    gkf    gkr   lbf   hs#
16021801 0.0    1.4206  100.0   100.0   100.0   0.0    0.0   1.0   01
16021802 0.0    100.0   100.0   100.0   100.0   0.0    0.0   1.0   09
16021803 0.0    100.0   1.4206  100.0   100.0   0.0    0.0   1.0   10
*
16021901 0.0    100.0   100.0   5.0     5.0     0.1    0.1   1.0   10
*
*
* heater tube thermal properties (type 304 stainless steel)
*-----------------------------------------------------------
*
20100400 tbl/fctn 1 1
* thermal conductivity (btu/s-ft-degf)
20100401 2.26e-3
*
* volumetric heat capacity (btu/ft**3-degf)
20100451 53.7
*
*
* tables of heater-tube heat flux [w/m**2] vs rx power [w]
*---------------------------------------------------------
*
* tables derived from refs. [188 - 193, 204, & 205] as per calcs. of app. d
*
* drain coolers
20258000 reac-t
20258009 3.293e9  31374. * jam
20258008 3.1284e9 29002. * jam
20258007 2.9637e9 26666. * jam
```

```
20258006 2.7991e9 24368. * jam
20258005 2.6344e9 21872. * jam
20258004 2.4698e9 19382. * jam
20258003 1.8384e9  9524. * jam
20258002 9.775e8   2047. * jam
20258001 0.        0.
*
*
*
* heater related control variables (tube powers [w])
*-----------------------------------------------------
*
* tube power = surface area * heat flux
*
* reactor power [w] = % rated power * rated power [w]
20580100  rxpower     mult  3.293e+07  3.3125499e+09 0
20580101 cntrlvar 010
*
* drain cooler (single)
20581600  pwrdc_s function  1.217e+03  3.8182160e+07 0
20581601 cntrlvar 801 580
*
* cntrlvar 0815: HTRA5 power (BTU/HR)
20581500  'HTR5-PWR' sum   3.414426   250700000.       0
20581501  0.0     1.0  q 530010000      1.0  q 530050000
20581502          1.0  q 530020000      1.0  q 530060000
20581503          1.0  q 530030000      1.0  q 530070000
20581504          1.0  q 530040000      1.0  q 530080000
*
* cntrlvar 0814: HTRA4 power (BTU/HR)
20581400  'HTR4-PWR' sum   3.414426   266000000.       0
20581401  0.0     1.0  q 540010000      1.0  q 540060000
20581402          1.0  q 540020000      1.0  q 540070000
20581403          1.0  q 540030000      1.0  q 540080000
20581404          1.0  q 540040000      1.0  q 540090000
20581405          1.0  q 540050000      1.0  q 540100000
*
* cntrlvar 0813: HTRA3 power (BTU/HR)
20581300  'HTR3-PWR' sum   3.414426   283000000.       0
20581301  0.0     1.0  q 550010000      1.0  q 550070000
20581302          1.0  q 550020000      1.0  q 550080000
20581303          1.0  q 550030000      1.0  q 550090000
20581304          1.0  q 550040000      1.0  q 550100000
20581305          1.0  q 550050000      1.0  q 550110000
```

```
20581306         1.0  q 550060000     1.0  q 550120000
*
* cntrlvar 0812: HTRA2 power (BTU/HR)
20581200  'HTR2-PWR' sum   3.414426   150800000.        0
20581201  0.0     1.0  q 590010000     1.0  q 590060000
20581202         1.0  q 590020000     1.0  q 590070000
20581203         1.0  q 590030000     1.0  q 590080000
20581204         1.0  q 590040000     1.0  q 590090000
20581205         1.0  q 590050000     1.0  q 590100000
*
* cntrlvar 811: HTRA1 power (BTU/HR)
20581100  'HTR1-PWR' sum   3.414426   227800000.        0
20581101  0.0     1.0  q 600010000     1.0  q 600060000
20581102         1.0  q 600020000     1.0  q 600070000
20581103         1.0  q 600030000     1.0  q 600080000
20581104         1.0  q 600040000     1.0  q 600090000
20581105         1.0  q 600050000     1.0  q 600100000
*
```

B

RELAP5 MODEL INPUT DECK WITH NEW RECIRCULATION CONTROLS

```
= brown's ferry relap5 plant model
* Full implementation of 3-train FW heaters
*
*card    prob type      transnt/stdy-st
*0000100      new           stdy-st
0000100      new           transnt
*0000100      restart       transnt
*
*card    inp-chk/run
0000101  run                                          *prb 01-24-96 10:13am
*
*card    input units    output units
0000102      british        british
*103 24012
*
*      restart file
*0000104 none *remove asterisk at beginning
*
*card    reference   elev     fluid     name
0000120      100010000   8.750        h2o      primary
0000121      960030000   597.020833     h2o       'FW-HTRS'
*
*
*-------------------------------------------------------------------------
*  time step control cards
*-------------------------------------------------------------------------
*card    end   min     max    cntrl   minor   major   restrt
0000201   1.00  1.e-6   0.025   00003   1000    2000    5000
0000201   200.  1.e-6   1.25e-2 00003   9000    14000   14000
*
*---------------
*  minor edits
*---------------
*
```

```
*0000301 cntrlvar 675       *stand alone
*0000301 cntrlvar 646       *labview
*0000302 cntrlvar 650
*0000303 cntrlvar 689
*0000305 mflowj   610012200      *HTR-A1 Feedwater flow (lb/sec)
*0000306 tempf    605010000     *HTR-A1 RFW outlet temperature
*0000310 cntrlvar 0306          *HTR-A1 level
*0000311 cntrlvar 0324          *HTR-A1 drain valve position
*0000312 cntrlvar 0811          *HTR-A1 power
*
*0000320 mflowj   588010000      *HTR-A2 Feedwater flow (lb/sec)
*0000321 tempf    595010000     *HTR-A2 RFW outlet temperature
*0000322 cntrlvar 0331          *HTR-A2 level
*0000323 cntrlvar 0349          *HTR-A2 drain valve position
*0000324 cntrlvar 0812          *HTR-A2 power
*
*0000330 mflowj   550010000      *HTR-A3 Feedwater flow (lb/sec)
*0000331 tempf    555010000     *HTR-A3 RFW outlet temperature
*0000332 cntrlvar 0361          *HTR-A3 level
*0000333 cntrlvar 0379          *HTR-A3 drain valve position
*0000334 cntrlvar 0813          *HTR-A3 power
*
*0000335 mflowj   540010000      *HTR-A4 Feedwater flow (lb/sec)
*0000336 tempf    545010000     *HTR-A4 RFW outlet temperature
*0000337 cntrlvar 0381          *HTR-A4 level
*0000338 cntrlvar 0399          *HTR-A4 drain valve position
*0000339 cntrlvar 0814          *HTR-A4 power
*
*0000340 mflowj   530010000      *HTR-A5 Feedwater flow (lb/sec)
*0000341 tempf    535010000     *HTR-A5 RFW outlet temperature
*0000342 cntrlvar 0410          *HTR-A5 level
*0000343 cntrlvar 0411          *HTR-A5 level lagged
*0000344 cntrlvar 0429          *HTR-A5 drain valve position
*0000345 cntrlvar 0815          *HTR-A5 power
*
* core flow [lbm/hr]
*20591500  coreflw     sum  7.930e+03  9.8994448e+07 0
*20591501 0. 1. mflowj 110010000 1. mflowj 110020000
*
*-----------------------------
* variable trip cards
*-----------------------------
*
* vessel level trips
```

```
0000401 cntrlvar        2 le     null        0 -1.2200e+02 n -1.0
0000402 cntrlvar        2 le     null        0 -4.5000e+01 n -1.0
0000403 cntrlvar        6 le     null        0  1.1200e+01 n -1.0
0000404 cntrlvar        7 le     null        0  2.7000e+01 n -1.0
0000405 cntrlvar        6 ge     null        0  5.1000e+01 n -1.0
0000406 cntrlvar        6 ge     null        0  5.5000e+01 l -1.0
*  ref. 55
*
* main turbine trips
0000407 cntrlvar      115 ge     null        0  1.0000e-01 l -1.0
*
* always true trip for tmdpjuns
0000408     time        0 ge     null        0   .0000e+00 l   .0
*
* always false for msiv open trip
0000409     time        0 ge     null        0  1.0000e+06 l -1.0
*
* msiv fast closure trips (all valves)
0000411 cntrlvar      500 le     null        0  8.5770e+02 l -1.0
* ref. 351, 358
*
* msiv single valve fast closure
0000415 cntrlvar      116 ge     null        0  1.0000e-01 l -1.0
*
* msiv single valve fast closure for dual msiv trip
0000416 cntrlvar      117 ge     null        0  1.0000e-01 l -1.0
*
* 30% permissive
0000417   mflowj 430000000 ge     null        0  1.1151e+03 n   .0
*   ref. 349
*
* recirc pump trips (both)
0000420     time        0 ge   timeof      402  1.7500e-01 l -1.0
0000421 cntrlvar       90 ge     null        0  1.1327e+03 n -1.0
0000422     time        0 ge   timeof      421  1.3500e-01 l -1.0
0000423 cntrlvar      114 ge     null        0  1.0000e-01 l -1.0
0000424     time        0 ge   timeof      640  1.6500e-01 l -1.0
* time for trip 424 based on 0.03 sec to tsv close setpt and 0.135 sec delay
* for recirc pump trip
*
* recirc pump a trip (single)
0000425 cntrlvar      113 ge     null        0  1.0000e-01 l -1.0
*
* 28% recirc pump runbacks (both)
```

```
0000427   mflowj 605040000 lt     null        0  7.4340e+02 n -1.0
0000430     time        0 ge   timeof      427  1.5000e+01 n -1.0
*
* RRP a 28% runback
0000431 cntrlvar       118 ge     null        0  1.0000e-01 n -1.0
*
* RRP b 28% runback
0000432 cntrlvar       119 ge     null        0  1.0000e-01 n -1.0
*
* RRP a seizure
0000433 cntrlvar       120 ge     null        0  1.0000e-01 l -1.0
*
* 75% recirc runback conditions
0000434   mflowj 570020000 lt     null        0  2.4780e+02 n -1.0
0000435   mflowj 571020000 lt     null        0  2.4780e+02 n -1.0
0000436   mflowj 572020000 lt     null        0  2.4780e+02 n -1.0
*
* feedwater single pump manual trips
0000437 cntrlvar       104 le     null        0  1.0000e-01 n -1.0
0000438 cntrlvar       105 le     null        0  1.0000e-01 n -1.0
0000439 cntrlvar       106 le     null        0  1.0000e-01 n -1.0
*
* manual hpci initiation
0000440 cntrlvar       121 ge     null        0  1.0000e-01 l -1.0
*
*manual RCIC initiation
0000442 cntrlvar       122 ge     null        0  1.0000e-01 l -1.0
*
* scram variable trips
0000445     time        0 ge   timeof      403  7.0000e-02 l -1.0
0000446 cntrlvar        90 ge     null        0  1.0577e+03 n -1.0
0000447     time        0 ge   timeof      605  4.5000e-01 l -1.0
* trip 447 assumes 4 sec msiv closure on trip, ref. 351 states 3 - 5 seconds
0000448 cntrlvar       123 ge     null        0  1.0000e-01 l -1.0
0000449     time        0 ge   timeof      640  8.0000e-02 l -1.0
0000450 cntrlvar        14 ge     null        0  1.1800e+02 l -1.0
0000451     time        0 ge   timeof      450  9.0000e-02 l -1.0
0000452     time        0 ge   timeof      446  7.0000e-02 l -1.0
* time delays on scram, except manual scram, include 0.05 sec time delay for
* scram solenoid deenergization per ref. 349
*
* srv setpoints
0000455        p 400010000 ge     null        0  1.1197e+03 n -1.0
0000456        p 400010000 ge     null        0  1.1297e+03 n -1.0
```

```
0000457       p 400010000 le     null        0  1.0860e+03 n   .0
0000458       p 400010000 le     null        0  1.0960e+03 n   .0
*
* condensate pump trips
0000460 cntrlvar       100 le     null        0  1.0000e-01 n -1.0
0000461 cntrlvar       101 le     null        0  1.0000e-01 n -1.0
*
* condensate booster pump trips
0000465 cntrlvar       102 le     null        0  1.0000e-01 n -1.0
0000466 cntrlvar       103 le     null        0  1.0000e-01 n -1.0
*
* small loca
0000468 cntrlvar       124 ge     null        0  1.0000e-01 l -1.0
*
* single element, feedwater pump control trips
0000470 cntrlvar       646 ge     null        0  9.0000e-01 n -1.0
* use 1st line with Labview, next line without Labview
*0000471 cntrlvar       631 lt     null        0  2.6762e+00 n -1.0 * steam flow lt 20%
0000471 cntrlvar       630 lt     null        0  2.6762e+00 n -1.0 * steam flow lt 20%
*
* trips to open minimum recirc valves in rfp trains
0000475   mflowj 570020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
0000476   mflowj 571020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
0000477   mflowj 572020000 le     null        0  1.6667e+02 n -1.0 * ref. 55
*
* trips to close minimum recirc valves in rfp trains
0000478   mflowj 570020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
0000479   mflowj 571020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
0000480   mflowj 572020000 ge     null        0  3.4444e+02 n   .0 * ref. 55
*
* runback reset trip
0000490 cntrlvar       125 ge     null        0   .9000e+00 n  -1.0 * when true, resets
*
* additional pump trips
0000501     time         0 le   timeof      614   .0000e+00 n   .0
0000502     time         0 le   timeof      612   .0000e+00 n   .0
0000506     time         0 le   timeof      460   .0000e+00 n   .0
0000507     time         0 le   timeof      461   .0000e+00 n   .0
0000508     time         0 le   timeof      465   .0000e+00 n   .0
0000509     time         0 le   timeof      466   .0000e+00 n   .0
*
* feed pump speed trips
0000510 pmpvel         570 lt   null        0     500.      n
0000511 pmpvel         571 lt   null        0     500.      n
```

```
0000512 pmpvel        572 lt   null        0     500.      n
*
* scram pump selection criteria
0000515 cntrlvar        7 le     null        0  1.1000e+01 n -1.0 * set scram response
0000516 time            0 le     timeof     649  6.0000e+01 n -1.0 * set scram response
0000517 cntrlvar        7 gt     cntrlvar   108  0.8        n -1.0 * reset scram response
0000518 time            0 gt     timeof     675  300.       l -1.0 * reset scram response
*
0000520 cntrlvar      675  gt     null        0  63.        n -1.0 *scram resp.
*
*------------------------------
* logic trip cards
*------------------------------
*
* main turbine trip
0000601  407  or  406 l  -1.0
*
* msiv fast closure (all vlvs)
0000605  401  or  411 l  -1.0
*
* recirc pumps trip (both)
0000610  420  or  422 l  -1.0
0000611  424  or  423 l  -1.0
0000612  610  or  611 l  -1.0
*
* recirc pump a trip
0000614  612  or  425 l  -1.0
*
* fw pump trips
0000618  437  or  406 n  -1.0
0000619  438  or  406 n  -1.0
0000620  439  or  406 n  -1.0
*
* 28% recirc pump runback, pump a
0000621  431  or  430 n  -1.0
*
* 28% recirc pump runback, pump b
0000622  432  or  430 n  -1.0
*
* 75% recirc pump runback
0000623  435  or  434 n  -1.0
0000624  623  or  436 n  -1.0
0000625  624 and  404 n  -1.0
*
```

```
* hpci initiation
0000629  440  or  402 n  -1.0
0000630  631  or  629 n  -1.0
0000631  630 and -405 n  -1.0
*
* inverse fwp trips for shell side ms tmdpjun's
632      -618 or -618 n  -1.0                 *jam 7-27-96
633      -619 or -619 n  -1.0                 *jam 7-27-96
634      -620 or -620 n  -1.0                 *jam 7-27-96
*
* rcic initiation
0000635  402  or  442 n  -1.0
0000636  637  or  635 n  -1.0
0000637  636 and -405 n  -1.0
*
* turbine stop valve closure and ge 30% flow
0000640  601 and  417 l  -1.0
*
* reactor scram
0000645  445  or  447 l  -1.0
0000646  448  or  449 l  -1.0
0000647  451  or  452 l  -1.0
0000648  645  or  646 l  -1.0
0000649  647  or  648 l  -1.0
*
* srv grp 1 lifted
0000655  656  or  455 n  -1.0
0000656  655 and -457 n  -1.0
*
* srv grp 2 lifted
0000660  661  or  456 n  -1.0
0000661  660 and -458 n  -1.0
*
* msiv single closure indication
0000665  415  or  605 l  -1.0 * single closure, ok
*
* msiv single closure for dual msiv trip w/ trip 665
0000666  416  or  605 l  -1.0 * single closure for dual trip, ok
*
* single element feed pump control
0000671  470  or  471 n  -1.0
*
* feed pump scram response
0000675  515  and 516 l  -1.0 * starts scram response
```

```
0000676  517  or  518 n  -1.0 * resets response, allowing pump restoration
0000677  675  and -676 n -1.0 * initially sets max pump speeds, all pumps
0000678  675  and 676 l  -1.0 * reset response in past
0000679  677  and -678 n -1.0 * imposes max pump speeds
*
* pump b response to scram
0000681  675  and -512 l -1.0 * initially drive b to 600 rpm
*
* pump a response to scram
0000682 -512  or  -511 n  0.0 * true if pmp b or c >500 rpm
0000684  682  and  675 l -1.0 * initially drives pmp a to 600 rpm
*
* additional runback trips to incorporate new reset button
* 28% runback trips, pump a
0000685  621  or   686 n  0.0 * used to init runback
0000686  685  and -490 n  -1.0
* 28% runback trips, pump b
0000687  622  or   688 n  0.0 * used to init runback
0000688  687  and -490 n  -1.0
** 75 % runback trips
0000689  625  or   690 n  0.0 * used to init runback
0000690  689  and -490 n  -1.0
*
0000691  510  or   684 n  -1.0
0000692  511  or   681 n  -1.0
*
*-------------------------
* control system general tables
*-------------------------
*
* recirc pmp speed controller function gen output (%) vs. spd controller outpt
*-------------------------------- ref. 349
20222000 reac-t
20222001 0.     0.
20222002 58.3   25.
20222003 84.2   50.
20222004 91.8367  69.64874
20222005 95.46  100.
20222006 97.04  160.
*
* recirc coupler torque first term vs. coupler slip, ref. 349
*--------------------------------
20224200 reac-t
20224201 0.        0.
```

```
20224202 4.1667e-2  2.0e-4
20224203 8.3333e-2  4.0046e-4
20224204 1.25e-1    6.0234e-4
20224205 2.0833e-1  1.0181e-3
20224206 2.5e-1     1.2375e-3
20224207 3.3333e-1  1.7185e-3
20224208 0.5        3.0e-3
20224209 0.75       6.6375e-3
20224210 .97982     1.3551e-2
*
* "normalized" recirc pump motor torque vs. % synchronous speed, ref. 349
*--------------------------------
20225400 reac-t
20225401 0.        0.8
20225402 40.       0.9
20225403 80.       1.6
20225404 95.6      2.2
20225405 98.0      1.0
20225406 100.      0.
20225407 102.      -1.
20225408 104.4     -2.2
20225409 120.      -1.6
20225410 160.      -0.9
20225411 200.      -0.8
*
* recirc pump motor torque multiplier vs generator rpm
*--------------------------------
20225800 reac-t
20225801 0.        0.
20225802 501.83    0.4015
20225803 607.11    0.5554
20225804 825.      1.0
*
* normalized load torque vs. % main turbine speed, ref. 349
*--------------------------------
20230000 reac-t
20230001 1.        -3.
20230002 94.       -2.
20230003 96.       -1.
20230004 98.       0.
20230005 100.      1.
20230006 102.      2.
20230007 199.      3.
*
```

```
* turbine control vlv linearization (function generator), ref. 349 and 17
*------------------------------------
20252000 reac-t
20252001 0.0       0.0
20252002 51.       20.
20252003 91.       40.
20252004 100.      52.2
20252005 102.      60.
20252006 111.      100.
*
* turbine control valve position multiplier vs. time since turbine trip
*------------------------------------
20252700 reac-t
20252701 0.0       1.0
20252702 0.1       0.0
*
* turbine normalized steam flow vs tcv position in %, ref. 349
*------------------------------------
20253500 reac-t
20253501 0.0   0.0
20253502 20.   0.51
20253503 40.   0.91
20253504 52.2  1.0
20253505 60.   1.02
20253506 100.  1.11
*
* single element controller gain based on # pumps and stm flow
*------------------------------------
20261700 reac-t
20261701 100.0  0.36364
20261702 101.338 0.36364
20261703 104.04  0.83333
20261704 116.0  0.83333
20261705 200.0  0.5
20261706 204.014 0.5
20261707 206.69  0.66667
20261708 210.04  0.74074
20261709 216.0  0.74074
20261710 300.0  0.57143
20261711 306.69 0.57143
20261712 310.04 0.74074
20261713 313.38 0.86957
*
* three element level controller gain based on steam flow in Mlbm/hr
```

```
*------------------------------------
20261800 reac-t
20261801 4.014 0.83333
20261802 6.690 0.74074
20261803 10.04 0.74074
20261804 13.38 0.86957
*
* three element steam/feed flow controller gain based on # pumps
*------------------------------------
20261900 reac-t
20261901 100.0  0.16667
20261902 216.0  0.16667
20261903 300.0  0.20
20261904 316.0  0.20
*
* lp delta enthalpy in turbine vs inlet pressure
*------------------------------------
20266300 reac-t
20266301  1.25   0.0
20266302  40.0   154.0
20266303  70.0   179.5
20266304  100.   199.0
20266305  130.   212.0
20266306  160.   220.0
20266307  180.   225.0
20266308  200.0  228.0
20266309  214.0  230.0
20266310  917.   222.
20266311  967.   264.5
*
*
*-------------------------
* control variables
*-------------------------
*20500000 999
*
* wide range level
*-----------------
*
* instantaneous wide range level
20500100   instwr      sum  1.000e+00  3.3058701e+01 0
20500101 -528.00  380.638  voidf  140010000
20500102          152.868  voidf  150010000 * inst zero @ 528 inches per ref 195
20500103          74.004   voidf  160010000
```

```
20500104          1.0     cntrlvar 866
*
*
20586600 addlevel      sum  2.678e+02   0. 0  1  .000e+00
20586601 -0.05    1.0   voidf 190010000
*
* lagged yarway wide range level
* this level detector also used for yarway narrow range control functions
20500200  wrlevel   lag  1.000e+00 3.3052502e+01 0  3 -1.550e+02  6.000e+01
20500201 1.0      cntrlvar 001  * ref. 349
*
* narrow range level
*-------------------
*
* lagged narrow range level
20500600  nrlevel     lag  1.00       33.0         0  3  -10.  70.
20500601 0.5      cntrlvar 001  *lag time const. per ref. 349
*
* dummy return control variable for labview to return level signal in
* stand alone mode
20500700 levelret constant  3.3000000e+01
*
* aprm scram setpoint
*--------------------
*
* total reactor power (lagged) in %, sensed rx power
20501000    rxpwr      lag  3.037e-08  1.0059400e+02 0
20501001 0.03     rktpow   0  * 100% = 3293mw, ref. 349
*
* combined recirc pump mass flows (lb/sec)
20501100 rcrcflow      sum  2.205e+00  9.7047197e+03 0
20501101 0.0      1.0      mflowj   230010000 * ref. 349
20501102          1.0      mflowj   280010000
*
* sensed percentage recirc flow
20501200 perrecrc      lag  1.053e-02  1.0219100e+02 0
20501201 0.5      cntrlvar 011 * ref. 349
*
* flow bias in percent
20501300  flobias      sum  1.000e+00   0. 0  3   .000e+00  5.800e+01
20501301 58.      -.58    cntrlvar 012  * aprm scram setpt per ref. 359, per
* bob stegl?
*
* aprm in percent including flow bias
```

```
20501400  aprmflo     sum  1.000e+00  1.0059400e+02 0
20501401 0.0      1.0     cntrlvar 010  * ref. 349, 359
20501402          1.0     cntrlvar 013
*
* reactor steam dome pressure (lagged)
*------------------------------------
20509000  rxpress     lag  1.450e-04  1.0233800e+03 0
20509001 0.5      p  190010000  * ref. 349
*
* dummy return control variable for labview to return pressure signal in
* stand alone mode
20509100 pressret constant  1.0233300e+03
*
*
* problem control inputs
*----------------------------------------------
*  note: some of these will not activate trips within the trip section
*  until the deck is altered for use with labview in the testing mode.
*
* condensate pump a control
20510000 condacnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate pump b/c control
20510100 condbcnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate booster pump a control
20510200 cndbacnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* condensate booster pump b/c control
20510300 cndbbcnt constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump a control
20510400 rfpacont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump b control
20510500 rfpbcont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* feedwater pump c control
20510600 rfpccont constant  1.0000000e+00 * 1.0 equals "run", 0.0 equals "tripped"
*
* manual speed setpoint, both recirc pumps
20510700 rrpmansp constant  9.7659264e+01
*
* level setpoint
```

```
20510800 lvlsetpt constant  3.3000000e+01 * ref. 348
*
* rod reactivity insertion rate (positive or negative)
20510900 reactrat constant   0.
*
* single rrp trip
20511300 sirrptrp constant   0. * 0. equals ok, 1.0 equals trip
*
* dual rrp trip
20511400 durrptrp constant   0. * 0. equals ok, 1.0 equals trip
*
* main turbine trip
20511500 mturbtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* single msiv trip
20511600 msiv1trp constant   0. * 0. equals ok, 1.0 equals trip
*
* single msiv trip
20511700 msiv2trp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp a runback trip
20511800 rrpartrp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp b runback trip
20511900 rrpbrtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* rrp seizure trip
20512000 rrpseize constant   0. * 0. equals ok, 1.0 equals trip
*
* hpci trip
20512100 hpci_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* rcic trip
20512200 rcic_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* scram trip
20512300 scramtrp constant   0. * 0. equals ok, 1.0 equals trip
*
* loca trip
20512400 loca_trp constant   0. * 0. equals ok, 1.0 equals trip
*
* runback reset
20512500 runbkrst constant   0. * 0. equals no reset action
*
```

```
*
* inverse scram response tripunit
20520000 negscrtr tripunit   1.0           1.  0
20520001 -679
*
* recirc pump speeds, all ref. 349 uno
*----------------------------------------------
*
* tripunit for large torque during pump a seizure
20520200 seizurea tripunit  1.500e+05   0. 0 * s is adjustable
20520201 433
*
*
* recirc pumps speed demand limiters
*
* 28% runback trip unit, pump a
20520800  trip28a tripunit  1.000e+00   0. 0
20520801 685
*
* 28% runback trip unit, pump b
20520900  trip28b tripunit  1.000e+00   0. 0
20520901 687
*
* 28% limiter, pump a
20521000   lim28a      sum  1.000e+00  1.2800000e+02 0
20521001 128.0    -100.   cntrlvar 208  * =128 for no runback, 28 @ runback
*
* 28% limiter, pump b
20521100   lim28b      sum  1.000e+00  1.2800000e+02 0
20521101 128.0    -100.   cntrlvar 209  * =128 for no runback, 28 @ runback
*
* 75% runback trip unit
20521200   trip75 tripunit  1.000e+00   0. 0
20521201 689
*
* 75% limiter, both pumps
20521300    lim75      sum  1.000e+00  1.7500000e+02 0
20521301 175.     -100.   cntrlvar 212  * 175 for no runback, 75 @ runback
*
* recirc pump a demand limiter (in %)
20521400  admdlim stdfnctn  1.000e+00  9.7659302e+01 0
20521401 min      cntrlvar 213
20521402          cntrlvar 210
20521403          cntrlvar 107
```

```
*
* recirc pump b demand limiter (in %)
20521500  bdmdlim stdfnctn  1.000e+00  9.7659302e+01 0
20521501 min      cntrlvar 213
20521502          cntrlvar 211
20521503          cntrlvar 107
*
* recirc pumps speed controllers
*
* recirc pump a speed error
20521600 rrpaspde      sum  1.000e+00  3.6342631e-04 0  3 -1.000e+01  1.000e+01
20521601 0.0      1.0      cntrlvar 214
20521602         -.0906924 cntrlvar 252
*
* recirc pump b speed error
20521700 rrpbspde      sum  1.000e+00  3.6342631e-04 0  3 -1.000e+01  1.000e+01
20521701 0.0      1.0      cntrlvar 215
20521702         -.0906924 cntrlvar 253
*
* recirc pump a speed controller integral term
20521800 rpascint integral  2.712e-02  8.9533699e+01 0  3      0.0     100.0
20521801 cntrlvar 216
*
* recirc pump b speed controller integral term
20521900 rpbscint integral  2.712e-02  8.9533699e+01 0  3      0.0     100.0
20521901 cntrlvar 217
*
* recirc pump a speed controller
20522000 rpascont      sum  1.000e+00  8.9533798e+01 0  3      0.0     100.0
20522001 0.0      0.3      cntrlvar 216 * jam
20522002          1.0      cntrlvar 218
*
* recirc pump b speed controller
20522100 rpbscont      sum  1.000e+00  8.9533798e+01 0  3      0.0     100.0
20522101 0.0      0.3      cntrlvar 217 * jam
20522102          1.0      cntrlvar 219
*
*
* recirc pump a generator speed in rpm
* s=conversion from 0-100% controller output to 0-1800 rpm generator speed
20525200 rpagensp      lag     18.0    1.0768101e+03   0
20525201 1.0    cntrlvar 220    * 1.0 sec lag assumed   prb/jam
*
* recirc pump b generator speed in rpm
```

```
* s=conversion from 0-100% controller output to 0-1800 rpm generator speed
20525300 rpbgensp      lag     18.0    1.0768101e+03   0
20525301 1.0    cntrlvar 221    * 1.0 sec lag assumed   prb/jam
*
* recirc pump motor torques
*
* recirc pump a percent of synchronous speed
* s= (gen synch speed @ no load)/(mtr synch speed at no load) * 100 * (60/2pi)
* generator no load speed is 1200 rpm, mtr no load synch speed is 1800 rpm,
* 100 converts to percent and (60/2pi) converts pmpvel from rad/s to rpm.
20525400 rpasynch      div  6.366e+02  9.7945000e+01 0
20525401 cntrlvar 252  pmpvel   230
*
* recirc pump b percent of synchronous speed
* s= (gen synch speed @ no load)/(mtr synch speed at no load) * 100 * (60/2pi)
* generator no load speed is 1200 rpm, mtr no load synch speed is 1800 rpm,
* 100 converts to percent and (60/2pi) converts pmpvel from rad/s to rpm.
20525500 rpbsynch      div  6.366e+02  9.7945000e+01 0
20525501 cntrlvar 253  pmpvel   280
*
* recirc pump a motor torque in lbf*ft at 100% speed
* s = 0.5 (value from ref. 349) since single pump instead of double pump
20525600 rpamtrtq function  2.245e+04  2.3067900e+04 0
20525601 cntrlvar 254  254
*
* recirc pump b motor torque in lbf*ft at 100% speed
* s = 0.5 (value from ref. 349) since single pump instead of double pump
20525700 rpbmtrtq function  2.245e+04  2.3067900e+04 0
20525701 cntrlvar 255  254
*
* recirc pump a motor torque multiplier for speed
20525800 ratrqmul function  1.000e+00  1.0000000e+00 0
20525801 cntrlvar 252  258
*
* recirc pump b motor torque multiplier for speed
20525900 rbtrqmul function  1.000e+00  1.0000000e+00 0
20525901 cntrlvar 253  258
*
* recirc pump a motor torque
20526000 rpamtrtq     mult  1.000e+00  2.3067900e+04 0
20526001 cntrlvar 256  cntrlvar 258
*
* recirc pump b motor torque
20526100 rpbmtrtq     mult  1.000e+00  2.3067900e+04 0
```

```
20526101 cntrlvar 257  cntrlvar 259
*
*
* recirc pump speeds (with no trip)
*
* recirc pump a torque difference in lbf*ft
20526200 rpadlttq      sum  1.000e+00 -4.8878230e-03 0
20526201 0.0       1.0       cntrlvar 260
20526202           0.7376    pmptrq   230 * conversion factor is n*m to lbf*ft
20526203          -1.0       cntrlvar 202 * applies large stopping torque for
*                                  seizure of pump a
*
* recirc pump b torque difference in lbf*ft
20526300 rpbdlttq      sum  1.000e+00 -4.8878230e-03 0
20526301 0.0       1.0       cntrlvar 261
20526302           0.7376    pmptrq   280 * conversion factor is n*m to lbf*ft
*
* recirc pump a speed with no pump trip
* s={(60/2pi)(32.174)[(19,175 lb*ft**2)**(-1)]}, pump and motor i is assumed
* to be 17,044 lb*ft**2 based on 1/2 of ref. 349 value, which lists 2 values
20526400 rpaspeed integral  1.602e-02  1.5820800e+03 0
20526401 cntrlvar 262
*
* recirc pump b speed with no pump trip
* s={(60/2pi)(32.174)[(17,044 lb*ft**2)**(-1)]}, pump and motor i is assumed
* to be 17,044 lb*ft**2 based on 1/2 of ref. 349 value, which lists 2 values
20526500 rpbspeed integral  1.602e-02  1.5820800e+03 0
20526501 cntrlvar 263
*
*
* rod reactivity, cumulative
*----------------------------
*
20530000 rodrctdm integral  5.000e-02   0. 0  3 -2.300e+01  3.000e+00
20530001 cntrlvar 109
*
* normalized scram curve
*  s is the inverse of 28.9308, the scram shutdown reactivity margin
20530100 normscrm function  3.457e-02   0. 0
20530101 time      0        200
*
* scram multiplier
*  this term will remove the rod reactivity added by cntrlvar 300 at the same
*  rate as scram reactivity is inserted.
```

```
20530200 scrmmult      sum  1.000e+00  1.0000000e+00 0
20530201 1.0       1.0       cntrlvar   301
*
* rod reactivity, including provision to disable following a scram
20530300 rodreact     mult  1.000e+00   0. 0
20530301 cntrlvar  302       cntrlvar   300
*
*
* feedwater heater level controls
*--------------------------------
*
* cntrlvar 305: RFW HTRA1 collapsed liquid level (inches above lower tap)
20530500 'HTRA1LVL'     sum     12.     16.0     1
20530501 -2.6641        1.3307  voidf   722010000
20530502                2.6667  voidf   721030000
20530503                2.6667  voidf   721020000
*20530504               10.4596 voidf   721010000
*20530505               13.7904 voidf   720010000
*
* heater A1 level out to LabVIEW
20530600  a1lvlout     lag  1.00       16.0         0  3  0.  32.  *prb
20530601 0.05     cntrlvar 305  *lag time const.
*
* instant drain vlv position in %, A1
20532300 a1drinst     constant         32.0
*
* drain vlv position, heater a1, normalized to 1.0
20532400 a1drnpos    lag  0.01         0.32         0
20532401 0.05  cntrlvar 323
*
* cntrlvar 0330: RFW HTRA2 collapsed liquid level (inches above lower tap)
20533000 'HTRA2LVL'     sum     12.     18.0     1
20533001 -6.9974        5.4974  voidf   733010000
20533002                3.0000  voidf   732020000
20533003                3.0000  voidf   732010000
*20533004               8.8763  voidf   731010000
*20533005               10.2904 voidf   730010000
*
* heater A2 level out to LabVIEW
20533100  a2lvlout     lag  1.00       18.0         0  3  0.  36.      *prb
20533101 0.05     cntrlvar 330  *lag time const.
*
* instant drain vlv position in %, A2
20534800 a2drinst      constant         44.0
```

```
*
* drain vlv position, heater a2
20534900 a2drnpos    lag  0.01          0.44          0
20534901 0.05 cntrlvar 348
*
* instant A2 bypass vlv position, in %
20535400 a2byinst     constant        0.0                              *prb 01-18-96 10:09am
*
* bypass vlv position, heater a2, normalized to 1.0
20535500 a2byppos    lag  0.01          0.0          0                      *prb 01-18-96 10:10am
20535501 0.05 cntrlvar 354
*
* cntrlvar 0360: RFW HTRA3 collapsed liquid level (inches above lower tap)
20536000 'HTRA3LVL'     sum     12.     18.0     1
20536001 -15.6068       7.0534  voidf   742040000
20536002                7.0534  voidf   742030000
20536003                3.0000  voidf   742020000
20536004                3.0000  voidf   742010000
*20536005               11.1133 voidf   741010000
*20536006               12.4284 voidf   740010000
*
* heater A3 level out to LabVIEW
20536100  a3lvlout     lag  1.00       18.0         0  3  0.  36.      *prb
20536101 0.05     cntrlvar 360  *lag time const.
*
* instant drain vlv position, A3 in %
20537800 a3drinst     constant         34.0
*
* drain vlv position, heater a3
20537900 a3drnpos    lag  0.01          0.34          0
20537901 0.05  cntrlvar 378
*
* cntrlvar 0380: RFW HTRA4 collapsed liquid level (inches above shell bottom)
20538000 'HTRA4LVL'     sum     12.     16.9375  1
20538001 0.0    0.1667  voidf   751010000   * upper tap 2" above centerline
20538002        2.9375  voidf   752010000   * shell radius
*
* heater A4 level out to LabVIEW
20538100  a4lvlout     lag  1.00       16.9375      0  3  0.  37.25    *prb
20538101 0.05     cntrlvar 380  *lag time const.
*
* instant drain vlv position, A4 in %
20539800 a4drinst     constant        40.0
*
```

```
* drain vlv position, heater a4
20539900 a4drnpos    lag  0.01         0.40         0
20539901 0.05 cntrlvar 398
*
* instant bypass vlv position, A4 in %
20540400 a4byinst      constant       0.0                              *prb 01-24-96 10:34am
*
* bypass vlv position, heater a4, normalized to 1.0
20540500 a4byppos      lag     0.01    0.0           0                  *prb 01-24-96 10:35am
20540501 0.05 cntrlvar 404
*
* cntrlvar 0410: RFW HTRA5 collapsed liquid level (inches above shell bottom)
20541000 'HTRA5LVL'     sum     12.     15.0    0
20541001 -5.2188       2.500   voidf 760030000 * level taps are at top
20541002               5.2188  voidf 760040000 * & bottom of collector tank
*
* heater A5 level out to LabVIEW
20541100  a5lvlout     lag  1.00      15.0        0  3  0.  30.      *prb
20541101 0.05     cntrlvar 410  *lag time const.
*
* instant drain vlv position, A5 in %
20542800 a5drinst     constant           40.0
*
* drain vlv position, heater a5, normalized to 1.0
20542900 a5drnpos    lag  0.01         0.40         0
20542901 0.05 cntrlvar 428
*
* instant bypass vlv position, A5 in %
20543400 a5byinst     constant           0.0                           *prb 01-25-96 09:08pm
*
* bypass vlv position, heater a5, normalized to 1.0
20543500 a4byppos    lag  0.01         0.0          0                   *prb 01-25-96 09:09pm
20543501 0.05 cntrlvar 434
*
* cntrlvar 440: RFW HTRB1 collapsed liquid level (inches above lower tap)
20544000 'HTRB1LVL'    sum     12.     16.0    1
20544001 -2.6641       1.3307  voidf   822010000
20544002               2.6667  voidf   821030000
20544003               2.6667  voidf   821020000
*20544004               10.4596 voidf   821010000
*20544005               13.7904 voidf   820010000
*
* heater b1 level out to LabVIEW
20544100  b1lvlout     lag  1.00      33.0        0  3  0.  44.
```

```
20544101 0.05     cntrlvar 440  *lag time const.
*
* auto vlv position demand, b1 drain vlv
20544900 b1draut      constant          32.0
*
* drain vlv position, heater b1, normalized to 1.0
20545000 b1drnpos    lag  0.01         0.32         0
20545001 0.05     cntrlvar 449
*
* cntrlvar 0451: RFW HTRB2 collapsed liquid level (inches above lower tap)
20545100 'HTRB2LVL'     sum     12.     18.0     1
20545101 -6.9974        5.4974  voidf   833010000
20545102                3.0000  voidf   832020000
20545103                3.0000  voidf   832010000
*205045104                8.8763  voidf   831010000
*205045105                10.2904 voidf   830010000
*
* heater b2 level out to LabVIEW
*205045200  b2lvlout     lag  1.00       33.0         0  3  0.  36.     *prb
20545200  b2lvlout     lag  1.00       18.0         0  3  0.  36.     *prb
20545201 0.05     cntrlvar 451  *lag time const.
*
* auto vlv position demand, b2 drain vlv
20545700 b2draut      constant               44.0
*
* drain vlv position, heater b2, normalized to 1.0
20545800 b2drnpos    lag  0.01         0.44         0
20545801 0.05 cntrlvar 457
*
* auto vlv position demand, b2 bypass vlv
20545900 b2byaut     constant          0.0
*
* bypass vlv position, heater b2, normalized to 1.0
20546000 b2byppos    lag  0.01         0.0          0                     *prb 01-23-96 01:10pm
20546001 0.05 cntrlvar 459
*
* cntrlvar 0465: RFW HTRB3 collapsed liquid level (inches above lower tap)
20546500 'HTRB3LVL'     sum     12.     18.0     0
20546501 -15.6068       7.0534  voidf   842040000
20546502                7.0534  voidf   842030000
20546503                3.0000  voidf   842020000
20546504                3.0000  voidf   842010000
*20504655                11.1133 voidf   841010000
*20504656                12.4284 voidf   840010000
```

```
*
* heater b3 level out to LabVIEW
20546600  b3lvlout     lag  1.00       18.0         0  3  0.  36.
20546601 0.05     cntrlvar 465  *lag time const.
*
* auto vlv position demand, b3 drain vlv, in %
20547100 b3draut      constant          34.
*
* drain vlv position, heater b3
20547200 b3drnpos    lag  0.01          0.34          0
20547201 0.05  cntrlvar 471
*
* cntrlvar 0475: RFW HTRB4 collapsed liquid level (inches above shell bottom)
20547500 'HTRB4LVL'     sum     12.     16.9375  0
20547501 0.0    0.1667  voidf   851010000   * upper tap 2" above centerline
20547502        2.9375  voidf   852010000   * shell radius
*
* heater b4 level out to LabVIEW
20547600  b4lvlout     lag  1.00       16.9375      0  3  0.  37.25    *prb
20547601 0.05     cntrlvar 475  *lag time const.
*
* auto vlv position demand, b4 drain vlv, in %
20548100 b4draut      constant          40.
*
* drain vlv position, heater b4, normalized to 1.0
20548200 b4drnpos    lag  0.01          0.40          0
20548201 0.05 cntrlvar 481
*
* auto vlv position demand, b4 bypass vlv, in %
20548300 b4byaut     constant          0.0
*
* bypass vlv position, heater b4, normalized to 1.0
20548400 b4byppos    lag  0.01          0.5          0
20548401 0.05 cntrlvar 483
*
* cntrlvar 0486: RFW HTRB5 collapsed liquid level (inches above shell bottom)
20548600 'HTRB5LVL'     sum     12.     15.0     0
20548601 -5.2188        2.500    voidf 860030000 * level taps are at top
20548602                5.2188  voidf 860040000 * & bottom of collector tank
*
* heater b5 level out to LabVIEW
20548700  b5lvlout     lag  1.00       15.0         0  3  0.  30.      *prb
20548701 0.05     cntrlvar 486  *lag time const.
*
```

```
* auto vlv position demand, b5 drain vlv, in %
20549200 b5draut      constant    40.
*
* drain vlv position, heater b5, normalized to 1.0
20549300 b5drnpos    lag  0.01          0.40          0
20549301 0.05 cntrlvar 492
*
* auto vlv position demand, b5 bypass vlv, in %
20549400 b5byaut      constant        0.0
*
* bypass vlv position, heater b5, normalized to 1.0
20549500 b5byppos    lag  0.01          0.0          0                    *prb 01-25-96 09:13pm
20549501 0.05 cntrlvar 494
*
*
* turbine control valve flow
*--------------------------
*
* pressure control unit (other units not modelled since pressure control is
*  sufficient for transients of interest)
*
* steam line pressure (psia)
20550000  slpress      lag  1.450e-04  9.7806598e+02 0
20550001 0.5       p         420030000 * ref. 349 for time constant, ref. 13
*
* pressure error signal (psid)
20550100 presserr      sum  1.000e+00  3.0066700e+01 0
20550101 -947.99951 1.0    cntrlvar 500  * pressure setpoint from ref. 349
* also ref. 361, 13, 14
*
* lead-lag press error signal
20550200 ldlgpres lead-lag  3.333e+00  1.0019800e+02 0
20550201 2.0       5.0     cntrlvar 501 * ref. 14, 349, 361
*
* inverse turbine trip, load limiter & max combined flow limiter
* assumed that load limiter is set to 110. & max combined flow = 125.
20550400 invttrip tripunit  1.100e+02  1.1000000e+02 0
20550401 -601  * ref. 15, 349, 361
*
* pressure control unit signal (lvg output)
20550600 pcusignl stdfnctn  1.000e+00  1.0019800e+02 0
20550601 min       cntrlvar 502
20550602           cntrlvar 504  * ref. 15, 349, 361
*
```

```
* turbine control valves (tcv) relay
20550800 tcvrelay      lag  1.000e+00  1.0019800e+02 0
20550801 0.02      cntrlvar 506  * ref. 349
*
* tcv delay function
20551000 tcvdelay    delay  1.000e+00  1.0019800e+02 0
20551001 cntrlvar  508       0.1        2 * ref. 349
*
* turbine control valve linearization (dfg board output)
20551200 tcvliner function  1.000e+00  5.2970501e+01 0
20551201 cntrlvar  510  520 * ref. 17, 349
* normalized shape of the curve from ref. 349 is the same as the dfg board
* output voltage vs. input voltage signal shown on ref. 17; values from ref.
* 349 are used in the table.
*
* lagged tcv servo position demand in % open
20551400 tcvsrvpd      lag  1.000e+00  5.2970299e+01 0  3   .000e+00  1.000e+02
20551401 0.1     cntrlvar 512 * ref. 16, 349
*
* max tcv positive position change in % open in this time step
20551600 tcvchgmx     mult  1.000e+01  5.0000000e-01 0
20551601 dt        0 * ref. 349
*
* tcv position max value in this time step
20551800 tcvposmx      sum  1.000e+00  5.3470299e+01 0
20551801 0.0       1.0      cntrlvar 516
20551802           1.0      cntrlvar 524 * ref. 349
*
* minimum of tcv position demand & max posit
20552000  tcvmin1 stdfnctn  1.000e+00  5.2970299e+01 0
20552001 min      cntrlvar 514
20552002          cntrlvar 518
*
* tcv position minimum value in % open in this time step
20552200 tcvposmn      sum  1.000e+00  5.2260300e+01 0
20552201 0.0      -1.42      cntrlvar 516 * max closure rate is 14.2% per second
20552202           1.0       cntrlvar 524 * ref. 349
*
* tcv current position with no turbine trip
20552400 postcvnt stdfnctn  1.000e+00  5.2970299e+01 0  3   .000e+00  1.000e+02
20552401 max       cntrlvar 520
20552402           cntrlvar 522
*
* turbine trip
```

```
20552500 turbtrip tripunit  1.000e+00   0. 0
20552501 601
*
* time since turbine trip
20552600 turbtrpt integral  1.000e+00   0. 0
20552601 cntrlvar 525
*
* tcv position multiplier with turbine trip
20552700 trbtmult function  1.000e+00  1.0000000e+00 0
20552701 cntrlvar  526  527   * tcv closure on trip in 0.1 sec, ref. 349
*
* tcv position in current time step
20552800 tcvposit     mult  1.000e+00  5.2970299e+01 0
20552801 cntrlvar  524       cntrlvar  527
*
* steam flow in lb/sec for 978.00 psia (100% turbine inlet pressure)
20553200 untbflow function  3.717e+03  3.7243401e+03 0 * s= 100% flow in lb/s
20553201 cntrlvar  528  535 * ref. 349 for table
*
* steam flow through tcv in lb/sec
*  multiplicative constant s= 1.45038e-4 * 1/978psia, or conversion factor for
*  pa to psia divided by 978 psia.  this gives tcv steam flow at any pressure.
20553600  tcvflow     mult  1.483e-07  3.7255500e+03 0
20553601 cntrlvar 532 * ref. 349
20553602 p 420030000
*
* convert tcv mass flow to velocity
*
20553700  tcvrhoa     mult  6.720e-01  2.4019800e+01 0
20553701 rho       420030000 avol       420030000
*
20553800   tcvvel      div  1.000e+00  1.5510300e+02 0
20553801 cntrlvar  537       cntrlvar   536
*
*
* turbine bypass valve steam flow in lb/sec
*-----------------------------------------
*
* pressure regulator and low value gate signal difference in %
20554000 ploaddif      sum  1.000e+00 -2.5000000e+00 0
20554001 -2.5      1.0       cntrlvar 502 * ref. 15, 349, 361
20554002          -1.0       cntrlvar 506 * -2.5 is small closing bias
*
* combined maximum flow limiter in %
```

```
20554200 maxflolm      sum  1.000e+00  2.4802401e+01 0
20554201 125.     -1.0       cntrlvar 506 * ref. 16, 349, 361
*
* bypass valve control signal, lvg output
20554400   bpvsig stdfnctn  1.000e+00   0. 0  3   .000e+00  2.620e+01
20554401 min       cntrlvar  540 * ref. 16, 349, 361
20554402           cntrlvar  542
*
* delayed bypass valve control signal
20554600 bpvsgdel    delay  1.000e+00   0. 0
20554601 cntrlvar  544       0.1  5 * ref. 349
*
* bpv position error signal
20554700 bpverror      sum  2.000e+01   0. 0  3 -1.050e+02  1.050e+02
20554701 0.0       1.0       cntrlvar 546 * ref. 16, 349, 361
20554702          -1.0       cntrlvar 548
*
* bpv servo position
20554800 bpvposit integral  1.000e+00   0. 0  3   .000e+00  2.620e+01
20554801 cntrlvar 547
*
* bpv steam flow in lb/sec
*  multiplicative factor is equal to conversion factor from pa to psia times
*  (1/978 psia) times 0.01 to convert from percentage flow at 978 psia.  s =
*  (1.45038e-4)*(1/978)* 0.01.
20555000 tbpvmflo     mult  5.512e-06   0. 0
20555001 p  420030000  * ref. 349
20555002 cntrlvar 548
*
* convert tbpv mdot to velocity
*
20555200  tbpvvel      div  1.000e+00   0. 0
20555201 cntrlvar  537       cntrlvar   550
*
*
* feedwater flow controller
*-----------------------------------
*
* feedpumps above min speed (in auto)
*
* rfp a above min speed tripunit
20558000 rfpaauto tripunit  1.0         1.0          0
20558001 -691
*
```

```
* rfp b above min speed tripunit
20558100 rfpbauto tripunit  1.0        1.0         0
20558101 -692
*
* rfp c above min speed tripunit
20558200 rfpcauto tripunit  1.0        1.0         0
20558201 -512
*
* terms used in Woodward governors
*
* error multiplier term 1
20558300 err1mult sum      1.0         0.1125       1
20558301 0.1  1.0 dt 0
20558301 0.07 1.0 dt 0
*
* error multiplier term
20558400 err_mult div      1.0         0.1          1
20558401 cntrlvar 583 dt 0
*
* sum mult term
20558500 sum_mult div      0.07        0.9          1
20558501 cntrlvar 583
*
* woodward governor a error term
*  (in percent or error/100)
20558600 woodaerr      sum  0.02       0.0          0
20558601 0.0      1.0      cntrlvar   689
20558602         -9.549     pmpvel     570
*
* woodward governor b error term
20558700 woodberr      sum  0.02       0.0          0
20558701 0.0      1.0      cntrlvar   686
20558702         -9.549     pmpvel     571
*
* woodward governor c error term
20558800 woodcerr      sum  0.02       0.0          0
20558801 0.0      1.0      cntrlvar   683
20558802         -9.549     pmpvel     572
*
* fsubn a
20559500 fsubn_a      lag  1.0        0.0          0
20559501 0.1   cntrlvar 586
*
* fsubn b
```

```
20559600 fsubn_b      lag  1.0       0.0          0
20559601 0.1   cntrlvar 587
*
* fsubn c
20559700 fsubn_c      lag  1.0       0.0          0
20559701 0.1   cntrlvar 588
*
*
* level signal, level error
*
* level error in inches
20560200 lvlerror      sum  1.000e+00 -5.6445029e-02 0
20560201 0.0       1.0       cntrlvar   108
20560202          -1.0       cntrlvar   007     * use with labview
*20560202         -1.0       cntrlvar   006     * use without labview
*
* bypass valve control
*
* bypass vlv control multiplier
20560400 byponoff constant   0. * equal 1.0 in bypass vlv auto control
*
* bypass proportional error
20560600 bypprope     mult  1.000e+00   0. 0
20560601 cntrlvar  602       cntrlvar   604 * s = tuning parameter
*
* bypass integral term
20560800 bypinter integral  1.667e-02   0. 0  3 0.  100. * s=tuning parameter in 1/sec
20560801 cntrlvar  606
*
* bypass valve controller lc-3-53 output
20560900  lc-3-53      sum  1.000e-02   0. 0 * s converts 100% demand to 1.0 position dmd
20560901 0.0       1.0       cntrlvar   606
20560902           1.0       cntrlvar   608 * ref. 104, 363
*
* bypass valve controller lc-3-53 switch
20561000  lc353swh     mult 1.0        0.0         0
20561001 cntrlvar  604       cntrlvar   609 * used to simulate manual closing when not in
use
*
* bypass valve position (normalized)
20561100 byppposit      lag  1.000e+00   0. 0  3   .000e+00  1.000e+00
20561101 2.0       cntrlvar  610 * time constant is a guess
*
* variable feedwater pump controller gains
```

```
*
* tripunit for feedpump a
20561300 rfpatrip tripunit 1.        1.        0
20561301 -618
*
* tripunit for feedpump b
20561400 rfpbtrip tripunit 1.        1.        0
20561401 -619
*
* tripunit for feedpump c
20561500 rfpctrip tripunit 1.        1.        0
20561501 -620
*
* dependent variable for single element gain
20561600 e1vargnx sum      1.        313.405    0
20561601 0.0      100.    cntrlvar   580
20561602          100.    cntrlvar   581
20561603          100.    cntrlvar   582
20561604          1.      cntrlvar   631      * use with Labview
*20561604         1.      cntrlvar   630      * use without Labview
*
* single element gain
20561700 e1vargny function 1.        0.86957    0 * tuning parameter
20561701 cntrlvar 616      617
*
* three element gain, level controller
20561800 e3vargny function 1.       0.86957     0 * tuning parameter
20561801 cntrlvar 631      618  * use with Labview
*20561801 cntrlvar 630      618  * use without Labview
*
* three element gain, sf/fw mismatch controller
20561900 e3misgan function 1.       0.86957     0 * tuning parameter
20561901 cntrlvar 616      619
*
* feedwater flow signal
*
* lagged feedwater mass flow in Mlbm/hr
*  s= conversion factor from kg/sec to Mlb/hr; flow is sum of lagged flows
*  through feedwater lines a and b.  lag time constant is from ref. 349.
20562200 lmflowfw      lag  7.938e-03  1.3405000e+01 0
20562201 0.5       mflowj    605040000
*
* return feedwater mass flow from LabVIEW
20562300 labfwflo constant  1.34050000e+01
```

```
*
* steam flow signal
*
* steam mass flow for use without LabVIEW
20563000 stmflow       sum  1.000e+00  1.3400000e+01 0
20563001 0.0       1.0       cntrlvar   900
20563002           1.0       cntrlvar   901
20563003           1.0       cntrlvar   902
*
* return steam mass flow from LabVIEW
20563100 labstflo constant  1.34050000e+01
*
*
* single or three element control selection
*
* bypass valve not being controlled multiplier
*  = 1 when bypass valve is not used to control level, 0 when in use.
20563400 bypasnot      sum  1.000e+00  1.0000000e+00 0
20563401 1.0      -1.0       cntrlvar   604
*
* operator selected single element feed pump control
*  = 1 when selected, 0 otherwise
20564600 e1selctd constant   0.
*
* single element feed pump control multiplier
*  = 1 when operator selected or tripped, 0 otherwise
20564800 sngelmlt tripunit  1.000e+00   0. 0
20564801 671
*
* operator selected three element feed pump control
*  = 1 when operator selected, 0 otherwise
20565000 elem3sel constant  1.0000000e+00
*
* single element inverse tripunit
*  = 1 when single element feed pump control is not selected or tripped
20565200 notsngle tripunit  1.000e+00  1.0000000e+00 0
20565201 -671
*
* three element level controller
*
* level pi zeroing error for 1e operation
20563200 e3lvlzer     mult  -1.0       0.0           0
20563201 cntrlvar  655       cntrlvar  648
*
```

```
* level error term for three element control
20565300 e3lvlerr     mult  1.0       0.0         0
20565301 cntrlvar  602       cntrlvar  652
20565302 cntrlvar  634
*
* proportional error term for three element control
20565400 e3proper     mult  1.0       0.0         0
20565401 cntrlvar  653       cntrlvar  618
*
* three element level error signal (1e or 3e)
20565500 e3lvler1     sum  1.0        0.0         0
20565501 0.0       1.0      cntrlvar  632
20565502           1.0      cntrlvar  653
*
* three element level integrand
20565600 e3integd  integral 9.5238e-03 0.0          0 3 0. 16.
20565601 cntrlvar  655
*
* steam flow in 3e, 0 otherwise
20565700 e3stmflo     mult  1.0       13.407      0
20565701 cntrlvar 631  cntrlvar 650  cntrlvar 652       * use with Labview
*20565701 cntrlvar 630  cntrlvar 650  cntrlvar 652       * use without Labview
*
* feed flow in 1e, 0 otherwise
20565800 e1fdflo      mult  1.0       0.          0
20565801 cntrlvar  648  cntrlvar 623    * use with labview
*20565801 cntrlvar  648  cntrlvar 622    * use without labview
*
* three element controller when in 3e or tracking in 1e
20565900 e3-e3cnt      sum  1.0       13.407      0 3 0.  16.
20565901 0.0       1.0       cntrlvar  654
20565902           1.0       cntrlvar  656
20565903           1.0       cntrlvar  657
20565904           1.0       cntrlvar  658
*
*
* steam flow feedwater flow mismatch
*
* level controller + steam flow minus feed flow
20566000 fwstmdel      sum  1.000e+00  0.000          0 * equals 0 when not in 3e
20566001 0.0       1.0       cntrlvar   659 * level pi + stm flow, ff in 1e
20566002          -1.0       cntrlvar   623 * feedflow (with Labview)
*20566002          -1.0       cntrlvar   622 * feedflow (without labview)
*
```

```
* feed flow proportional error
20566100 ffproerr     mult  1.000e+00  0.0          0
20566101 cntrlvar  660      cntrlvar   619
*
* track 1e error
20566200 e1errtr      sum  1.0       0.0          0
20566201 0.0       1.0      cntrlvar  682
20566202          -1.0      cntrlvar  665
*
* track 1e error times 1e multiplier
20566300 e1ertrp     mult  1.0       0.0          0
20566301 cntrlvar 662  cntrlvar 648
*
* total error for sf_fw integral
20566400 sffwerr      sum  1.0       0.0          0
20566401 0.0       1.0      cntrlvar  663
20566402           1.0      cntrlvar  660
*
* three element sf_fw integrand
20566500 sffwintg  integral 2.3813-01  84.324       0 3 0. 100.
20566501 cntrlvar  664
*
* three element sf_fw controller output
20566600 sffwout      sum  1.0       84.324       0 3 0. 100.
20566601 0.0       1.0       cntrlvar  665
20566602           1.0       cntrlvar  661
*
*
* single element controller
*
* level error term for single element control
20566700 e1lvlerr     mult  1.0       0.0          0
20566701 cntrlvar  602      cntrlvar  648
20566702 cntrlvar  634      cntrlvar  200
*
* proportional error term for single element control
20566800 e1proper     mult  1.0       0.0          0
20566801 cntrlvar  667      cntrlvar  617
*
* three element tracking error
20566900 e3trerr      sum  1.0       0.0          0
20566901 0.0       1.0      cntrlvar  666
20566902          -1.0      cntrlvar  675
*
```

```
* three element tracking error when in 3e
20567000 e3trerrt     mult  1.0        0.0          0
20567001 cntrlvar  669  cntrlvar 650  cntrlvar 652
*
* single element integral error term
20567100 e1err        sum  1.0       0.0          0
20567101 0.0       1.0  cntrlvar  670
20567102           1.0  cntrlvar  667
20567103           1.0  cntrlvar  804
*
* single element integrand
20567400 e1integd  integral 1.667e-2   84.324        0 3 0. 100.
20567401 cntrlvar  671
*
* single element controller
20567500 e1-e1cnt      sum  1.0       84.324        0 3 0.  100.
20567501 0.0       1.0      cntrlvar  668
20567502           1.0      cntrlvar  674
*
* track 3E selection
20567600 track3el     mult  1.0       84.324        1
20567601 cntrlvar  652      cntrlvar  666
*
* track 1E selection
20567700 track1el     mult  1.0       0.          0
20567701 cntrlvar  648      cntrlvar  675
*
* controller output in 1e or 3e
20567800 e1-e1e3o      sum  1.0       84.324       0 3 0. 100.
20567801 0.0       1.0      cntrlvar  677
20567802           1.0      cntrlvar  676
*
* scram response tripunit
20567900 scrrespt tripunit 37.0       0.          0
20567901 679 * = 37 when scram respnse in, 0 otherwise
*
* max controller output following a scram response
20568000 scrrspmx      sum  1.0       100.         0
20568001 100.     -1.0       cntrlvar  679 * 63. when response in
*
* single element controller out in 1e/3e w/ scram response
20568100 e1scram  stdfnctn  1.0       84.324        0
20568101 min  cntrlvar 680  cntrlvar 678
*
```

```
* controller output with bypass zero feature
20568200 i_apiout     mult  1.0       84.324       0
20568201 cntrlvar  681       cntrlvar  634
*
* conversion of demand signal to speed demand
20568300 spddmd        sum  1.0       4816.2       0
20568301 600.      50.      cntrlvar  682
*
* individual pump responses
*
* pump b speed limiter tripunit
20568400 b600rpm  tripunit  9400.      0.0         0
20568401 681 * s = amt subtracted from large # to give limit
*
* pump b speed limit following scram response
20568500 b600limt sum       1.0       10000.      0
20568501 10000.  -1.0       cntrlvar   684
*
* pump b speed controller output
20568600 bcontout stdfnctn  1.0       4816.2       0
20568601 min  cntrlvar  685  cntrlvar  683 * controller output to pump b
*
* pump a speed limiter tripunit
20568700 a600rpm  tripunit  9400.      0.0         0
20568701 684 * s = amt subtracted from large # to give limit
*
* pump a speed limit following scram response
20568800 a600limt sum       1.0       10000.      0
20568801 10000.  -1.0       cntrlvar   687
*
* pump a speed controller output
20568900 acontout stdfnctn  1.0       4816.2       0
20568901 min  cntrlvar  688  cntrlvar  683 * controller output to pump a
*
*
* mathematical models of governors
*
* woodward a governor differential term
20569000 woodadif diffreni  3.5       0.0    0
20569000 woodadif diffreni  .35       0.0    0
20569001 cntrlvar 595
*
* woodward b governor differential term
20569100 woodbdif diffreni  .35       0.0    0
```

```
20569101 cntrlvar 596
*
* woodward c governor differential term
20569200 woodcdif diffreni  .35       0.0    0
20569201 cntrlvar 597
*
* woodward a governor integral term
20569600 woodaint integral  2.8e+00    37.983       0  3   0.       100.
20569601 cntrlvar  595
*
* woodward b governor integral term
20569700 woodbint integral  2.8e+00    37.983       0  3   0.       100.
20569701 cntrlvar  596
*
* woodward c governor integral term
20569800 woodcint integral  2.8e+00    37.983       0  3   0.       100.
20569801 cntrlvar  597
*
* woodward a output in valve poppet dmd (sec op cyl pos)
*  s=  (6.37"/100%)
20569900 woodaout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20569901 0.0      7.00     cntrlvar  595
20569902          1.0      cntrlvar  690
20569903          1.0      cntrlvar  696
*
* woodward b output in valve poppet dmd (sec op cyl pos)
*  s=  (6.37"/100%)
20570000 woodbout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20570001 0.0      7.00     cntrlvar  596
20570002          1.0      cntrlvar  697
20570003          1.0      cntrlvar  691
*
* woodward c output in valve poppet dmd (sec op cyl pos)
*  s=  (6.37"/100%)
20570100 woodcout sum      6.370e-02  2.4195099e+00 0  3   .000e+00  6.370e+00
20570101 0.0      7.00     cntrlvar  597
20570102          1.0      cntrlvar  698
20570103          1.0      cntrlvar  692
*
* woodward a output w/ pump tripunit
20570500 rfpasctr    mult  1.0       2.4195700e+00 0
20570501 cntrlvar 613  cntrlvar 699
*
* woodward b output w/ pump tripunit
```

```
20570600 rfpbsctr     mult  1.0        2.4195700e+00 0
20570601 cntrlvar 614  cntrlvar 700
*
* woodward c output w/ pump tripunit
20570700 rfpcsctr     mult  1.0        2.4195700e+00 0
20570701 cntrlvar 615  cntrlvar 701
*
* rfpt a secondary operating cylinder position (valve position)
20570800 secopaps      lag  1.000e+00  2.4195700e+00 0
20570801 0.1       cntrlvar  705 * lag time constant is a guess to acct for
*                          valve response to sec op cyl position
*
* rfpt b secondary operating cylinder position (valve position)
20570900 secopbps      lag  1.000e+00  2.4187300e+00 0
20570901 0.2       cntrlvar  706 * lag time constant is from governor tuning
*
* rfpt c secondary operating cylinder position (valve position)
20571000 secopcps      lag  1.000e+00  2.4187300e+00 0
20571001 0.2       cntrlvar  707 * lag time constant is from governor tuning
*
* steam inlet valve and turbine math models
*
* rfp a instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571100 rfpamdot      sum  2.911e+01  6.6794998e+01 0  3   .000e+00  8.020e+01
20571101 -.125     1.0       cntrlvar  708  * cntrlvar 708 is sec cyl travel
*
* rfp b instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571200 rfpbmdot      sum  2.911e+01  6.6770401e+01 0  3   .000e+00  8.020e+01
20571201 -.125     1.0       cntrlvar  709  * cntrlvar 709 is sec cyl travel
*
* rfp c instantaneous lp steam mass flow in klbm/hr at 198.6 psia inlet p
*  flow at fully open lp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571300 rfpcmdot      sum  2.911e+01  6.6770500e+01 0  3   .000e+00  8.020e+01
20571301 -.125     1.0       cntrlvar  710  * cntrlvar 710 is sec cyl travel
*
* rfp a instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571400 rfpahpfl      sum  2.381e+01   0. 0  1  .000e+00
```

```
20571401 -2.88     1.0       cntrlvar   708  * cntrlvar 708 is sec cyl travel
*
* rfp b instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571500 rfpbhpfl      sum  2.381e+01   0. 0  1  .000e+00
20571501 -2.88     1.0       cntrlvar   709  * cntrlvar 709 is sec cyl travel
*
* rfp c instantaneous hp steam mass flow in klbm/hr at 965.0 psia inlet p
*  flow at fully open hp poppets from ref. 378; secondary cylinder travel
*  from ref. 74
20571600 rfpchpfl      sum  2.381e+01   0. 0  1  .000e+00
20571601 -2.88     1.0       cntrlvar   710  * cntrlvar 710 is sec cyl travel
*
* lp poppet inlet pressure, based on steam flow, see curves developed by saic
*  from heat balance information
20571700 lppopptp      sum  1.427e+01  1.9357700e+02 0  1 1.470e+01
20571701 0.1510    1.0       cntrlvar   900
20571702           1.0       cntrlvar   901
20571703           1.0       cntrlvar   902
*
* multiplicative factor for low press flow based on inlet pressure
*  assumed linear with p-inlet
20571800 flowmult     mult  5.035e-03  9.7465998e-01 0
20571801 cntrlvar  717
*
* multiplicative factor for high press flow based on inlet pressure
*  assumed linear with p-inlet
20571900 hflomult     mult  1.503e-07  1.0138201e+00 0
20571901 p         420030000 * s = (1/965psia)(1.450383-4 psi/pa)
*
* lp delta enthalpy across rfpt in btu/lbm vs. inlet pressure
20572000 rfptenth function  1.000e+00  2.2703700e+02 0
20572001 cntrlvar  717       663
*
* hp delta enthalpy across rfpt in btu/lbm vs. inlet pressure
20572100 hpdlenth function  1.000e+00  2.6450000e+02 0
20572101 p         420030000 663
*
* rfp a instantaneous turbine power output in hp from lp valves
20572200 talpipwr     mult  3.930e-01  5.8087798e+03 0
20572201 cntrlvar  720       cntrlvar   718
20572202 cntrlvar  711
*
```

```
* rfp b instantaneous turbine power output in hp from lp valves
20572300 tblpipwr     mult  3.930e-01  5.8066401e+03 0
20572301 cntrlvar  720      cntrlvar   718
20572302 cntrlvar  712
*
* rfp c instantaneous turbine power output in hp from lp valves
20572400 tclpipwr     mult  3.930e-01  5.8066499e+03 0
20572401 cntrlvar  720      cntrlvar   718
20572402 cntrlvar  713
*
* rfp a instantaneous turbine power output in hp from hp valves
20572500 tahpipwr     mult  3.930e-01   0. 0
20572501 cntrlvar  721      cntrlvar   719
20572502 cntrlvar  714
*
* rfp b instantaneous turbine power output in hp from hp valves
20572600 tbhpipwr     mult  3.930e-01   0. 0
20572601 cntrlvar  721      cntrlvar   719
20572602 cntrlvar  715
*
* rfp c instantaneous turbine power output in hp from hp valves
20572700 tchpipwr     mult  3.930e-01   0. 0
20572701 cntrlvar  721      cntrlvar   719
20572702 cntrlvar  716
*
* rfp a instantaneous turbine power output in hp
20573000 rfptaipw      sum  1.000e+00  5.8087798e+03 0
20573001 0.0       1.0      cntrlvar   725
20573002           1.0      cntrlvar   722
*
* rfp b instantaneous turbine power output in hp
20573100 rfptbipw      sum  1.000e+00  5.8066401e+03 0
20573101 0.0       1.0      cntrlvar   726
20573102           1.0      cntrlvar   723
*
* rfp c instantaneous turbine power output in hp
20573200 rfptcipw      sum  1.000e+00  5.8066499e+03 0
20573201 0.0       1.0      cntrlvar   727
20573202           1.0      cntrlvar   724
*
* rfp a turbine power output in hp
20573500 rfptapwr      lag  1.000e+00  5.8088701e+03 0
20573501 0.05      cntrlvar  730
*
```

```
* rfp b turbine power output in hp
20573600 rfptbpwr      lag  1.000e+00  5.8067700e+03 0
20573601 0.05      cntrlvar  731
*
* rfp c turbine power output in hp
20573700 rfptcpwr      lag  1.000e+00  5.8067798e+03 0
20573701 0.05      cntrlvar  732
*
* rfpa load power,pl, in hp
20574000 rfpalpwr     mult  1.341e-03 -5.8111099e+03 0
20574001 pmpvel    570       pmptrq     570
*
* rfpb load power,pl, in hp
20574100 rfpblpwr     mult  1.341e-03 -5.8104702e+03 0
20574101 pmpvel    571       pmptrq     571
*
* rfpc load power,pl, in hp
20574200 rfpclpwr     mult  1.341e-03 -5.8104800e+03 0
20574201 pmpvel    572       pmptrq     572
*
* rfp a differential power
20574500 rfpadpwr      sum  1.000e+00 -2.2463901e+00 0
20574501 0.0       1.0       cntrlvar   735
20574502           1.0       cntrlvar   740
*
* rfp b differential power
20574600 rfpbdpwr      sum  1.000e+00 -3.7010801e+00 0
20574601 0.0       1.0       cntrlvar   736
20574602           1.0       cntrlvar   741
*
* rfp c differential power
20574700 rfpcdpwr      sum  1.000e+00 -3.7016301e+00 0
20574701 0.0       1.0       cntrlvar   737
20574702           1.0       cntrlvar   742
*
* rfp a net angular acceleration, in rpm/sec
20575000 rfpaalfa      div  3.806e+02 -1.7738999e-01 0 * (550lbf-ft/hp-sec)(32.17lbm-ft**2/
20575001 cntrlvar  756  cntrlvar  745   * sec**2)(60sec/min)**2
*                                /{(4239lbm-ft**2)(2pi)**2} = s
*
* rfp b net angular acceleration, in rpm/sec
20575100 rfpbalfa      div  3.806e+02 -2.9226699e-01 0
20575101 cntrlvar  757       cntrlvar   746
*
```

```
* rfp c net angular acceleration, in rpm/sec
20575200 rfpcalfa      div  3.806e+02 -2.9231101e-01 0
20575201 cntrlvar  758       cntrlvar   747
*
* rfp a delta rpm
20575300 rfpadrpm     mult  1.000e+00 -8.8695129e-03 0
20575301 cntrlvar  750       dt         0
*
* rfp b delta rpm
20575400 rfpbdrpm     mult  1.000e+00 -1.4613370e-02 0
20575401 cntrlvar  751       dt         0
*
* rfp c delta rpm
20575500 rfpcdrpm     mult  1.000e+00 -1.4615540e-02 0
20575501 cntrlvar  752       dt         0
*
* rfp a current rpm
20575600  rfparpm     sum  1.000e+00  4.8197402e+03 0
20575601 0.0       1.0      cntrlvar   753
20575602           1.0      cntrlvar   756
*
* rfp b current rpm
20575700  rfpbrpm     sum  1.000e+00  4.8196499e+03 0
20575701 0.0       1.0      cntrlvar   754
20575702           1.0      cntrlvar   757
*
* rfp c current rpm
20575800  rfpcrpm     sum  1.000e+00  4.8196499e+03 0
20575801 0.0       1.0      cntrlvar   755
20575802           1.0      cntrlvar   758
*
20580200 output01  tripunit 1.0       0.          0
20580201 520
*
20580300 scramerr      sum  7.5       0.          0
20580301 63.      -1.0      cntrlvar   675
*
20580400 scramer1     mult  .027027    0.          0
20580401 cntrlvar  679  cntrlvar 802 cntrlvar 803
*
*
*-------------------------------
* additional rfwcs output control variables *
*-------------------------------
```

```
* mass flow rate, steam line a, in mlbm/hr
20590000  stmfloa     mult  7.938e-03  3.3373001e+00 0
20590001 mflowj 412000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* mass flow rate, steam line b, in mlbm/hr
20590100  stmflob     mult  7.938e-03  3.3373001e+00 0
20590101 mflowj 411000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* mass flow rate, steam line c/d, in mlbm/hr
20590200 stmflocd     mult  7.938e-03  6.7396998e+00 0
20590201 mflowj 410000000 * constant = (2.205 lbm/kg)(3600sec/hr)(1.e-6)
*
* reactor scram signal
20590600 scramsig tripunit  1.000e+00   0. 0
20590601 649
*
* level 8 signal (trips all rfps)
20590700 lvl8_sig tripunit  1.000e+00   0. 0
20590701 406
*
*  problem time
20590800 probtime     mult  1.000e+00  1.0000000e+03 0
20590801  time    0
*
*
20591000  rfparpm     mult  9.549e+00  4.8196001e+03 0
20591001 pmpvel 570
*
20591100  rfparpm     mult  9.549e+00  4.8195098e+03 0
20591101 pmpvel 571
*
20591200  rfparpm     mult  9.549e+00  4.8195098e+03 0
20591201 pmpvel 572
*
* cntrlvar 940: RFW HTRC1 collapsed liquid level (inches above lower tap)
20594000 'HTRC1LVL'    sum     12.     16.0     1
20594001 -2.6641        1.3307  voidf   922010000
20594002                2.6667  voidf   921030000
20594003                2.6667  voidf   921020000
*20509404                10.4596 voidf   921010000
*20509405                13.7904 voidf   920010000
*
* heater c1 level out to LabVIEW
20594100  c1lvlout     lag  1.00       33.0        0  3  0.  44.
```

```
20594101 0.5      cntrlvar 940  *lag time const.
*
* auto vlv position demand, c1 drain vlv, in %
20594900 c1draut      constant       32.
*
* drain vlv position, heater c1
20595000 c1drnpos    lag  0.01         0.32         0
20595001 0.05  cntrlvar 949
*
* cntrlvar 0951: RFW HTRC2 collapsed liquid level (inches above lower tap)
20595100 'HTRC2LVL'     sum     12.     18.0     1
20595101 -6.9974        5.4974  voidf   933010000
20595102               3.0000  voidf   932020000
20595103               3.0000  voidf   932010000
*20509514               8.8763  voidf   931010000
*20509515               10.2904 voidf   930010000
*
* heater c2 level out to LabVIEW
20595200  c2lvlout     lag  1.00       18.0         0  3  0.  36.      *prb
20595201 0.5      cntrlvar 951  *lag time const.
*
* auto vlv position demand, c2 drain vlv, in %
20595700 c2draut      constant    44.
*
* drain vlv position, heater c2
20595800 c2drnpos    lag  0.01         0.44         0
20595801 0.05 cntrlvar 957
*
* auto vlv position demand, c2 bypass vlv, in %
20595900 c2byaut      constant       0.0
*
* bypass vlv position, heater c2, normalized to 1.0
20596000 c2byppos    lag  0.01        0.0          0
20596001 0.05 cntrlvar 959
*
* cntrlvar 0965: RFW HTRC3 collapsed liquid level (inches above lower tap)
20596500 'HTRC3LVL'     sum     12.     18.0     0
20596501 -15.6068       7.0534  voidf   942040000
20596502               7.0534  voidf   942030000
20596503               3.0000  voidf   942020000
20596504               3.0000  voidf   942010000
*20509655               11.1133 voidf   941010000
*20509656               12.4284 voidf   940010000
*
```

```
* heater c3 level out to LabVIEW
20596600  c3lvlout     lag  1.00       18.0          0  3  0.  36.      *prb
20596601 0.5      cntrlvar 965  *lag time const.
*
* auto vlv position demand, c3 drain vlv, in %
20597100 c3draut      constant       34.
*
* drain vlv position, heater c3
20597200 c3drnpos    lag  0.01          0.34          0
20597201 0.05  cntrlvar 971
*
* cntrlvar 0975: RFW HTRC4 collapsed liquid level (inches above shell bottom)
20597500 'HTRC4LVL'     sum      12.     16.9375  0
20597501 0.0    0.1667  voidf   951010000   * upper tap 2" above centerline
20597502         2.9375  voidf   952010000   * shell radius
*
* heater c4 level out to LabVIEW
20597600  c4lvlout     lag  1.00       16.9375       0  3  0.  37.25    *prb
20597601 0.05      cntrlvar 975  *lag time const.
*
* auto vlv position demand, c4 drain vlv, in %
20598100 c4draut      constant     40.
*
* drain vlv position, heater c4, normalized to 1.0
20598200 c4drnpos    lag  0.01          0.40          0
20598201 0.05 cntrlvar 981
*
* auto vlv position demand, c4 bypass vlv, in %
20598300 c4byaut      constant       0.0
*
* bypass vlv position, heater c4, normalized to 1.0
20598400 c4byppos    lag  0.01          0.0           0                        *prb 01-24-96 10:46am
20598401 0.05 cntrlvar 983
*
* cntrlvar 0986: RFW HTRC5 collapsed liquid level (inches above shell bottom)
20598600 'HTRC5LVL'     sum      12.     15.0     0
20598601 -5.2188        2.500   voidf 960030000 * level taps are at top
20598602                 5.2188  voidf 960040000 * & bottom of collector tank
*
* heater c5 level out to LabVIEW
20598700  c5lvlout     lag  1.00       15.0          0  3  0.  30.      *prb
20598701 0.05      cntrlvar 986  *lag time const.
*
* auto vlv position demand, c5 drain vlv, in %
```

```
20599200 c5draut      constant        40.
*
* drain vlv position, heater c5, normalized to 1.0
20599300 c5drnpos    lag  0.01          0.40          0
20599301 0.05 cntrlvar 992
*
* auto vlv position demand, c5 bypass vlv, in %
20599400 c5byaut      constant         0.0
*
* bypass vlv position, heater c5, normalized to 1.0
20599500 c5byppos    lag  0.01         0.0          0                        *prb 01-25-96 09:22pm
20599501 0.05 cntrlvar 994
*
*
*---------------------------------------------
*  hydrodynamic components
*---------------------------------------------
*---------------------------------------------
*  reactor vessel
*---------------------------------------------
* note:  initial conditions are takent from the output
*       of a steady state calculation run for 1000 sec.
*
*       the brown's ferry retran input deck is
*       reference [349]
*-------------------------------------------
* (100)  entrance volume to core
*-------------------------------------------
1000000      lplenum     branch
*card      jun        vel/flow
1000001            1         0
*
*card     vol flow area   vol length    vol of vol   az angle
1000101      0.0           17.534      2230.000       0.
*card     inc angle    elev change roughness   hyd dia   pvbfe
1000102      90.        17.534        5.e-6     .8628    00000
*-------------------------------------------------------------
* volume length, volume, elev change, hyd dia are from ref. [349].
*-------------------------------------------------------------
*card      ebt       press     ul        ug       alpha
1000200   0 1.0450000e+03 5.1590997e+02 1.1091000e+03  0.
*
*  jun (100-01) lower plenum to core inlet
*-------------------------------------------
```

```
*card      from       to        area     kf     kr      fvcahs
1001101     100010000   110000000   37.503    0.0000  9.1510   001000
*------------------------------------------------------------------
* junction area is from ref. [349]
* kf:  modelling assumption
* kr:  ref. [349]
*------------------------------------------------------------------
*card      int. liq flow   int. vap flow      int vel
1001201     1.5436000e+01  1.7542999e+01   0.
*
*-------------------------------------------
*  (110) core inlet
*-------------------------------------------
*card      name        type
1100000    corein      branch
*
*card      jun        vel/flow
1100001           2        0
*
*card     vol flow area   vol length    vol of vol   az angle
1100101      0.0          0.492           37.710     0.
*card      inc angle    elev change roughness   hyd dia   pvbfe
1100102     90.         0.492         5.e-6      0.04461  00000
*-------------------------------------------------------------
* volume length, volume, elev change, hyd dia are from ref. [349].
*-------------------------------------------------------------
*card      ebt       press       ul        ug        alpha
1100200   0 1.0417000e+03 5.1590997e+02 1.1092000e+03  0.
*
*  jun (110-01) core inlet to reactor core
*------------------------------------------
*card      from       to        area     kf     kr     fvcahs
1101101     110010000   120000000  83.9636  0.615385 0.07692  001000
*------------------------------------------------------------------
* junction area, kf, and kr are from ref. [349].
*------------------------------------------------------------------
*card      int. liq flow   int. vap flow      inter. vel
1101201     6.0906000e+00  9.3687000e+00   0.
1102201     1.0246000e+02  1.0581000e+02   0.
*
*  jun (110-02) core inlet to core bypass
*------------------------------------------
*card      from       to        area     kf     kr      fvcahs
1102101     110010000   130000000   0.6590    0.084   0.648    001000
```

```
*------------------------------------------------------------------
* junction area is from ref. [349].
* kf:  modelling assumption used to achieve a 0.119 bypass ratio
* kr:  ref. [349]
*------------------------------------------------------------------
*
*  -------------------------------------------------------
*  (111)  loca time dependent junction
*  -------------------------------------------------------
*card     component name     type
1110000     locajun        tmdpjun
1110101     100000000   113000000  0.
1110200   1  468
1110201   -1.0  0.0  0.0  0.0
1110202    0.0  40.0 0.0  0.0
*
*
*  -------------------------------------------------------
*  (112)  single junction:  core region (120) - core exit (170)
*  --------------------------------------------------------
*card     component name     type
1120000     singjun        sngljun
*
*card   from vol    to vol     jun area    f loss   r loss  fvcahs
1120101 120010000  170000000    84.9744   0.10000   7.11200 001000
*------------------------------------------------------------------
* junction area, kf, and kr are from ref. [349].
*------------------------------------------------------------------
*
*card   vel/flow  int liq flow      int vapor flow      interface vel
1120201    0  1.6455999e+01  2.8388000e+01   0.
*
*------------------------------------
*  (113) loca time dependent volume
*------------------------------------
*card     component name     type
1130000   locavol          tmdpvol
1130101  0.  1. 1.  0.  0.  0.  0.  0.  00000
1130200  001
1130201 0.0 526. 0.
*
*------------------------------------
*  (120) core region  (pipe)
*------------------------------------
```

```
*card       component    type
1200000       core       pipe
*
*card       num vol
1200001       5
*card       vol flow area   vol
1200101       0.0          5
*card       jun flow area   jun
1200201       0.0          4
*card       vol length     vol
1200301       2.7386       5
*card       vol of vol     vol
1200401      232.7108       5
*card       azmuthal angle  vol
1200501       0.0          5
*card     inclination angle  vol
1200601      90.0          5
*card     elevation change   vol
1200701       2.7386       5
*card     wall roughness    hyd dia    vol
1200801       5.e-6      0.0446      5
*------------------------------------------
* vol length, vol, elev change are calculated in
* appendix a.  hyd dia from ref. [349].
*-------------------------------------------
*card       f loss coeff     r loss coeff    jun
1200901       2.0000           0.2500       4
*--------------------------------------------
* kf and kr are calculated in appendix a
*--------------------------------------------
*card         pvbfe          vol
1201001        11100           5
*
*card         fvcahs         jun
1201101        001000          4
*
*card    ebt   press       ul        ug     alpha      w5  vol
1201201 0 1.0410000e+03 5.3301001e+02 1.1092000e+03 1.1264000e-01  .0  1
1201202 0 1.0395000e+03 5.4077002e+02 1.1093000e+03 3.7233001e-01  .0  2
1201203 0 1.0377000e+03 5.4346002e+02 1.1093000e+03 4.7633001e-01  .0  3
1201204 0 1.0356000e+03 5.4379999e+02 1.1094000e+03 5.1504999e-01  .0  4
1201205 0 1.0334000e+03 5.4351001e+02 1.1095000e+03 6.8190002e-01  .0  5
*
*card        vel/flow
```

```
1201300 0
*
*card      int liq flow      int vap flow      inter vel  jun
1201301    6.8456001e+00  1.0574000e+01   0.         1
1201302    9.4076996e+00  1.5172000e+01   0.         2
1201303    1.0775000e+01  2.3551001e+01   0.         3
1201304    1.1115000e+01  3.1582001e+01   0.         4
*
*------------------------------
*  (130) core bypass  (branch)
*------------------------------
*card     component name     type
1300000     coreby         branch
*
*card       num jun       vel/flow
1300001           1        0
*
*card      vol flow area     vol length     vol of vol     az angle
1300101       0.0             13.693         952.140       0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1300102       90.0        13.693        5.0e-6      0.1867     00000
*----------------------------------------------------------------
* vol length, vol, elev change, hyd dia are from ref. [349].
*----------------------------------------------------------------
*card    ebt    press      ul       ug       alpha
1300200   0 1.0351000e+03 5.1590997e+02 1.1094000e+03  0.
*
*  jun (130-01)   core bypass - core exit
*------------------------------------------
*card    from vol     to vol   jun area    f loss    r loss    fvcahs
1301101  130010000  170000000   46.5040    0.747     0.374     001000
*-----------------------------------------------------------------
* junction area, kf, kr are from the ref. [349].
*-----------------------------------------------------------------
*card    int liq flow    int vap flow    inter vel
1301201      1.4520000e+00  6.1647000e+00   0.
*
*------------------------------------------
*  (140)   lower downcomer  (branch)
*------------------------------------------
*card     component name     type
1400000    lowerdc         branch
*card      num jun   vel/flow
1400001           2        0
```

```
*
*card      vol flow area     vol length     vol of vol   az angle
1400101        0.0           21.330        2004.467      0.0
*card      inc angle    elev change    rough      hyd dia     pvbfe
1400102      -90.0        -21.330      5.e-6    1.9452      00000
*-----------------------------------------------------------------
* vol length, vol, elev change are calculated in app a
* hyd dia from ref. [349]
*-----------------------------------------------------------------
*card       ebt      press       ul       ug    alpha
1400200   0 1.0323000e+03 5.1578003e+02 1.1095000e+03  0.
*
*  jun (140-01)    lower downcomer to recirculation pump suction(a)
*-------------------------------------------------------------
*card   from vol    to vol   jun area   f loss   r loss  fvcahs
1401101 140010000  220000000   3.5410    0.005    1.00   001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf modelling assumption,
* kr from ref. [349]
*-----------------------------------------------------------------
*card    int liquid flow      int vapor flow    inter vel
1401201      2.8816000e+01  3.0966000e+01   0.
1402201      2.8816000e+01  3.0966000e+01   0.
*
*  jun (140-02)   lower downcomer to recirculation pump suction(b)
*-------------------------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss  fvcahs
1402101 140010000  270000000   3.5410     0.005     1.00  001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf modelling assumption,
* kr from ref. [349]
*-----------------------------------------------------------------
*
*-----------------------------------
*  (150)  middle downcomer  (branch)
*-----------------------------------
*card     component name     type
1500000     middledc        branch
*card       num jun       vel/flow
1500001           1         0
*
*card      vol flow area     vol length     vol of vol     az angle
1500101       0.0            12.739       1411.466        0.0
*card      inc angle    elev change    roughness    hyd dia  pvbfe
```

```
1500102      -90.0       -12.739      5.e-6      2.716    00000
*-----------------------------------------------------------------
* see note with card 1400101
*-----------------------------------------------------------------
*card       ebt    press      ul     ug     alpha
1500200   0 1.0266000e+03 5.1595001e+02 1.1097000e+03  0.
*
*  jun (150-01)   middle downcomer to lower downcomer
*------------------------------------------------
*card   from vol    to vol    jun area  f loss   r loss  fvcahs
1501101 150010000  140000000   87.0380   0.00    0.00    001000
*------------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*------------------------------------------------------------------
*card    int liquid flow     int vapor flow   inter vel
1501201      2.3452001e+00  2.9754000e+00   0.
*
*---------------------------------------
*  (160) upper downcomer
*---------------------------------------
*card      name         type
1600000    uppdc        branch
*
*card      jun        vel/flow
1600001           1        0
*
*card     area   length of vol   vol of vol    az angle
1600101    0.        6.167         965.359      0.0
*card    inc angle   elev change   roughness    hyd dia    pvbfe
1600102    -90.      -6.167         5.e-6       0.8132    00000
*--------------------------------------------------------------
* see note with card 1400101
*--------------------------------------------------------------
*card     ebt    press      ul       ug        alpha
1600200   0 1.0242000e+03 5.2938000e+02 1.1099000e+03 6.2769002e-01
*
*   jun (160-01)   upper downcomer to middle downcomer
*------------------------------------------------------
*card     from       to         area      kf     kr    fvcahs
1601101   160010000   150000000   156.536    0.00   0.00   001000
*---------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*---------------------------------------------------------------
*card    int liq flow   int vap flow     inter. vel.
```

```
1601201     -1.8235701e-04 -1.7219000e+00   0.
*
*----------------------------------
*  (170)  core exit  (branch)
*----------------------------------
*card     component name     type
1700000      uplenum       branch
*card        num jun       vel/flow
1700001            0        0
*
*card      vol flow area     vol length     vol of vol     az angle
1700101        0.0             12.739         1330.250        0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1700102        90.0        12.739        5.e-6       0.5054    10000
*-----------------------------------------------------------------
* vol length, vol, elev change, hyd dia from ref. [349]
*-----------------------------------------------------------------
*card        ebt    press      ul      ug       alpha
1700200   0 1.0315000e+03 5.4301001e+02 1.1095000e+03 5.4667002e-01
*
*---------------------------------------------
*  (180) steam separator  (branch:separator)
*---------------------------------------------
*card     component name       type
1800000   seprt               separatr
*
*card        num jun          vel/flow
1800001            3        0
*
*card      vol flow area     vol length     vol of vol     az angle
1800101        0.0           6.167           461.676        0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1800102      90.0       6.167          5.e-6       0.7658     00010
*------------------------------------------------------------------
* vol length, vol, elev change, hyd dia from ref. [349]
*------------------------------------------------------------------
*card      ebt  pres      ul        ug     vapor void fraction
1800200   0 1.0251000e+03 5.4235999e+02 1.1096000e+03 6.9423002e-01
*
*  jun (180-01)   separator - steam dome
*-------------------------------------
*card   from vol    to vol    jun area  f loss  r loss  fvcahs   void
1801101 180010000 190000000 280.478 150. 150.   001000 0.5 * kwr
*-------------------------------------------------------------------
```

```
* junction area is set equal to the volume flow area of the steam dome
* kf, kr from ref. [349]
*----------------------------------------------------------------------
*card   int liq flow   int vap flow  inter vel
1801201      3.4347999e-01  5.7609000e+00   0.
1802201      8.6007996e+00  8.6309996e+00   0.
1803201      1.0917000e+01  2.7964001e+01   0.
*
*   jun (180-02)   separator to middle downcomer
*------------------------------------------------
*card   from vol   to vol    jun area  f loss   r loss   fvcahs  void
1802101 180000000 150000000 60.0000 3.    3.    001000 0.15 * kwr

*----------------------------------------------------------------------
* junction area from ref. [349] (50.6358) was too small and restricted
* flow to the middle downcomer, so a new value was used that would allow
* the required mass flow to the middle downcomer.  kf and kr from ref.
* [349]
*----------------------------------------------------------------------
*   jun (180-03) core exit to steam separator
*------------------------------------------------
*card   from vol   to vol     jun area   f loss  r loss   fvcahs
1803101 170010000 180000000 104.423 13.4 13.4 001000 * kwr
*----------------------------------------------------------------------
* junction area from ref. [349].  kf and kr:  modelling assumption
* used to acheive the required flow
*----------------------------------------------------------------------
*
*---------------------------------
*  (190) steam dome  (branch)
*---------------------------------
*card     component name     type
1900000      stdome        branch
*
*card       num jun       vel/flow
1900001            2         0
*1900001      3           0
*
*card      vol flow area     vol length     vol of vol     az angle
1900101        0.0            22.318         6259.714        0.0
*card      inc angle    elev change    roughness    hyd dia    pvbfe
1900102        90.0        22.318        5.e-6        17.932    11000
*---------------------------------------------------------------------
* vol length, vol, elev change, hyd dia from the retran input deck
```

```
*----------------------------------------------------------------
*card      ebt    press       ul         ug       alpha
1900200   0 1.0236000e+03 5.4206000e+02 1.1097000e+03 9.9997002e-01
*
*   jun (190-01)   steam dome to main steamline
*-------------------------------------
*card     from          to          area     kf      kr     fvcahs
1901101   190010000     400000000    12.6713   1.6937  1.6937 001000
*1901101   190010000     400000000    12.6713   1.2000  1.0000 001000
*----------------------------------------------------------------
* junction area from retran input deck.  kf and kr:  modelling
* assumption used to achieve the required flow
*----------------------------------------------------------------
*card     int. liq flow   int vap flow     inter. vel
1901201      1.2182000e+02  1.2764000e+02   0.
1902201      2.6910000e+00 -2.8625701e-04   0.
*1903201   3.4839001e+00  -3.3684799e-05  0.0000000e+00
*
*   jun (190-02) steam dome to upper downcomer
*----------------------------------------------------
*card     from        to         area     kf     kr     fvcahs
1902101   190000000   160000000  136.0630  0.00   0.00   001000
*----------------------------------------------------------------
* junction area, kf, kr from ref. [349]
*----------------------------------------------------------------
*
*-------------------------------------------------------
*  jet pumps and recirculation loops
*-------------------------------------------------------
*  loop a
*-------------------------------------------------------
*------------------------------------------
*****(200)  jet pump (a) (branch:*****jetmixer)
*------------------------------------------
*card     component name     type
2000000      jetpa        jetmixer
*card       num jun       vel/flow
2000001           3        0
*
*card      vol flow area     vol length     vol of vol     az angle
2000101         0.0           7.0000         27.840           0.0
*card      inc angle    elev change    roughness     hyd dia     pvbfe
2000102       -90.0       -7.0000        5.e-6      5.0       00000
*----------------------------------------------------------------
```

```
* see calculations in appendix c for vol length, vol, elev change.
* hyd dia from ref. [349]
*-----------------------------------------------------------------
*card      ebt   press      ul        ug     alpha
2000200   0 1.0118000e+03 5.1594000e+02 1.1101000e+03  0.
*
*  jun (200-01)   recirculation discharge (a) to jetpump (a)
*-----------------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss  fvcahs
2001101 240010000  200000000    0.8226    1.1      1.100  001000
*-----------------------------------------------------------------
* junction area, kf and kr used to achieve required flow.
*-----------------------------------------------------------------
*card   int liq flow    int vapor flow    inter vel
2001201      1.2392000e+02  1.2392000e+02   0.
2002201      6.7608002e+01  7.0873001e+01   0.
2003201      7.8358002e+01  8.2028000e+01   0.
*
*  jun (200-02) middle downcomer to jet pump (a)
*--------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss   fvcahs
2002101 150010000  200000000    2.7724   0.24     5.000   001000
*-----------------------------------------------------------------
* junction area, kf and kr used to achieve required flow.
*-----------------------------------------------------------------
*  jun (200-03)   jet pump (a) to jet pump diffuser
*--------------------------------------------
*card    from vol   to vol    jun area   f loss    r loss   fvcahs
2003101 200010000  210000000   3.6950     0.0       0.0     001000
*-----------------------------------------------------------------
* junction area from ref. [349], kf and kr used to achieve required flow.
*-----------------------------------------------------------------
*
*-----------------------------------------------
*  (210) jet pump diffuser (a)
*-----------------------------------------------
*card          name          type
2100000        diffa         branch
*
*card      jun          vel/flow
2100001           1        0
*card      area    length      volume    az angle
2100101    0.0       7.1851     83.520     0.0
*card     incl angle    dz    rough      dh      pvbfe
```

```
2100102    -90.0     -7.1851   5.e-6     0.0     00000
*----------------------------------------------------------------
* see calculations in appendix c
*----------------------------------------------------------------
*card     ebt      press      ul        ug       alpha
2100200   0 1.0379000e+03 5.1594000e+02 1.1093000e+03  0.
*
* jun (210-01) jet pump diffuser (a) to lower plenum
*---------------------------------------------------
*card    from        to        area     kf      kr    fvcahs
2101101  210010000  100010000  19.689  0.15   0.15   001000
*----------------------------------------------------------------
* junction area from ref. [349].  kf and kr:  modelling
* assumption used to achieve the required pressure and flow.
*----------------------------------------------------------------
*card    init liq flow   init vap flow     inter vel
2101201      1.4702000e+01  1.6590000e+01   0.
*
*-------------------------------------------
*  (220) recirculation suction (a)
*-------------------------------------------
*card         component        type
2200000          recira        snglvol
*
*card      vol flow area     vol length   vol of vol    az angle
2200101        0.0              47.427      167.939       0.0
*card      inc angle    elev change   roughness    hyd dia   pvbfe
2200102      -28.95      -41.499       5.e-6       1.0617   01000
*------------------------------------------------------------------
* see calculations in appendix c.
*------------------------------------------------------------------
*card   ebt     press       ul         ug        alpha
2200200   0 1.0375000e+03 5.1578998e+02 1.1093000e+03  0.  0.
*
*----------------------------------------
*  (230) recirculation pump (a)
*----------------------------------------
*card     component      type
2300000     pumpa       pump
*
*card      vol flow area     vol length     vol of vol     az angle
2300101         0.0           28.235          76.344         0.0
*card      inc angle    elev change    pvbfe
2300102      13.22        6.457        00000
```

```
*-----------------------------------------------------------------
* see calculations in appendix c.
*-----------------------------------------------------------------
*
*pump junction geometry cards:
*card     from vol     jun area   f loss cof     r loss cof  vcahs
2300108    220010000      0.0        1.000         1.000      00000
*card     to vol       jun area   f loss cof     r loss cof  vcahs
2300109    240000000      0.0        10.00         10.00     00000
*-----------------------------------------------------------------
* kf and kr from ref. [349]
*-----------------------------------------------------------------
*pump initial condition cards:
*card     ebt   press      ul     ug      alpha
2300200  0 1.1499000e+03 5.1589001e+02 1.1059000e+03  0.  0.
*card      vel/flow     int liquid flow    int vapor flow     inter
2300201  0  3.7737000e+01  3.7737000e+01   0.
2300202  0  3.9660000e+01  3.9660000e+01   0.
*
*pump index and option card
*card   indic  2p    2pd   motor pump torq   tdp vel  pump trip  rev
2300301  280   -1    -3        -1             0       408      0
*
*pump description card (from ref. [1] pg 6i)
*card     pump vel    ratio     flow      head    torque    inertia
2300302   1.6200000e+03 9.7660494e-01 4.5200000e+04 7.6325000e+02 2.1326699e+04
2300303   1.9174500e+04
*card     density   motor torw      w1       w2   w3   w4
2300304    47.167       0.0         1122.5   0.0  0.0  0.0
*-----------------------------------------------------------------
* since this model has two loops the flow, torque, and inertia values
* from ref. [349] were divided in half.
*-----------------------------------------------------------------
*
* speed table
2306100 501 cntrlvar 264
2306101 0. 0.
2306102 1.e4 1.e4
*
*
*------------------------------------------
*  (240) recirculation discharge (a)
*------------------------------------------
*card        component       type
```

```
2400000        discha        snglvol
*
*card      vol flow area   vol length   vol of vol    az angle
2400101       0.0         115.912       297.963        0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2400102      29.10        56.372         5.e-6      0.949     01000
*------------------------------------------------------------------
* see calculations in appendix c.
*------------------------------------------------------------------
*card   ebt   press       ul        ug        alpha
2400200   0 1.1711000e+03 5.1591998e+02 1.1053000e+03  0. 0.
*
*---------------------------------------------------------
*  !jet pumps and recirculation loops
*---------------------------------------------------------
*  loop b
*---------------------------------------------------------
*----------------------------------------
*  (250)  jet pump (b) (branch:jet mixer)
*----------------------------------------
* see card 200 for reference.
*---------------------------------------------------------
*card     component name     type
2500000    jetpb          jetmixer
*card       num jun        vel/flow
2500001           3        0
*
*card      vol flow area   vol length   vol of vol    az angle
2500101      0.0          7.0000      27.840        0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2500102       -90.0       -7.0000        5.0e-6     5.0      00000
*
*card        ebt      press       ul        ug    alpha
2500200   0 1.0118000e+03 5.1594000e+02 1.1101000e+03  0.
*
*  jun (250-01)   recirculation discharge (b) to jetpump (b)
*-------------------------------------------------------
*card   from vol    to vol     jun area   f loss   r loss   fvcahs
2501101 290010000  250000000    0.8226    1.1       1.100   001000
*
*card    int liquid flow    int vapor flow    inter vel
2501201      1.2392000e+02  1.2392000e+02   0.
2502201      6.7608002e+01  7.0873001e+01   0.
2503201      7.8358002e+01  8.2028000e+01   0.
```

```
*
*  jun (250-02)   middle downcomer to jet pump (b)
*----------------------------------------------
*card   from vol    to vol    jun area   f loss   r loss   fvcahs
2502101 150010000  250000000    2.7724    0.24    5.000    001000
*---------------------------------------------------------
*
*  jun (250-03)    jet pump (b) to jet pump diffuser
*---------------------------------------------
*card   from vol    to vol    jun area   f loss    r loss   fvcahs
2503101 250010000  260000000   3.695      0.0        0.0    001000
*
*---------------------------------------------------------
*  (260) jet pump diffuser (b)
*---------------------------------------------------------
* see card 210 for references.
*------------------------------------------------------------------
*card        name           type
2600000      diffb          branch
*
*card        jun        vel/flow
2600001           1        0
* card      area    length   volume    az angle
2600101     0.0     7.1851   83.520      0.0
*card    incl angle   dz     rough     dh     pvbfe
2600102   -90.0      -7.1851   5.e-6     0.0     00000
*
*card     ebt     press      ul      ug      alpha
2600200   0 1.0379000e+03 5.1594000e+02 1.1093000e+03  0.
*
*  jun (260-01) jet pump diffuser (b) to lower plenum
*--------------------------------------------------------
*card    from       to       area    kf     kr     fvcahs
2601101  260010000  100010000  19.689 0.15   0.15    001000
*
*card   init liq flow  init vap flow   inter vel
2601201      1.4702000e+01  1.6590000e+01   0.
*
*--------------------------------------------
*  (270)  recirculation suction (b)
*--------------------------------------------
* see card 220 for references.
*------------------------------------------------------------
*card         component        type
```

```
2700000        recirb         snglvol
*
*card      vol flow area   vol length   vol of vol   az angle
2700101        0.0          47.427       167.939       0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2700102      -28.95       -41.499        5.0e-6       1.0617   01000
*card        ebt       press        ul         ug       alpha
2700200   0 1.0375000e+03 5.1578998e+02 1.1093000e+03  0.  0.
*
*------------------------------------------
*  (280)  recirculation pump (b) (pump)
*------------------------------------------
*see card 230 for references, unless otherwise noted.
*-----------------------------------------------------------------
*card     component      type
2800000      pumpb       pump
*
*card      vol flow area   vol length   vol of vol   az angle
2800101       0.0          28.235         76.344       0.0
*card      inc angle    elev change    pvbfe
2800102      13.22        6.457        00000
*
*pump junction geometry cards:
*card      from vol     jun area   f loss cof     r loss cof  vcahs
2800108   270010000       0.0         1.000         1.000    00000
*card      to vol       jun area   f loss cof     r loss cof  vcahs
2800109   290000000       0.0         10.00         10.00     00000
*
*pump initial condition cards:
*card      ebt    press      ul       ug    alpha
2800200  0 1.1499000e+03 5.1589001e+02 1.1059000e+03  0.  0.
*
*card      vel/flow     int liquid flow    int vapor flow     inter vel
2800201  0  3.7737000e+01  3.7737000e+01   0.
2800202  0  3.9660000e+01  3.9660000e+01   0.
*
*pump index and option card
*card   indic  2p    2pd   m pump torq   tdp vel   pump trip   rev
2800301   0    -1    -3         -1          0        408       0
*
*pump description card
*card      pump vel    ratio     flow       head   torque    iner
2800302   1.6200000e+03 9.7660494e-01 4.5200000e+04 7.6325000e+02 2.1326699e+04
2800303   1.9174500e+04
```

```
*card     density   motor torw   w1       w2    w3    w4
2800304   47.167      0.0       1122.5     0.0   0.0   0.0
*
* single phase homologous curves (from ref. [349])
*
* pump head curves
*card     type   regime   phead1   phead2   phead1   phead2
2801100    1      1       0.0      1.41     0.25     1.365
2801101                   0.33     1.345    0.50     1.280
2801102                   0.67     1.195    0.75     1.150
2801103                   1.00     1.00
*
2801200    1      2       0.2      -0.32    0.25     -0.290
2801201                   0.33     -0.230   0.40     -0.170
2801202                   0.50     -0.05    0.60     0.100
2801203                   0.67     0.230    0.75     0.390
2801204                   0.80     0.500    1.00     1.000
*
2801300    1      3       -1.      1.920    -0.80    1.725
2801301                   -0.67    1.625    -0.50    1.540
2801302                   -0.33    1.480    -0.25    1.465
2801303                   -0.01    1.420    0.00     1.410
*
2801400    1      4       -1.00    2.24     -0.66    1.180
2801401                   -0.50    0.800    -0.24    0.64
*
2801500    1      5       0.00     0.926    0.25     0.882
2801501                   0.33     0.884    0.50     0.908
2801502                   0.67     0.948    0.75     0.960
2801503                   1.00     1.00
*
2801600    1      6       0.20     -0.314   0.25     -0.250
2801601                   0.33     -0.140   0.40     -0.051
2801602                   0.50     0.100    0.60     0.275
2801603                   0.67     0.387    0.75     0.530
2801604                   0.80     0.627    1.00     1.00
*
2801700    1      7       -1.00    -1.880   -0.67    1.450
2801701                   -0.50    1.270    -0.33    1.140
2801702                   -0.25    1.070    -0.01    0.930
2801703                   0.00     0.926
*
2801800    1      8       -1.00    1.760    0.66     1.080
2801801                   -0.50    0.920    -0.24    0.720
```

```
*
* pump torque curves
*card     type   regime  ptork1   ptork2   ptork1   ptork2
2801900    2       1      0.0     0.930    0.25     0.870
2801901                  0.33     0.890    0.50     0.900
2801902                  0.67     0.960    0.75     0.950
2801903                  1.00     1.000
*
2802000    2       2      0.20    -7.84     0.25    -4.000
2802001                  0.33    -1.16     0.40    -0.320
2802002                  0.50     0.40     0.60     0.820
2802003                  0.67     0.87     0.75     1.000
2802004                  0.80     0.98     0.99     0.999
*
2802100    2       3     -1.00     1.88    -0.67     1.450
2802101                 -0.50     1.27    -0.33     1.140
2802102                 -0.25     1.07    -0.01     0.930
*
2802200    2       4     -0.99     1.760   -0.66     2.400
2802201                 -0.50     3.840   -0.24    12.500
*
2802300    2       5      0.00    -0.720    0.30    -0.600
2802301                  0.42    -0.400    0.50    -0.050
2802302                  0.75     0.250    1.00     0.57
*
2802400    2       6      0.00     1.44     0.10     1.400
2802401                  0.22     1.20     0.33     1.100
2802402                  0.55     1.00     0.80     0.80
2802403                  1.00     0.57
*
2802500    2       7     -1.00    -2.00    -0.30    -1.500
2802501                 -0.18    -1.35    -0.07    -1.000
2802502                  0.00    -0.92
*
2802600    2       8     -1.00    -2.00    -0.25    -1.800
2802601                 -0.12    -1.50    -0.08    -1.400
2802602                  0.00    -1.00
*
* speed table
2806100 502 cntrlvar 265
2806101 0. 0.
2806102 1.e4 1.e4
*
* tmp - use simple target-core-flow controller
```

```
*2806100 408 cntrlvar 831
*
* tmp - ramp pump speed from somewhere to somewhere else and hold
*2806100 408
*2806101 0. 1581.48 60. 982.
*
*-------------------------------------------
*  (290)  recirculation discharge piping (b)
*-------------------------------------------
* see card 240 for references.
*------------------------------------------------------------------
*card        component       type
2900000        dischb          snglvol
*card      vol flow area     vol length     vol of vol     az angle
2900101       0.00            115.912       297.963        0.0
*card      inc angle    elev change    roughness    hyd dia   pvbfe
2900102       29.10       56.372        5.0e-6       0.949    01000
*
*card        ebt       press       ul        ug      alpha
2900200   0 1.1711000e+03 5.1591998e+02 1.1053000e+03  0.  0.
*
*-------------------------------------------------
*  hpci and rcic systems
*-------------------------------------------------
*------------------------------------------
*(300) hpci and rcic supply
*------------------------------------------
*card      name        type
3000000     rcicvola      tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3000101     5.0          10.0           0.0       0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3000102       90.          10.0       0.00015    1.0     00010
*-------------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-------------------------------------------------------------
*card      ebt        trip no.
3000200    001          408
*card     search variable     temp    quality
3000201       0.              99.99   0.0
*-------------------------------------------------------------
* the thermodynamic values are based on nominal pool temperature
*-------------------------------------------------------------
```

```
*
*-------------------------------------------
*(301) hpci and rcic supply
*-------------------------------------------
*card      name        type
3010000    rcicvolb     tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3010101    5.0          10.0            0.0        0.0
*card    incl. angle   elev change   roughness  hyd dia   pvbfe
3010102      90.          10.0        0.00015    1.0     00010
*------------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*------------------------------------------------------------
*card      ebt         trip no.
3010200   001           408
*card    search variable    temp    quality
3010201      0.              99.99   0.0
*------------------------------------------------------------
* the thermodynamic values are based on nominal pool temperature
*------------------------------------------------------------
*
*
*-------------------------------------------
* (310) hpci supply valve
*-------------------------------------------
*card       name        type
3100000    hpcijun      tmdpjun
*
*card     from          to          jun area
3100101   301000000    150000000     1.
*card     control word    table trip
3100200        1        631
*card     search var.    liq vel/flow  vap vel/flow    inter. vel
3100201     -1.             0.          0.           0.
3100202      0.             0.          0.           0.
3100203     20.           694.          0.           0.
*
*-------------------------------------------
*(320) rcic supply valve
*-------------------------------------------
*card       name        type
3200000    rcicjun     tmdpjun
*
```

```
*card     from          to          jun area
3200101   300000000    150000000    1.
*card     control word    table trip
3200200        1           637
*card     search var.    liq vel/flow   vap vel/flow    inter. vel
3200201     -1.            0.          0.          0.
3200202      0.            0.          0.          0.
3200203     20.           82.4         0.          0.
*
*-------------------------------------------
*(350) hpci and rcic exhaust
*-------------------------------------------
*card       name         type
3500000    exhausta      tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3500101     5.0         10.0           0.0        0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3500102      90.          10.0       0.00015    1.0     00010
*-----------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-----------------------------------------------------------
*card      ebt          trip no.
3500200    001           408
*card     search variable    temp    quality
3500201      0.            212.0    1.0
*-----------------------------------------------------------
* the thermodynamic values are for steam at atmospheric conditions
*-----------------------------------------------------------
*
*-------------------------------------------
*(351) hpci and rcic exhaust
*-------------------------------------------
*card       name         type
3510000    exhaustb      tmdpvol
*
*card    flow area   length of vol   vol of vol   az angle
3510101     5.0         10.0           0.0        0.0
*card     incl. angle   elev change   roughness  hyd dia   pvbfe
3510102      90.          10.0       0.00015    1.0     00010
*-----------------------------------------------------------
* length, vol, elev change, hyd dia values are assumed.
*-----------------------------------------------------------
*card      ebt          trip no.
```

```
3510200    001          408
*card     search variable     temp    quality
3510201      0.            212.0     1.0
*------------------------------------------------------------
* the thermodynamic values are for steam at atmospheric conditions
*------------------------------------------------------------
*
*---------------------------------------------
*(360) hpci turbine supply
*---------------------------------------------
*card       name         type
3600000    hpciturb     tmdpjun
*
*card     from         to          jun area
3600101   190000000    351000000     1.
*card     control word    table trip
3600200      1            631
*card     search var.    liq vel/flow  vap vel/flow    inter. vel
3600201     -1.           0.            0.          0.
3600202      0.           0.            58.3         0.
*
*---------------------------------------------
*(370) rcic turbine supply
*---------------------------------------------
*card       name         type
3700000    rcicturb     tmdpjun
*
*card     from         to          jun area
3700101   190000000    350000000     1.
*card     control word    table trip
3700200      1            636
*card     search var.    liq vel/flow  vap vel/flow    inter. vel
3700201     -1.           0.            0.          0.
3700202      0.           0.            9.17        0.
*
*--------------------------------------------------
*  main steam system
*--------------------------------------------------
*-------------------------------------------
*  (400) main steam line
*-------------------------------------------
*card        component       type
4000000       steamln        snglvol
*
```

```
*card       vol flow area    length   vol of vol   az angle
4000101          0.0         116.770    1507.501      0.0
*card        incl angle   elev change   roughness   hyd dia   pvbfe
4000102         33.777      64.720       5.e-6      8.108    11000
*-------------------------------------------------------------------
* see calculations in appendix c.
*-------------------------------------------------------------------
*card       ebt    press      ul      ug       alpha
4000200   0 1.0120000e+03 5.4041998e+02 1.1095000e+03 9.9992001e-01  0.
*
*-----------------------------------------------------
* main steam valve double (representative of 2 msivs)
*-----------------------------------------------------
*
4100000     msiv_d     valve
*
*card   from vol   to vol      jun area  f loss    r loss   fvcahs
4100101 400010000  420000000    6.4550     4.0       4.5    001020
*-----------------------------------------------------------------
* junction flow area is representative of 2 msiv's.  see calculations
* in appendix c.  kf and kr are assumed.
*-----------------------------------------------------------------
*card      flag      int liq flow   int vap flow   inter vel
4100201    0  1.2715000e+02  1.2715000e+02   0.
*
*card     valve type
4100300     mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4100301      409          666        0.25              1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4100401 0. 1.e6 1.e6
4100402 1. 1.e6 1.e6
*
*------------------------------------------------------
* main steam valve single 1 (representative of 1 msiv)
*------------------------------------------------------
*
4110000     msiv_s1     valve
*
*card   from vol   to vol      jun area  f loss    r loss   fvcahs
4110101 400010000  420000000     3.227     4.10      4.5    001020
```

```
*-----------------------------------------------------------------
* junction flow area is representative of 1 msiv.  see calculations
* in appendix c.  kf and kr are assumed.
*-----------------------------------------------------------------
*
*card      flag      int liq flow   int vap flow   inter vel
4110201    0  1.2594000e+02  1.2594000e+02   0.
*
*card     valve type
4110300     mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4110301      409          665        0.25               1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4110401 0. 1.e6 1.e6
4110402 1. 1.e6 1.e6
*
*----------------------------------------------------
* main steam valve single 2 (representative of 1 msiv)
*----------------------------------------------------
*
4120000      msiv_s2     valve
*
*card   from vol   to vol      jun area  f loss    r loss   fvcahs
4120101 400010000  420000000     3.227     4.10      4.5    001020
*-----------------------------------------------------------------
* junction flow area is representative of 1 msiv.  see calculations
* in appendix c.  kf and kr are assumed.
*-----------------------------------------------------------------
*
*card      flag      int liq flow   int vap flow   inter vel
4120201    0  1.2594000e+02  1.2594000e+02   0.
*
*card     valve type
4120300     mtrvlv
*
*card    open trip     close trip   vel change rate    init pos  table
4120301      409          605        0.25               1.       545
* valve closes in 4 sec. -- initial position = 1.0; fully open
*
* table defined to give negligible form loss
4120401 0. 1.e6 1.e6
```

```
4120402 1. 1.e6 1.e6
*
*------------------------------------------
*  (420) main steam header to turbine -- 4 line
*------------------------------------------
*        name               type
4200000   turbine             pipe
*
*card    number of vols
4200001      3
*
*card      vol area      vol number
4200101      0.0           3
*
*card     init jun flow area    jun number
4200201       10.875             2
*
*card    pipe vol length   vol number
4200301      58.271         1
4200302      35.670         2
4200303      12.000         3
*
*card    vol of vol       vol number
4200401    633.529          1
4200402    387.911          2
4200403    130.494          3
*
*card     az angle        vol number
4200501      0.0            3
*
*card     incl. angle      vol number
4200601      0.0            1
4200602    90.00            3
*
*card     elev change      vol number
4200701      0.0            1
4200702    35.670           2
4200703    12.000           3
*
*card     roughness    hyd dia    vol number
4200801    5.0e-6      7.442       3
*------------------------------------------------------------
* see calculations in appendix c for vol length, vol, elev change
* and hyd dia.
```

```
*-----------------------------------------------------------------
*card       kf          kr      jun number
4200901    2.500      2.500        1
4200902    0.000      1.710        2
*-----------------------------------------------------------------
* kf and kr values were used that would maintain the pressure in
* volume 420-03 equal to 970 psi.
*-----------------------------------------------------------------
*card     pvbfe       vol number
4201001   11000          3
*card     fvcahs       jun number
4201101   001020         2
*card     ebt     press     ul     ug     alpha
4201201 0 9.9373999e+02 5.3834998e+02 1.1090000e+03 9.9984998e-01  .0  1
4201202 0 9.7894000e+02 5.3546997e+02 1.1101000e+03 9.9967003e-01  .0  2
4201203 0 9.7832001e+02 5.3535999e+02 1.1103000e+03 9.9963999e-01  .0  3
*
*card  pipe vol control word
4201300 0
*card  init liq flow   init vap flow   inter vel    jun number
4201301     1.5260001e+02  1.5260001e+02   0.          1
4201302     1.5496001e+02  1.5496001e+02   0.          2
*
*
*----------------------------------------------
*(430) turbine control and stop valve
*----------------------------------------------
*card     name        type
4300000   tcs-valv    tmdpjun
*card    from        to         area
4300101  420010000   450000000    10.875
*--------------------------------------------------------------------
* area set equal to area of volume 420-03.
*--------------------------------------------------------------------
*card    vel/flow    table trip #    var req     num var req
4300200     0           408         cntrlvar    538
*card     search var     init liq vel   init vap vel    inter vel
4300201     -1.           152.99         152.99         0.
4300203      0.            0.             0.           0.
4300204      1.e+4          1.e+4          1.e+4       0.
*
*----------------------------
*(440)  turbine bypass valve
*----------------------------
```

```
4400000 bypsvlv tmdpjun
4400101 420010000 451000000 0.
4400200 0 408 cntrlvar 552
*
4400201 -1.   0.   0.   0.
4400202  0.   0.   0.   0.
4400203  1.e+4  1.e+4  1.e+4  0.
*
*-----------------------------------------------
*  (450)  main condenser (steam exhaust)
*-----------------------------------------------
*card     name      type
4500000   condns1a   tmdpvol
*card    vol flow area    length   vol of vol     az angle
4500101   1.0+6           0.0       1.0+6        0.0
*card     incl angle    elev change   roughness   hyd dia   pvbfe
4500102      0.0          0.0          0.0       0.0     00010
*----------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*----------------------------------------------------------------
*card     ebt        trip #
4500200   003        401
*card    search var    press    temp
4500201     0.0       916.0     544.
*-----------------------------------------------------------------
* thermodynamic values are assumed.
*-----------------------------------------------------------------
*
*
*-----------------------------------------------
*  (451)  main condenser (steam exhaust)
*-----------------------------------------------
*card     name      type
4510000   condns1b   tmdpvol
*card    vol flow area    length   vol of vol     az angle
4510101   1.0+6           0.0       1.0+6        0.0
*card     incl angle    elev change   roughness   hyd dia   pvbfe
4510102      0.0          0.0          0.0       0.0     00010
*----------------------------------------------------------------
* vol flow area, vol, elev change, hyd dia are assumed.
*----------------------------------------------------------------
*card     ebt          trip #
4510200   003          408
*card    search var    press    temp
```

4510201 0.0 14.7 212.
*--
* thermodynamic values are for steam at atmospheric conditions.
*--
*
*--
* (460) suppression pool
*--
*card name type
4600000 spool1a tmdpvol
*card area length vol of vol az angle
4600101 1.0e+6 0.0 1.0e+6 0.0
*card incl angle elev change roughness hyd dia pvbfe
4600102 0.0 0.0 0.0 0.0 00010
*---
* vol flow area, vol, elev change, hyd dia are assumed.
*---
*card ebt trip #
4600200 003 408
*card search var. press temp
4600201 0.0 14.7 212.
*--
* thermodynamic values are for steam at atmospheric conditions.
*--
*
*
*--
* (461) suppression pool
*--
*card name type
4610000 spool1b tmdpvol
*card area length vol of vol az angle
4610101 1.0e+6 0.0 1.0e+6 0.0
*card incl angle elev change roughness hyd dia pvbfe
4610102 0.0 0.0 0.0 0.0 00010
*---
* vol flow area, vol, elev change, hyd dia are assumed.
*---
*card ebt trip #
4610200 003 408
*card search var. press temp
4610201 0.0 14.7 212.
*--
* thermodynamic values are for steam at atmospheric conditions.

```
*-------------------------------------------------------------
*
*---------------------------------------
* s/rv valves
*---------------------------------------
*-----------------------------------------------
* (470) safety relief valve #1
*-----------------------------------------------
4700000 srv1 valve
4700101 400000000 460000000  0.4300   1.0  1.0  000100
* valve area required to achieve correct mass flow through
* each valve.  valves max flow = 950,000 lb/hr each.
* mass flow through bank #1 should be equal to 1056 lb/s.
4700201    0   0.   0.   0.
4700300 trpvlv
4700301 656
*
*----------------------------------------------
* (480) safety relief valve #2
*----------------------------------------------
4800000 srv2 valve
4800101 400000000 461000000  0.9800   1.0   1.0  000100
4800201    0   0.   0.   0.
* valve area required to achieve correct mass flow through
* each valve.  valves max flow = 950,000 lb/hr each.
* mass flow through bank #2 should be equal to 2375 lb/s.
4800300 trpvlv
4800301 661
*
*
*
*--------------------- |
*    heat structures    |
*--------------------- |
*----------------------------------------
* (1)  nuclear heat structures  (core region)
* ----------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11201000    5    4    2    0    .00000e+00
*
*card      loc flag    format flag
11201100      0           1
*
*card      num intervals   right coordinate
```

```
11201101       1        .01708        *  uo-2 pellet
11201102       1        .01745        *  he-gap
11201103       1        .020117        *  zircaloy-2 clad
*-----------------------------------------------------------
* coordinates from ref. [349]
*-----------------------------------------------------------
*card       comp num    interval num
11201201      1            1
11201202     -2            2 * neg sign added - kwr
11201203     -3            3 * neg sign added - kwr
*
*card     source value   interval num (ref [1] pg 18)
11201301     1.00         1
11201302     0.00         3
*
11201400  -1
11201401 1.8951e+03 1.1451e+03 6.1207e+02 5.6766e+02
11201402 2.4940e+03 1.3402e+03 6.3223e+02 5.7362e+02
11201403 2.5437e+03 1.3544e+03 6.3439e+02 5.7483e+02
11201404 2.1243e+03 1.2240e+03 6.2057e+02 5.7044e+02
11201405 1.3737e+03 9.4812e+02 5.9176e+02 5.6189e+02
*
*
*
*card          temperature     mesh pt num
*-------------------------------------------------------------
* initial temperatures taken from the output of the steady state
* calculation after 1000 seconds.
*-------------------------------------------------------------
*
*card    left vol   incr   b.cond   sa code    area/factor    hs
11201501     0      0      0      0           0.0        5
*
*card    right vol   incr   b.cond    sa code    area/factor   hs
11201601 120010000   10000    1       0         14974.10       5
*-------------------------------------------------------------
* see calculations in appendix c for area/factor.
*-------------------------------------------------------------
*card      source type   mult     heat left   heat right    hs
11201701     1000      .1825      0.0          0.0         1
11201702     1000      .2424      0.0          0.0         2
11201703     1000      .2465      0.0          0.0         3
11201704     1000      .2066      0.0          0.0         4
11201705     1000      .1220      0.0          0.0         5
```

```
*-------------------------------------------------------------
* see calculations in appendix c for axial mult.
*
*  note -- 1000 in card 701-703 specifies total reactor power from
*  the reactor kinetics calculation
*-------------------------------------------------------------
*
*card       source type   mult     heat left   heat right    hs
*11201701    10099      .1825      0.0          0.0        1
*11201702    10099      .2424      0.0          0.0        2
*11201703    10099      .2465      0.0          0.0        3
*11201704    10099      .2066      0.0          0.0        4
*11201705    10099      .1220      0.0          0.0        5
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11201801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    5
11201901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    5
*
*-----------------------------------------------------
* additional reactor vessel heat structures
*    see calculations in appendix c
*-----------------------------------------------------
*-----------------------------------------------------
* (1001) vessel bottom head
*-----------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11001000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11001100      0           1
*
*card      num intervals   right coordinate
11001101         1         10.9948
*
*card       comp num    interval num
11001201       5              1
*
*card     source value   interval num
11001301      0.00          1
*
11001400  -1
11001401 5.2595e+02 5.2293e+02
*
*
```

```
*card    left vol   incr   b.cond   sa code    area/factor   hs
11001501  100010000   0      1       1          687.23       1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11001601   -100       0     3101     1          687.23       1
*
*card       source type
11001701     0   0   0   0   1
*
*card    qv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11001801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11001901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*
*-----------------------------------------------------
* (1401) lower downcomer
*-----------------------------------------------------
*card       num hs   mesh pts   geom type   int flag    left coord
11401000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11401100      0           1
*
*card      num intervals   right coordinate
11401101         1          10.9948
*
*card       comp num    interval num
11401201       5            1
*
*card     source value   interval num
11401301      0.00          1
*
11401400  -1
11401401 5.2640e+02 5.2322e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11401501  140010000   0      1       1          1401.625     1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11401601  -100        0     3101     1          1401.625     1
*
*card       source type
11401701     0   0   0   0   1
```

```
*
* card   eqv dia     length   hlr  gslf  gslr glcf glcr  lbf   hs
11401801   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11401901   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*-----------------------------------------------------
* (1501) middle downcomer vessel barrel
*-----------------------------------------------------
*card      num hs   mesh pts   geom type   int flag    left coord
11501000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11501100      0           1
*
*card      num intervals   right coordinate
11501101        1         10.9948
*
*card       comp num    interval num
11501201       5             1
*
*card     source value   interval num
11501301      0.00          1
*
11501400  -1
11501401 5.2655e+02 5.2330e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11501501  150010000  0       1       1          837.098     1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11501601   -100      0     3101     1          837.098     1
*
*card      source type
11501701     0   0   0   0   1
*
* card   eqv dia     length   hlr  gslf  gslr glcf glcr  lbf   hs
11501801   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11501901   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*-----------------------------------------------------
* (1601) upper downcomer vessel barrel
*-----------------------------------------------------
*card      num hs   mesh pts   geom type   int flag    left coord
```

```
11601000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11601100     0           1
*
*card      num intervals   right coordinate
11601101        1          10.9948
*
*card       comp num    interval num
11601201      5             1
*
*card     source value   interval num
11601301     0.00          1
*
11601400  -1
11601401 5.3686e+02 5.3481e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11601501  160010000   0      1       1          405.242      1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11601601   -100      0     3101     1          405.242      1
*
*card      source type
11601701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11601801   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11601901   0.0        10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
*-------------------------------------------------------
* (1901) steam dome
*-------------------------------------------------------
*card      num hs   mesh pts   geom type   int flag    left coord
11901000    1    2    2    0   1.04583e+01
*
*card      loc flag    format flag
11901100     0           1
*
*card      num intervals   right coordinate
11901101        1          10.9948
*
*card       comp num    interval num
```

```
11901201      5             1
*
*card     source value   interval num
11901301     0.00          1
*
11901400  -1
11901401 5.4718e+02 5.4300e+02
*
*
*card    left vol   incr   b.cond   sa code    area/factor   hs
11901501  190010000   0      1       1         687.230      1
*
*card    right vol  incr   b.cond   sa code    area/factor   hs
11901601  -100       0     3101     1         687.230      1
*
*card       source type
11901701     0   0   0   0   1
*
* card   eqv dia      length   hlr  gslf  gslr glcf glcr  lbf   hs
11901801   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
11901901   0.0       10.0    10.0  0.0   0.0  0.0  0.0   1.0    1
*
* temperature
*---------------------------
20210000   temp
20210001   0.   135.
*---------------------------
* from section 4.2.4.9 of the fsar (bfnp-7)
* outside air temperature
*---------------------------
*
* heat transfer coefficient
*---------------------------
20210100     htc-t
20210101      -1.0     5.3458e-5
20210102       0.0     5.3458e-5
20210103       1.0e6   5.3458e-5
*---------------------------
* see calculations in app. c
* from section 4.2.4.9 of the fsar (bfnp-7)
*---------------------------
*
*------------------------------------------------------
* point kinetics
```

```
*-------------------------------------------------------
30000000      point       separabl
*
*             total     init.   delay/    f.p.    u238
*             power      react.  prompt    yield    yield
30000001    gamma    3293.e+6    0.    165.000    1.    1.
*-------------------------------------------------------
* above values are from ref. [349]
*-------------------------------------------------------
*
* scram
30000011 200
*
* rod insertion
30000012 10300  *jam steady-state
*
* density reactivity feedback
*       density  reactivity
*       (lb/ft3) (dollars)
*30000501    0.      -6.
*30000502   47.2      0.
*-------------------------------------------------------
* see calculations in app. c
*-------------------------------------------------------
30000501  0.  -9.
30000502 47.2   0.
*30000501    0.       0.      *steady-state   prb
*30000502   47.2      0.      *steady-state   prb
* density feedback adjusted to give good power response to changes
* in core flow
*
* doppler reactivity feedback
*       temperature reactivity
*       (deg f)     (dollars)
30000601  500.  0.
*30000602 4172. -2.6321
30000602 4172. -1.6
*30000601  500.  0.           *steady-state   prb
*30000602 4172. -0.0           *steady-state   prb
*-------------------------------------------------------
* see calculations in app. c
*-------------------------------------------------------
* doppler feedback adjusted to give good power response to changes
* in core flow
```

```
*
* volume weighting factors
*30000701     120010000    0  .1583       0.
*30000702     120020000    0  .2795       0.
*30000703     120030000    0  .2887       0.
*30000704     120040000    0  .2028       0.
*30000705     120050000    0  .0707       0.
30000701     120020000    0 1.          0.
*
* heat structure weighting factors
*30000801       1201001       0  .1583       0.
*30000802       1201002       0  .2795       0.
*30000803       1201003       0  .2887       0.
*30000804       1201004       0  .2028       0.
*30000805       1201005       0  .0707       0.
30000801       1201002       0  1.          0.
*------------------------------------------------------------------
* see calculations in appendix c for vol weighting factors and
* heat structure weighting factors.
*------------------------------------------------------------------
* weighting tied to the most dynamic hydro cell and fuel segment
* to give good power response to changes in core flow
*
* reactor scram curve
*
*card        table type    trip no.
20220000       reac-t        649
*
*card        argument      function
20220001      -1.0          0.
20220002       .270         0.
20220003       .620        -0.7859
20220004       .970        -1.3479
20220005      1.337        -2.2928
20220006      1.703        -4.0022
20220007      2.070        -6.7163
20220008      2.445       -10.7728
20220009      2.820       -17.0824
20220010      3.195       -24.6860
20220011      3.570       -28.4429
20220012      3.945       -28.9308
20220013      1.0e+6      -28.9308
*------------------------------------------------------------------
* scram curve is from fig 3.6-13 of the fsar (bfnp-7).
```

```
*------------------------------------------------------------------
*
*
*
*-------------------------------------------
*-------------------------------------------
*  heat structure thermal property data
*-------------------------------------------
*-------------------------------------------
* u0-2 fuel  table  (1)
* ---------------------
* card      material type     format flag      vol heat cap flag
20100100      tbl/fctn          1                  1
*
* thermal conductivity data
*-------------------------------------------------------
*card       temp   thermal cond        temp   thermal cond
20100101     500.0     9.281e-4          650.0    8.253e-4
20100102     800.0     7.436e-4          950.0    6.775e-4
20100103    1100.0     6.228e-4         1250.0    5.772e-4
20100104    1400.0     5.389e-4         1550.0    5.064e-4
20100105    1700.0     4.789e-4         1850.0    4.553e-4
20100106    2000.0     4.272e-4         2150.0    4.186e-4
20100107    2300.0     4.047e-4         2450.0    3.931e-4
20100108    2600.0     3.839e-4         3100.0    3.675e-4
20100109    3600.0     3.703e-4         4100.0    3.906e-4
20100110    4600.0     4.272e-4         5100.0    4.806e-4
20100111    1.0e+6     4.806e-4
*---------------------------------------------------------------------
* data from ref. [349]
*---------------------------------------------------------------------
*
*volumetric heat capacity data
*-------------------------------------------------------
*card       temp   vol heat cap        temp   vol heat cap
20100151      32.0    34.45             122.0     38.35
20100152     212.0    40.95             392.0     43.55
20100153     752.0    46.80            2012.0     51.35
20100154    2732.0    52.65            3092.0     56.55
20100155    3452.0    63.05            3812.0     72.80
20100156    4352.0    89.70            4532.0     94.25
20100157    4532.1    98.15            4892.0    100.10
20100158    5144.0   101.40            1.0e+6    101.40
*---------------------------------------------------------------------
```

```
* data from ref. [349]
*-----------------------------------------------------------------
*
*
*
* he-gap    table  (2)
* --------------------
* card      material type    format flag      vol heat cap flag
20100200      tbl/fctn          1                1
*
* thermal conductivity data
*---------------------------------------------------
*card       thermal cond
20100201     3.09410e-5
*-----------------------------------------------------------------
* data from ref. [349]
*-----------------------------------------------------------------
*
*volumetric heat capacity data
*---------------------------------------------------
*card      vol heat cap
20100251      0.010
*-----------------------------------------------------------------
* data from ref. [349]
*-----------------------------------------------------------------
*
*
* zircaloy   table  (3)
* --------------------
* card      material type    format flag      vol heat cap flag
20100300      tbl/fctn          1                1
*
* thermal conductivity data
*---------------------------------------------------
*card       temp    thermal cond       temp     thermal cond
20100301     32.0    2.170e-3          212.0     2.220e-3
20100302     392.0    2.280e-3          572.0     2.440e-3
20100303     752.0    2.650e-3          932.0     2.889e-3
20100304    1112.0    3.119e-3         1292.0     3.469e-3
20100305    1472.0    3.661e-3         1652.0     3.881e-3
20100306    1832.0    4.111e-3         2012.0     4.481e-3
20100307    2192.0    4.939e-3         2372.0     5.461e-3
20100308    2552.0    6.050e-3         2732.0     6.681e-3
20100309    3092.0    8.031e-3         3360.0     9.200e-3
```

```
20100310     1.0e+6    9.200e-3
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*volumetric heat capacity data
*--------------------------------------------------
*card       temp    vol heat cap        temp     vol heat cap
20100351      0.0     28.39            1480.3     34.48
20100352    1675.0     85.18            1787.5     34.48
20100353    1.0e+6     34.48
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
* steel table  (5)
* --------------------
* card      material type     format flag       vol heat cap flag
20100500      tbl/fctn          1                 1
*
* thermal conductivity data
*--------------------------------------------------
*card       temp    thermal cond      temp     thermal cond
20100501     0.0    2.500e-3          200.0      2.500e-3
20100502   1600.0    4.167e-3         1.0e+6      4.167e-3
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*volumetric heat capacity data
*--------------------------------------------------
*card       temp    vol heat cap       temp     vol heat cap
20100551    200.0     60.00            2200.0     80.00
20100552   1.0e+6     80.00
*------------------------------------------------------------------
* data from ref. [349]
*------------------------------------------------------------------
*
*
******
* table for normal valve area vs. stem position
******
*
*   the following table gives valve flow area vs stem position
```

```
*   valve area = ( stem position )**3.
*
20254500      normarea
20254501       .0        .0
20254502       .16675     .059
20254503       .3334      .089
20254504       .43339     .098
20254505       .5        .457
20254506       .583375    .667
20254507       .6666      .819
20254508       .79435    1.
20254509      1.        1.
*
*
*-----------------
* feedwater train
*-----------------
*
* feedwater train hydro components
*----------------------------------
*
*** condensate supply (at the base of the condensers) ***
*   press. and temp. per refs. [368] and [188], respectively
*
5000000 condensr tmdpvol
5000101 0. 100. 1.e6 0. 0. 0.
5000102 0. 0. 00010
5000200 003
5000201 0. 0.9824 101.1
*
*** piping from condensers to condensate pumps ***
*   3 36" dia. sch. 40 pipes 100' long are represented here.  see app. d
*   for reasoning elev. change per ref. [285 & 368].
*
5020000 cnd_pmp branch
5020001           1       0
5020101 19.4754 100. 0. 0. -5.3 -9.20 0.00015 2.8750 01000
5020200   0 2.8822999e+00 6.9094002e+01 1.0562000e+03  0.
5021101 500000000 502000000 0. 0. 0. 001000
5021201      3.0864000e+00  3.0864000e+00   0.
*
*** condensate pump (single) ***
*   geometry and performance from ref. [90] as per calculations of app. d.
*
```

```
5050000 cndpmp_s pump
5050101 0. 50.2 277. 0. 0. 0. 00000
5050108 502010000 7.069 0. 0.    001000
5050109 508000000 3.142 262. 1.e99 001000
5050200 0 7.2176003e+01 6.9154999e+01 1.1005000e+03  0.  0.
5050201 0  2.8364000e+00  2.8364000e+00   0.
5050202 0  6.3801999e+00  6.3801999e+00   0.
5050301 0 -1 -3 -1 0 460 0
5050302   1.1700000e+03 1.0000000e+00 1.0830000e+04 2.8400000e+02
* need correct inertia
5050303 3983. 1355. 62.4 0.
5050304 0. 0. 0. 0.
* han
5051100 1 1
5051101 0.   1.276421
5051102 0.05 1.270980
5051103 0.1  1.262995
5051104 0.15 1.253315
5051105 0.2  1.242654
5051106 0.25 1.231591
5051107 0.3  1.220570
5051108 0.35 1.209902
5051109 0.4  1.199759
5051110 0.45 1.190182
5051111 0.5  1.181074
5051112 0.55 1.172205
5051113 0.6  1.163208
5051114 0.65 1.153582
5051115 0.7  1.142693
5051116 0.75 1.129767
5051117 0.8  1.113900
5051118 0.85 1.094051
5051119 0.9  1.069043
5051120 0.95 1.037564
5051121 1.   1.
* hvn
5051200 1 2
5051201  0.52 0. *jam
5051202  0.75 0.434464
5051203 0.775 0.489052
5051204   0.8 0.541027
5051205 0.825 0.592472
5051206  0.85 0.644935
5051207 0.875 0.699426
```

```
5051208   0.9 0.756421
5051209 0.925 0.815858
5051210  0.95 0.877137
5051211 0.975 0.939126
5051212    1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5051300 1 3 0. 1.276421
5051400 1 4 0. 1.276421
* ban
5051500 2 1
5051501   0. 0.658983
5051502 0.05 0.657930
5051503  0.1 0.660392
5051504 0.15 0.666062
5051505  0.2 0.674639
5051506 0.25 0.685835
5051507  0.3 0.699368
5051508 0.35 0.714969
5051509  0.4 0.732377
5051510 0.45 0.751340
5051511  0.5 0.771615
5051512 0.55 0.792970
5051513  0.6 0.815183
5051514 0.65 0.838039
5051515  0.7 0.861334
5051516 0.75 0.884874
5051517  0.8 0.908474
5051518 0.85 0.931959
5051519  0.9 0.955161
5051520 0.95 0.977925
5051521   1. 1.
* bvn
5051600 2 2
5051601  0.35 0. * extrapolated value
5051602  0.75 0.617190
5051603 0.775 0.659431
5051604   0.8 0.697266
5051605 0.825 0.733179
5051606  0.85 0.768990
5051607 0.875 0.805856
5051608   0.9 0.844273
5051609 0.925 0.884074
5051610  0.95 0.924429
```

```
5051611 0.975 0.963845
5051612    1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5051700 2 3 0. 0.658983
5051800 2 4 0. 0.658983
*
* velocity table
5056100 506
5056101 0. 1170.
*
*** condensate pump (double) ***
*   geometry and performance from ref. [90] as per calculations of app. d.
*
5060000 cndpmp_d pump
5060101 0. 50.2 554. 0. 0. 0. 00000
5060108 502010000 14.138   0. 0.    001000
5060109 508000000  6.284 262. 1.e99 001000
5060200 0 7.2193001e+01 6.9154999e+01 1.1005000e+03  0.  0.
5060201 0  2.8334000e+00  2.8334000e+00   0.
5060202 0  6.3734002e+00  6.3734002e+00   0.
5060301 505 -1 -3 -1 0 461 0
5060302  1.1700000e+03 1.0000000e+00 2.1660000e+04 2.8400000e+02
* need correct inertia
5060303 7966. 2710. 62.4 0.
5060304 0. 0. 0. 0.
*
* velocity table
5066100 507
5066101 0. 1170.
*
*** piping from condensate pumps to condensate booster pumps ***
*   3 18" dia. sch. 40 pipes 100' long are represented here.  see app. d
*   for explanation.  elev. change per ref. [285 & 327].
*
5080000 pmp_pmp branch
5080001           0        0
5080101 4.6599 100. 0. 0. 3.3 5.75 0.00015 1.4063 01000
5080200   0 6.5344002e+01 6.9155998e+01 1.0992000e+03  0.
*
*** condensate booster pump (single) ***
*   pump performance from "turbine cycle performance monitoring instruction
*   unit 2", 2-ti-266 rev. 0004 as per calculations of app. d.
*
```

```
5100000 bstpmp_s pump
* need true length/volume
5100101 1.5533 0. 20. 0. 0. 0. 00000
5100108 508010000 1.5533 0. 0.    001000
5100109 515000000 1.5533 0. 1.e99 001000
5100200 0 1.8571001e+02 6.9267998e+01 1.1128000e+03  0.  0.
5100201 0  1.2955000e+01  1.2955000e+01   0.
5100202 0  1.2951000e+01  1.2951000e+01   0.
5100301 0 -1 -3 -1 0 465 0
* need true inertia
5100302 1.7800000e+03 1.0000000e+00 1.0800000e+04 5.3500000e+02 4.8920000e+03
5100303 9.0000000e+02 6.2099998e+01
5100304 0. 0. 0. 0. 0.
* han
5101100 1 1
5101101   0. 1.192908
5101102 0.05 1.186873
5101103  0.1 1.181114
5101104 0.15 1.175519
5101105  0.2 1.169975
5101106 0.25 1.164371
5101107  0.3 1.158596
5101108 0.35 1.152542
5101109  0.4 1.146100
5101110 0.45 1.139163
5101111  0.5 1.131625
5101112 0.55 1.123380
5101113  0.6 1.114325
5101114 0.65 1.104356
5101115  0.7 1.093370
5101116 0.75 1.081268
5101117  0.8 1.067948
5101118 0.85 1.053312
5101119  0.9 1.037261
5101120 0.95 1.019698
5101121   1. 1.
* hvn
5101200 1 2
5101201  0.60 0. *jam
5101202  0.75 0.432022
5101203 0.775 0.496009
5101204   0.8 0.555960
5101205 0.825 0.612788
5101206  0.85 0.667405
```

5101207 0.875 0.720723
5101208   0.9 0.773656
5101209 0.925 0.827115
5101210 0.95 0.882014
5101211 0.975 0.939264
5101212   1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5101300 1 3 0. 1.192908
5101400 1 4 0. 1.192908
* ban
5101500 2 1
5101501   0. 0.557646
5101502 0.05 0.572111
5101503 0.1 0.586739
5101504 0.15 0.601668
5101505 0.2 0.617028
5101506 0.25 0.632941
5101507 0.3 0.649524
5101508 0.35 0.666885
5101509 0.4 0.685126
5101510 0.45 0.704341
5101511 0.5 0.724618
5101512 0.55 0.746038
5101513 0.6 0.768675
5101514 0.65 0.792593
5101515 0.7 0.817854
5101516 0.75 0.844509
5101517 0.8 0.872603
5101518 0.85 0.902176
5101519 0.9 0.933257
5101520 0.95 0.965871
5101521   1. 1.
* bvn
5101600 2 2
5101601 0.05 0. *jam
5101602 0.85 0.833692
5101603 0.875 0.858738
5101604   0.9 0.883908
5101605 0.925 0.909902
5101606 0.95 0.937417
5101607 0.975 0.967152
5101608   1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump

```
* operation are of concern)
5101700 2 3 0. 0.557646
5101800 2 4 0. 0.557646
*
* velocity table
5106100 508
5106101 0. 1780.
*
*** condensate booster pump (double) ***
*   pump performance from "turbine cycle performance monitoring instruction
*   unit 2", 2-ti-266 rev. 0004 as per calculations of app. d.
*
5110000 bstpmp_d pump
* need true length/volume
5110101 3.1066 0. 40. 0. 0. 0. 00000
5110108 508010000 3.1066 0. 0. 001000
5110109 515000000 3.1066 0. 1.e99 001000
5110200 0 1.8573000e+02 6.9268997e+01 1.1128000e+03  0. 0.
5110201 0  1.2868000e+01  1.2868000e+01   0.
5110202 0  1.2864000e+01  1.2864000e+01   0.
5110301 510 -1 -3 -1 0 466 0
* need true inertia
5110302 1.7800000e+03 1.0000000e+00 2.1600000e+04 5.3500000e+02 9.7840000e+03
5110303 1.8000000e+03 6.2099998e+01
5110304 0. 0. 0. 0. 0.
*
* velocity table
5116100 509
5116101 0. 1780.
*
*** piping from condensate booster pumps to drain coolers ***
*   3 18" dia. sch. 40 pipes 100' long are represented here.  see app. d
*   for explanation.  elev. change per ref. [327].
*
5150000 pmp_dc branch
5150001 3        0
5150101 4.6599 100. 0. 0. 0.3 30. 0.00015 1.4063 01000
5150200   0 3.0087000e+02 6.9269997e+01 1.1172000e+03  0.
5151101 515010000 520000000 0. 0. 0. 001000
5152101 515010000 521000000 0. 0. 0. 001000
5153101 515010000 522000000 0. 0. 0. 001000
5151201 5.5050998e+00  5.5050998e+00   0.
5152201 5.5050998e+00  5.5050998e+00   0.
5153201 5.5050998e+00  5.5050998e+00   0.
```

```
*
*** drain cooler A ***
*   geometry per vendor spec shts. included with app. d
5200000 'drcool-A'      snglvol
5200101 3.65 92. 0. 0. 0.
5200102 0. 5.e-6 0.0567 01000
5200200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03  0. 0.
*
*** drain cooler B ***
*   geometry per vendor spec shts. included with app. d
5210000 'drcool-B'      snglvol
5210101 3.65 92. 0. 0. 0.
5210102 0. 5.e-6 0.0567 01000
5210200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03  0. 0.
*
*** drain cooler C ***
*   geometry per vendor spec shts. included with app. d
5220000 'drcool-C'      snglvol
5220101 3.65 92. 0. 0. 0.
5220102 0. 5.e-6 0.0567 01000
5220200 0 2.9114999e+02 9.8335999e+01 1.1170000e+03  0. 0.
*
*** piping from drain cooler A to heater A5 ***
*   geometry per refs. [324, 326, 327, & 328]
5250000 'DC-HTRA5'      pipe
5250001 1
5250101 1.5533 1
5250301 14. 1
5250401 0. 1
5250501 0. 1
5250601 42.7 1
5250701 9.5 1
5250801 0.00015 1.4063 1
5251001 01000 1
5251201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03  0.  .0  1
*
*** piping from drain cooler B to heater B5 ***
*   geometry per refs. [324, 326, 327, & 328]
5260000 'DC-HTRB5'      pipe
5260001 1
5260101 1.5533 1
5260301 14. 1
5260401 0. 1
5260501 0. 1
```

```
5260601 42.7 1
5260701 9.5 1
5260801 0.00015 1.4063 1
5261001 01000 1
5261201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03  0.  .0  1
*
*** piping from drain cooler C to heater C5 ***
*   geometry per refs. [324, 326, 327, & 328]
5270000 'DC-HTRC5'      pipe
5270001 1
5270101 1.5533 1
5270301 14. 1
5270401 0. 1
5270501 0. 1
5270601 42.7 1
5270701 9.5 1
5270801 0.00015 1.4063 1
5271001 01000 1
5271201 0 2.8410001e+02 9.8336998e+01 1.1168000e+03  0.  .0  1
*
*
* component 530 - RFW Heater A5 Tubes
5300000  'HTRA5-p'      pipe
*
*       nv
5300001  8
*
*       varea          vn
5300101  3.0778         8      *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea          jn
5300201  3.0778         7
*
*       vlength        vn
5300301  9.7917         8      * total tube length = (2)(39' 2")
*
*       volume         vn
5300401  0.0            8
*
*       incl           vn
5300601  0.0            8
*
*       roughness      dhyd    vn
5300801  1.5e-4         0.0462  8
```

```
*
*       kf    kr     jn
5300901  0.0    0.0     7
*
*       pvbfe         vn
5301001  00000          8
*
*       fvcahs        jn
5301101  001000         7
*
*       ebt   press.   temp.                     vn
5301201  3     281.31   147.046 0.     0.     0.     1
5301202  3     279.96   160.125 0.     0.     0.     2
5301203  3     278.61   169.237 0.     0.     0.     3
5301204  3     277.26   174.520 0.     0.     0.     4
5301205  3     275.92   180.835 0.     0.     0.     5
5301206  3     274.57   184.710 0.     0.     0.     6
5301207  3     273.22   186.605 0.     0.     0.     7
5301208  3     271.87   187.884 0.     0.     0.     8
*
*       vel/flow
5301300  0
*
*       liq-flo       vap-flo        int    jn
5301301  6.5111       6.5111          0.     1
5301302  6.5184       6.5184          0.     2
5301303  6.5268       6.5268          0.     3
5301304  6.5343       6.5343          0.     4
5301305  6.5723       6.5723          0.     5
5301306  6.5960       6.5960          0.     6
5301307  6.6071       6.6071          0.     7
*
*
* component 531 - RFW Heater B5 Tubes
5310000  'HTRB5-p'      pipe
*
*       nv
5310001  8
*
*       varea         vn
5310101  3.0778         8      *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea         jn
5310201  3.0778         7
```

```
*
*      vlength      vn
5310301  9.7917        8      * total tube length = (2)(39' 2")
*
*      volume       vn
5310401  0.0          8
*
*      incl         vn
5310601  0.0          8
*
*      roughness     dhyd   vn
5310801  1.5e-4        0.0462  8
*
*      kf    kr     jn
5310901  0.0    0.0    7
*
*      pvbfe        vn
5311001  00000        8
*
*      fvcahs       jn
5311101  001000       7
*
*      ebt   press.   temp.                    vn
5311201  3    281.31   147.046 0.    0.     0.     1
5311202  3    279.96   160.125 0.    0.     0.     2
5311203  3    278.61   169.237 0.    0.     0.     3
5311204  3    277.26   174.520 0.    0.     0.     4
5311205  3    275.92   180.835 0.    0.     0.     5
5311206  3    274.57   184.710 0.    0.     0.     6
5311207  3    273.22   186.605 0.    0.     0.     7
5311208  3    271.87   187.884 0.    0.     0.     8
*
*      vel/flow
5311300  0
*
*      liq-flo       vap-flo        int    jn
5311301  6.5111      6.5111          0.     1
5311302  6.5184      6.5184          0.     2
5311303  6.5268      6.5268          0.     3
5311304  6.5343      6.5343          0.     4
5311305  6.5723      6.5723          0.     5
5311306  6.5960      6.5960          0.     6
5311307  6.6071      6.6071          0.     7
*
```

```
*
* component 532 - RFW Heater C5 Tubes
5320000  'HTRC5-p'      pipe
*
*       nv
5320001  8
*
*       varea         vn
5320101  3.0778        8      *1832 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea         jn
5320201  3.0778        7
*
*       vlength       vn
5320301  9.7917        8      * total tube length = (2)(39' 2")
*
*       volume        vn
5320401  0.0           8
*
*       incl          vn
5320601  0.0           8
*
*       roughness     dhyd    vn
5320801  1.5e-4        0.0462  8
*
*       kf    kr     jn
5320901  0.0   0.0    7
*
*       pvbfe         vn
5321001  00000         8
*
*       fvcahs        jn
5321101  001000        7
*
*       ebt   press.   temp.                  vn
5321201  3     281.31   147.046 0.    0.     0.     1
5321202  3     279.96   160.125 0.    0.     0.     2
5321203  3     278.61   169.237 0.    0.     0.     3
5321204  3     277.26   174.520 0.    0.     0.     4
5321205  3     275.92   180.835 0.    0.     0.     5
5321206  3     274.57   184.710 0.    0.     0.     6
5321207  3     273.22   186.605 0.    0.     0.     7
5321208  3     271.87   187.884 0.    0.     0.     8
*
```

```
*       vel/flow
5321300  0
*
*       liq-flo        vap-flo         int     jn
5321301  6.5111       6.5111           0.      1
5321302  6.5184       6.5184           0.      2
5321303  6.5268       6.5268           0.      3
5321304  6.5343       6.5343           0.      4
5321305  6.5723       6.5723           0.      5
5321306  6.5960       6.5960           0.      6
5321307  6.6071       6.6071           0.      7
*
*** piping from heater A5 to heater A4 ***
*   geometry per refs. [324, 326, 327, & 328]
5350000 'htrA5_4'       pipe
5350001 1
5350101 1.5533 1
5350301 21. 1
5350401 0. 1
5350501 0. 1
5350601 0. 1
5350701 0. 1
5350801 0.00015 1.4063 1
5351001 01000 1
5351201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*** piping from heater B5 to heater B4 ***
*   geometry per refs. [324, 326, 327, & 328]
5360000 'htrB5_4'       pipe
5360001 1
5360101 1.5533 1
5360301 21. 1
5360401 0. 1
5360501 0. 1
5360601 0. 1
5360701 0. 1
5360801 0.00015 1.4063 1
5361001 01000 1
5361201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*** piping from heater C5 to heater C4 ***
*   geometry per refs. [324, 326, 327, & 328]
5370000 'htrC5_4'       pipe
5370001 1
```

```
5370101 1.5533 1
5370301 21. 1
5370401 0. 1
5370501 0. 1
5370601 0. 1
5370701 0. 1
5370801 0.00015 1.4063 1
5371001 01000 1
5371201 0 2.7210001e+02 1.5058000e+02 1.1165000e+03  0.  .0  1
*
*
* component 540 - RFW Heater A4 Tubes
*
5400000  'HTRA4-p'      pipe
*
*       nv
5400001  10
*
*       varea          vn
5400101  2.9736         10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea          jn
5400201  2.9736         9
*
*       vlength        vn
5400301  7.8333         10      * total tube length = (2)(39' 2")
*
*       volume         vn
5400401  0.0           10
*
*       incl           vn
5400601  0.0           10
*
*       roughness      dhyd    vn
5400801  1.5e-4        0.0462  10
*
*       kf     kr      jn
5400901  0.0    0.0     9
*
*       pvbfe          vn
5401001  00000         10
*
*       fvcahs         jn
5401101  001000         9
```

```
*
*      ebt   press.   temp.                    vn
5401201  3     273.96   189.940 0.     0.      0.      1
5401202  3     272.49   195.815 0.     0.      0.      2
5401203  3     271.03   212.726 0.     0.      0.      3
5401204  3     269.56   224.282 0.     0.      0.      4
5401205  3     268.09   231.955 0.     0.      0.      5
5401206  3     266.61   237.355 0.     0.      0.      6
5401207  3     265.13   240.458 0.     0.      0.      7
5401208  3     263.66   242.113 0.     0.      0.      8
5401209  3     262.18   242.934 0.     0.      0.      9
5401210  3     260.70   243.473 0.     0.      0.      10
*
*      vel/flow
5401300  1
*
*      liq-flo       vap-flo        int     jn
5401301  1232.9        0.0            0.     9
*
*
* component 541 - RFW Heater B4 Tubes
*
5410000  'HTRB4-p'      pipe
*
*      nv
5410001  10
*
*      varea         vn
5410101  2.9736        10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea         jn
5410201  2.9736        9
*
*      vlength       vn
5410301  7.8333        10      * total tube length = (2)(39' 2")
*
*      volume        vn
5410401  0.0           10
*
*      incl          vn
5410601  0.0           10
*
*      roughness     dhyd    vn
5410801  1.5e-4        0.0462  10
```

```
*
*       kf     kr      jn
5410901  0.0    0.0     9
*
*       pvbfe          vn
5411001  00000          10
*
*       fvcahs         jn
5411101  001000         9
*
*       ebt   press.   temp.                     vn
5411201  3     273.96   189.940 0.     0.      0.     1
5411202  3     272.49   195.815 0.     0.      0.     2
5411203  3     271.03   212.726 0.     0.      0.     3
5411204  3     269.56   224.282 0.     0.      0.     4
5411205  3     268.09   231.955 0.     0.      0.     5
5411206  3     266.61   237.355 0.     0.      0.     6
5411207  3     265.13   240.458 0.     0.      0.     7
5411208  3     263.66   242.113 0.     0.      0.     8
5411209  3     262.18   242.934 0.     0.      0.     9
5411210  3     260.70   243.473 0.     0.      0.     10
*
*       vel/flow
5411300  1
*
*       liq-flo        vap-flo         int     jn
5411301  1232.9         0.0             0.     9
*
*
* component 542 - RFW Heater C4 Tubes
*
5420000  'HTRC4-p'      pipe
*
*       nv
5420001  10
*
*       varea          vn
5420101  2.9736         10      *1770 tubes, 5/8" OD, .035" wall, 20BWG
*
*       jarea          jn
5420201  2.9736         9
*
*       vlength        vn
5420301  7.8333         10      * total tube length = (2)(39' 2")
```

```
*
*      volume        vn
5420401  0.0          10
*
*      incl          vn
5420601  0.0          10
*
*      roughness     dhyd    vn
5420801  1.5e-4        0.0462  10
*
*      kf    kr     jn
5420901  0.0    0.0     9
*
*      pvbfe         vn
5421001  00000         10
*
*      fvcahs        jn
5421101  001000        9
*
*      ebt   press.   temp.                 vn
5421201  3     273.96   189.940 0.     0.     0.     1
5421202  3     272.49   195.815 0.     0.     0.     2
5421203  3     271.03   212.726 0.     0.     0.     3
5421204  3     269.56   224.282 0.     0.     0.     4
5421205  3     268.09   231.955 0.     0.     0.     5
5421206  3     266.61   237.355 0.     0.     0.     6
5421207  3     265.13   240.458 0.     0.     0.     7
5421208  3     263.66   242.113 0.     0.     0.     8
5421209  3     262.18   242.934 0.     0.     0.     9
5421210  3     260.70   243.473 0.     0.     0.     10
*
*      vel/flow
5421300  1
*
*      liq-flo       vap-flo        int    jn
5421301  1232.9        0.0            0.     9
*
*
*** piping from heater A4 to heater A3 ***
*   geometry per refs. [324, 326, 327, & 328]
5450000 'htrA4_3'      pipe
5450001 1
5450101 1.5533 1
5450301 116. 1
```

```
5450401 0. 1
5450501 0. 1
5450601 -3.6 1
5450701 -7.25 1
5450801 0.00015 1.4063 1
5451001 01000 1
5451201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03  0.  .0  1
*
*** piping from heater B4 to heater B3 ***
*   geometry per refs. [324, 326, 327, & 328]
5460000 'htrB4_3'       pipe
5460001 1
5460101 1.5533 1
5460301 116. 1
5460401 0. 1
5460501 0. 1
5460601 -3.6 1
5460701 -7.25 1
5460801 0.00015 1.4063 1
5461001 01000 1
5461201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03  0.  .0  1
*
*** piping from heater C4 to heater C3 ***
*   geometry per refs. [324, 326, 327, & 328]
5470000 'htrC4_3'       pipe
5470001 1
5470101 1.5533 1
5470301 116. 1
5470401 0. 1
5470501 0. 1
5470601 -3.6 1
5470701 -7.25 1
5470801 0.00015 1.4063 1
5471001 01000 1
5471201 0 2.6126001e+02 2.0678999e+02 1.1162000e+03  0.  .0  1
*
*
* component 550 - RFW Heater A3 Tubes
5500000  'HTRA3-p'      pipe
*
*       nv
5500001  12
*
*       varea          vn
```

```
5500101  3.1315       12     *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea        jn
5500201  3.1315       11
*
*      vlength      vn
5500301  7.0534       1      *
5500302  7.0534       2      *
5500303  3.0000       3      *volume center = lower level tap
5500304  3.0000       4      *volume center = upper level tap
5500305  11.1133      5      *remaining 35.5' total tube length
5500306  11.1133      6      *remaining 35.5' total tube length
5500307  11.1133      7      *remaining 35.5' total tube length
5500308  11.1133      8      *remaining 35.5' total tube length
5500309  3.0000       9      *volume center = lower level tap
5500310  3.0000       10     *volume center = upper level tap
5500311  7.0534       11     *
5500312  7.0534       12     *
*
*      volume       vn
5500401  0.0          12
*
*      incl         vn
5500601  90.0         6
5500602  -90.0        12
*
*      roughness    dhyd   vn
5500801  1.5e-4       0.0462  12
*
*      kf    kr    jn
5500901  0.0   0.0   11
*
*      pvbfe        vn
5501001  00000        12
*
*      fvcahs       jn
5501101  001000       11
*
*      ebt   press.   temp.                vn
5501201  3     259.34   244.415 0.    0.    0.    1
5501202  3     255.25   246.066 0.    0.    0.    2
5501203  3     252.33   247.155 0.    0.    0.    3
5501204  3     250.59   254.653 0.    0.    0.    4
5501205  3     246.53   272.296 0.    0.    0.    5
```

```
5501206  3     240.14   283.712 0.     0.     0.     6
5501207  3     238.21   291.042 0.     0.     0.     7
5501208  3     240.73   295.669 0.     0.     0.     8
5501209  3     242.32   296.721 0.     0.     0.     9
5501210  3     242.99   297.405 0.     0.     0.     10
5501211  3     244.12   297.600 0.     0.     0.     11
5501212  3     245.70   297.363 0.     0.     0.     12
*
*     vel/flow
5501300  1
*
*     liq-flo      vap-flo      int    jn
5501301  1232.9       0.0          0.     11
*
*
* component 551 - RFW Heater B3 Tubes
5510000  'HTRB3-p'     pipe
*
*     nv
5510001  12
*
*     varea        vn
5510101  3.1315       12     *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*     jarea        jn
5510201  3.1315       11
*
*     vlength      vn
5510301  7.0534       1      *
5510302  7.0534       2      *
5510303  3.0000       3      *volume center = lower level tap
5510304  3.0000       4      *volume center = upper level tap
5510305  11.1133       5      *remaining 35.5' total tube length
5510306  11.1133       6      *remaining 35.5' total tube length
5510307  11.1133       7      *remaining 35.5' total tube length
5510308  11.1133       8      *remaining 35.5' total tube length
5510309  3.0000       9      *volume center = lower level tap
5510310  3.0000       10      *volume center = upper level tap
5510311  7.0534       11      *
5510312  7.0534       12      *
*
*     volume       vn
5510401  0.0          12
*
```

```
*       incl          vn
5510601  90.0          6
5510602  -90.0         12
*
*       roughness     dhyd    vn
5510801  1.5e-4        0.0462  12
*
*       kf     kr     jn
5510901  0.0    0.0     11
*
*       pvbfe         vn
5511001  00000         12
*
*       fvcahs        jn
5511101  001000        11
*
*       ebt   press.   temp.                    vn
5511201  3     259.34   244.415 0.    0.     0.     1
5511202  3     255.25   246.066 0.    0.     0.     2
5511203  3     252.33   247.155 0.    0.     0.     3
5511204  3     250.59   254.653 0.    0.     0.     4
5511205  3     246.53   272.296 0.    0.     0.     5
5511206  3     240.14   283.712 0.    0.     0.     6
5511207  3     238.21   291.042 0.    0.     0.     7
5511208  3     240.73   295.669 0.    0.     0.     8
5511209  3     242.32   296.721 0.    0.     0.     9
5511210  3     242.99   297.405 0.    0.     0.     10
5511211  3     244.12   297.600 0.    0.     0.     11
5511212  3     245.70   297.363 0.    0.     0.     12
*
*       vel/flow
5511300  1
*
*       liq-flo       vap-flo        int     jn
5511301  1232.9        0.0            0.      11
*
*
* component 552 - RFW Heater C3 Tubes
5520000  'HTRC3-p'      pipe
*
*       nv
5520001  12
*
*       varea         vn
```

```
5520101  3.1315        12      *1864 tubes, 5/8" OD, .035" wall, 20BWG
*
*      jarea         jn
5520201  3.1315        11
*
*      vlength       vn
5520301  7.0534        1       *
5520302  7.0534        2       *
5520303  3.0000        3       *volume center = lower level tap
5520304  3.0000        4       *volume center = upper level tap
5520305  11.1133       5       *remaining 35.5' total tube length
5520306  11.1133       6       *remaining 35.5' total tube length
5520307  11.1133       7       *remaining 35.5' total tube length
5520308  11.1133       8       *remaining 35.5' total tube length
5520309  3.0000        9       *volume center = lower level tap
5520310  3.0000        10      *volume center = upper level tap
5520311  7.0534        11      *
5520312  7.0534        12      *
*
*      volume        vn
5520401  0.0           12
*
*      incl          vn
5520601  90.0          6
5520602  -90.0         12
*
*      roughness     dhyd    vn
5520801  1.5e-4        0.0462  12
*
*      kf    kr     jn
5520901  0.0   0.0    11
*
*      pvbfe         vn
5521001  00000         12
*
*      fvcahs        jn
5521101  001000        11
*
*      ebt   press.   temp.                  vn
5521201  3     259.34   244.415 0.    0.     0.    1
5521202  3     255.25   246.066 0.    0.     0.    2
5521203  3     252.33   247.155 0.    0.     0.    3
5521204  3     250.59   254.653 0.    0.     0.    4
5521205  3     246.53   272.296 0.    0.     0.    5
```

```
5521206  3    240.14   283.712 0.     0.     0.     6
5521207  3    238.21   291.042 0.     0.     0.     7
5521208  3    240.73   295.669 0.     0.     0.     8
5521209  3    242.32   296.721 0.     0.     0.     9
5521210  3    242.99   297.405 0.     0.     0.     10
5521211  3    244.12   297.600 0.     0.     0.     11
5521212  3    245.70   297.363 0.     0.     0.     12
*
*       vel/flow
5521300  1
*
*       liq-flo       vap-flo        int    jn
5521301  1232.9        0.0            0.     11
*
*
*** piping from heaters 3 to feed pumps ***
*   geometry per refs. [216, 324, 326, 327, 328]
5550000 htr3_pmp branch
5550001 4        0
5550101 4.6599 12. 0. 0. 0. 0. 0.00015 1.4063 01000
5550200   0 2.5089999e+02 2.6672000e+02 1.1158000e+03  0.
5551101 550010000 555000000 0. 0. 0. 001000
5552101 551010000 555000000 0. 0. 0. 001000
5553101 552010000 555000000 0. 0. 0. 001000
5554101 555010000 557000000 0.3491 7.301 7.417 001000
5551201      6.9323001e+00  6.9323001e+00   0.
5552201      6.9323001e+00  6.9323001e+00   0.
5553201      6.9323001e+00  6.9323001e+00   0.
5554201      6.0248899e-06  6.0249299e-06   0.
*
* feedwater bypass valve inlet
5570000 bypinlet snglvol
5570101 0.3491  40.  0.  0.  20.55  14.04  .00015  0.  01000
5570200   0 2.4930000e+02 2.6673999e+02 1.1158000e+03  0. 0.
*
* feedwater bypass valve
5580000 bypvalve valve
5580101 557010000  559000000 0.3491 4.76  9.99e+99 000100
5580201    0   0.   0.   0.
5580300 srvvlv
5580301 611
*
* feedwater bypass valve outlet
5590000 bypotlet snglvol
```

```
5590101 0.3491  40.  0.  0.  20.55  14.04  .00015  0.  01000
5590200   0 1.0997000e+03 2.6729001e+02 1.1074000e+03  0. 0.
*
*** feed pump (a) inlet volume
5600000 apmpin  branch
5600001           1        0
5600101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5600200   0 2.4492000e+02 2.6673001e+02 1.1156000e+03  0.
5601101 555010000 560000000 1.5533 0. 0. 001000
5601201      1.3924000e+01  1.3924000e+01   0.
*
*** feed pump (b) inlet volume
5610000 bpmpin  branch
5610001           1        0
5610101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5610200   0 2.4492000e+02 2.6673001e+02 1.1156000e+03  0.
5611101 555010000 561000000 1.5533 0. 0. 001000
5611201      1.3923000e+01  1.3923000e+01   0.
*
*** feed pump (c) inlet volume
5620000 cpmpin  branch
5620001           1        0
5620101 1.5533 67. 0. 0. 24.78 28.08 0.00015 1.4063 01000
5620200   0 2.4492000e+02 2.6673001e+02 1.1156000e+03  0.
5621101 555010000 562000000 1.5533 0. 0. 001000
5621201      1.3923000e+01  1.3923000e+01   0.
*
*** reactor feed pump (a) ***
*   performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
5700000 fdpmp_a pump
* need true volume
5700101 1.5533 0. 30. 0. 0. 0. 00000
5700108 560010000 1.5533 0. 0. 001000
5700109 575000000 1.5533 4. 0. 001000
5700200  0 6.7017999e+02 2.6726001e+02 1.1173000e+03  0.  0.
5700201  0  1.3924000e+01  1.3924000e+01   0.
5700202  0  1.3907000e+01  1.3907000e+01   0.
5700301 0 -1 -3 -1 0 408 0
5700302   5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03
5700303 8279. 4239. 57.2 0.
5700304 0. 0. 0. 0.
* han
5701100 1 1
5701101      0. 1.197067
```

```
5701102    0.05 1.184067
5701103     0.1 1.173948
5701104    0.15 1.166099
5701105     0.2 1.159951
5701106    0.25 1.154979
5701107     0.3 1.150703
5701108    0.35 1.146687
5701109     0.4 1.142538
5701110    0.45 1.137910
5701111     0.5 1.132499
5701112    0.55 1.126046
5701113     0.6 1.118334
5701114    0.65 1.109195
5701115     0.7 1.098501
5701116    0.75 1.086169
5701117     0.8 1.072161
5701118    0.85 1.056483
5701119     0.9 1.039186
5701120    0.95 1.020363
5701121      1. 1.
* hvn
5701200 1 2
5701201   0.618 0. * extrapolated value
5701202   0.725 0.384958
5701203    0.75 0.447154
5701204   0.775 0.504118
5701205     0.8 0.557846
5701206   0.825 0.609998
5701207    0.85 0.661900
5701208   0.875 0.714540
5701209     0.9 0.768575
5701210   0.925 0.824324
5701211    0.95 0.881772
5701212   0.975 0.940568
5701213      1. 1.
* had and hvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5701300 1 3 0. 1.197067
5701400 1 4 0. 0.7 * jam
* ban
5701500 2 1
5701501      0. 0.482838
5701502    0.05 0.500041
5701503     0.1 0.520557
```

```
5701504    0.15 0.543522
5701505     0.2 0.568180
5701506    0.25 0.593886
5701507     0.3 0.620100
5701508    0.35 0.646396
5701509     0.4 0.672452
5701510    0.45 0.698057
5701511     0.5 0.723108
5701512    0.55 0.747612
5701513     0.6 0.771684
5701514    0.65 0.795547
5701515     0.7 0.819534
5701516    0.75 0.844086
5701517     0.8 0.869753
5701518    0.85 0.897194
5701519     0.9 0.927177
5701520    0.95 0.960578
5701521      1. 1.
* bvn
5701600 2 2
5701601    0.27 0. *jam
5701602   0.725 0.579497
5701603    0.75 0.613313
5701604   0.775 0.646402
5701605     0.8 0.679301
5701606   0.825 0.712545
5701607    0.85 0.746670
5701608   0.875 0.782212
5701609     0.9 0.819708
5701610   0.925 0.859692
5701611    0.95 0.902700
5701612   0.975 0.949269
5701613      1. 1.
* bad and bvd (incomplete but sufficient - only normal modes of pump
* operation are of concern)
5701700 2 3 0. 0.482838
5701800 2 4 0. 0.8 * jam
*
* velocity table
5706100 408 cntrlvar 756
5706101 0. 0. 10000. 10000.
*
*** reactor feed pump (b) ***
*   performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
```

```
5710000 fdpmp_b pump
* need true volume
5710101 1.5533 0. 30. 0. 0. 0. 00000
5710108 561010000 1.5533 0. 0. 001000
5710109 576000000 1.5533 4. 0. 001000
5710200  0 6.7017999e+02 2.6726001e+02 1.1173000e+03  0.  0.
5710201  0  1.3923000e+01  1.3923000e+01   0.
5710202  0  1.3906000e+01  1.3906000e+01   0.
5710301 570 -1 -3 -1 0 408 0
5710302   5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03
5710303 8279. 4239. 57.2 0.
5710304 0. 0. 0. 0.
*
* velocity table
5716100 408 cntrlvar 757
5716101 0. 0. 10000. 10000.
*
*** reactor feed pump (c) ***
*   performance from ref. [bfn-vtd-p025-0050] as per calcs. of app. d.
5720000 fdpmp_c pump
* need true flow area and length
5720101 1.5533 0. 30. 0. 0. 0. 00000
5720108 562010000 1.5533 0. 0. 001000
5720109 577000000 1.5533 4. 0. 001000
5720200  0 6.7017999e+02 2.6726001e+02 1.1173000e+03  0.  0.
5720201  0  1.3923000e+01  1.3923000e+01   0.
5720202  0  1.3906000e+01  1.3906000e+01   0.
5720301 570 -1 -3 -1 0 408 0
5720302   5.5000000e+03 8.7630910e-01 1.1200000e+04 2.8000000e+03
* moment of inertia per Bill Babb, GE
5720303 8279. 4239. 57.2 0.
5720304 0. 0. 0. 0.
*
* velocity table
5726100 408 cntrlvar 758
5726101 0. 0. 10000. 10000.
*
*** feed pump (a) outlet volume (with check valve function) ***
*   large loss coef. in reverse direction serves check valve function
5750000 apmpout branch
5750001           1         0
5750101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5750200   0 1.0966000e+03 2.6726999e+02 1.1075000e+03  0.
5751101 575010000 588000000 1.5533 0. 1.e99 001000
```

```
5751201      1.3886000e+01  1.3886000e+01   0.
*
*** feed pump (b) outlet volume (with check valve function) ***
*   large loss coef. in reverse direction serves check valve function
5760000 bpmpout branch
5760001           1        0
5760101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5760200   0 1.0966000e+03 2.6726999e+02 1.1075000e+03  0.
5761101 576010000 588000000 1.5533 0. 1.e99 001000
5761201      1.3885000e+01  1.3885000e+01   0.
*
*** feed pump (c) outlet volume (with check valve function) ***
*   large loss coef. in reverse direction serves check valve function
5770000 cpmpout branch
5770001           1        0
5770101 1.5533 5. 0. 0. 0. 0. 0.00015 1.4063 01000
5770200   0 1.0966000e+03 2.6726999e+02 1.1075000e+03  0.
5771101 577010000 588000000 1.5533 0. 1.e99 001000
5771201      1.3885000e+01  1.3885000e+01   0.
*
*** min. recirc. valve (a) ***
*   this is a trip type valve with choked flow logic enabled, and
*   abrupt area change logic invoked.  the area of this valve is
*   best defined as the area of the orifice placed in min. recirc.
*   piping.  this area has been estimated from consideration of
*   ref. [178].  it corresponds to a diameter of 2".
5800000 recirc_a valve
5800101 575010000 581000000 0.0014 6.4764 6.4764 000100
5800201    0   0.   0.   0.
5800300 mtrvlv *jam
5800301 475  478  1.  0. *jam
*
*** min. recirc. (a) sink ***
*   fluid conditions of condensers (see comp. 500)
5810000 sink_a tmdpvol
5810101 0. 100. 1.e6 0. 0. 0.
5810102 0. 0. 00010
5810200 003
5810201 0. 0.9824 101.1
*
*** min. recirc. valve (b) ***
*   (see note of component 580)
5820000 recirc_b valve
5820101 576010000 583000000 0.0014 6.4764 6.4764 000100
```

```
5820201    0   0.   0.   0.
5820300 mtrvlv *jam
5820301 476  479  1.  0. *jam
*
*** min. recirc. (b) sink ***
*   fluid conditions of condensers (see comp. 500)
5830000 sink_b tmdpvol
5830101 0. 100. 1.e6 0. 0. 0.
5830102 0. 0. 00010
5830200 003
5830201 0. 0.9824 101.1
*
*** min. recirc. valve (c) ***
*   (see note of component 580)
5840000 recirc_c valve
5840101 577010000 585000000 0.0014 6.4764 6.4764 000100
5840201    0   0.   0.   0.
5840300 mtrvlv *jam
5840301 477  480  1.  0.  *jam
*
*
*** min. recirc. (c) sink ***
*   fluid conditions of condensers (see comp. 500)
5850000 sink_c tmdpvol
5850101 0. 100. 1.e6 0. 0. 0.
5850102 0. 0. 00010
5850200 003
5850201 0. 0.9824 101.1
*
*** piping from feed pumps to heaters 2 ***
*   geometry per ref. [216]
*
5880000 pmp_htr2 branch
5880001 4        0
5880101 4.6599 220.14 0. 0. -7.2 -27.75 0.00015 1.4063 01000
5880200   0 1.1017000e+03 2.6726999e+02 1.1074000e+03  0.
5881101 588010000 590000000 0. 0. 0. 001000
5882101 588010000 591000000 0. 0. 0. 001000
5883101 588010000 592000000 0. 0. 0. 001000
5884101 559010000 588000000 0.3491 8.229 1.e+99 001000
5881201      7.5832000e+00  7.5832000e+00   0.
5882201      7.5832000e+00  7.5832000e+00   0.
5883201      7.5832000e+00  7.5832000e+00   0.
5884201      0.   0.    0.
```

```
*
*
* component 590 - RFW Heater A2 Tubes
5900000  'HTRA2-p'      pipe
*
*       nv
5900001  10
*
*       varea         vn
5900101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
5900201  2.8872        9
*
*       vlength       vn
5900301  5.4974        1       *
5900302  3.0000        2       *volume center = lower level tap
5900303  3.0000        3       *volume center = upper level tap
5900304  8.8763        7       *remaining 35.5' total tube length
5900305  3.0000        8       *volume center = lower level tap
5900306  3.0000        9       *volume center = upper level tap
5900307  5.4974        10      *
*
*       volume        vn
5900401  0.0           10
*
*       incl          vn
5900601  90.0          5
5900602  -90.0         10
*
*       roughness     dhyd    vn
5900801  1.5e-4        0.0439  10      *.527" ID
*
*       kf    kr     jn
5900901  0.0    0.0    9
*
*       pvbfe         vn
5901001  00000         10
*
*       fvcahs        jn
5901101  001000        9
*
*       ebt   press.   temp.                   vn
5901201  3     1110.0   301.969 0.     0.      0.      1
```

```
5901202  3     1107.4   303.527 0.     0.      0.      2
5901203  3     1105.5   309.131 0.     0.      0.      3
5901204  3     1101.9   319.624 0.     0.      0.      4
5901205  3     1096.4   325.800 0.     0.      0.      5
5901206  3     1094.5   329.305 0.     0.      0.      6
5901207  3     1096.0   331.281 0.     0.      0.      7
5901208  3     1097.0   331.801 0.     0.      0.      8
5901209  3     1097.5   331.601 0.     0.      0.      9
5901210  3     1098.3   330.416 0.     0.      0.      10
*
*       vel/flow
5901300  1
*
*       liq-flo       vap-flo        int     jn
5901301  1232.9        0.0            0.     9
*
*
* component 591 - RFW Heater B2 Tubes
5910000  'HTRB2-p'      pipe
*
*       nv
5910001  10
*
*       varea         vn
5910101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
5910201  2.8872        9
*
*       vlength       vn
5910301  5.4974        1       *
5910302  3.0000        2       *volume center = lower level tap
5910303  3.0000        3       *volume center = upper level tap
5910304  8.8763        7       *remaining 35.5' total tube length
5910305  3.0000        8       *volume center = lower level tap
5910306  3.0000        9       *volume center = upper level tap
5910307  5.4974        10      *
*
*       volume        vn
5910401  0.0           10
*
*       incl          vn
5910601  90.0          5
5910602  -90.0         10
```

```
*
*       roughness      dhyd    vn
5910801  1.5e-4         0.0439  10      *.527" ID
*
*       kf     kr      jn
5910901  0.0    0.0     9
*
*       pvbfe          vn
5911001  00000          10
*
*       fvcahs         jn
5911101  001000         9
*
*       ebt   press.   temp.                    vn
5911201  3     1110.0   301.969 0.     0.     0.     1
5911202  3     1107.4   303.527 0.     0.     0.     2
5911203  3     1105.5   309.131 0.     0.     0.     3
5911204  3     1101.9   319.624 0.     0.     0.     4
5911205  3     1096.4   325.800 0.     0.     0.     5
5911206  3     1094.5   329.305 0.     0.     0.     6
5911207  3     1096.0   331.281 0.     0.     0.     7
5911208  3     1097.0   331.801 0.     0.     0.     8
5911209  3     1097.5   331.601 0.     0.     0.     9
5911210  3     1098.3   330.416 0.     0.     0.     10
*
*       vel/flow
5911300  1
*
*       liq-flo        vap-flo         int     jn
5911301  1232.9         0.0             0.      9
*
*
* component 592 - RFW Heater C2 Tubes
*
5920000  'HTRC2-p'      pipe
*
*       nv
5920001  10
*
*       varea          vn
5920101  2.8872         10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea          jn
5920201  2.8872         9
```

```
*
*       vlength       vn
5920301  5.4974        1       *
5920302  3.0000        2       *volume center = lower level tap
5920303  3.0000        3       *volume center = upper level tap
5920304  8.8763        7       *remaining 35.5' total tube length
5920305  3.0000        8       *volume center = lower level tap
5920306  3.0000        9       *volume center = upper level tap
5920307  5.4974        10       *
*
*       volume        vn
5920401  0.0          10
*
*       incl          vn
5920601  90.0         5
5920602  -90.0        10
*
*       roughness     dhyd   vn
5920801  1.5e-4       0.0439  10      *.527" ID
*
*       kf    kr    jn
5920901  0.0   0.0   9
*
*       pvbfe         vn
5921001  00000        10
*
*       fvcahs        jn
5921101  001000       9
*
*       ebt   press.   temp.                    vn
5921201  3     1110.0   301.969 0.    0.    0.    1
5921202  3     1107.4   303.527 0.    0.    0.    2
5921203  3     1105.5   309.131 0.    0.    0.    3
5921204  3     1101.9   319.624 0.    0.    0.    4
5921205  3     1096.4   325.800 0.    0.    0.    5
5921206  3     1094.5   329.305 0.    0.    0.    6
5921207  3     1096.0   331.281 0.    0.    0.    7
5921208  3     1097.0   331.801 0.    0.    0.    8
5921209  3     1097.5   331.601 0.    0.    0.    9
5921210  3     1098.3   330.416 0.    0.    0.    10
*
*       vel/flow
5921300  1
*
```

```
*       liq-flo       vap-flo        int     jn
5921301  1232.9        0.0            0.      9
*
*
*** piping from heater A2 to heater A1 ***
*   geometry per ref. [215 & 216]
5950000 'htrA2_1' pipe
5950001 1
5950101 1.755 1
5950301 2. 1
5950401 0. 1
5950501 0. 1
5950601 0. 1
5950701 0. 1
5950801 0.00015 1.4948 1
5951001 01000 1
5951201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03  0.  .0  1
*
*** piping from heater B2 to heater B1 ***
*   geometry per ref. [215 & 216]
5960000 'htrB2_1' pipe
5960001 1
5960101 1.755 1
5960301 2. 1
5960401 0. 1
5960501 0. 1
5960601 0. 1
5960701 0. 1
5960801 0.00015 1.4948 1
5961001 01000 1
5961201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03  0.  .0  1
*
*** piping from heater C2 to heater C1 ***
*   geometry per ref. [215 & 216]
5970000 'htrC2_1' pipe
5970001 1
5970101 1.755 1
5970301 2. 1
5970401 0. 1
5970501 0. 1
5970601 0. 1
5970701 0. 1
5970801 0.00015 1.4948 1
5971001 01000 1
```

```
5971201 0 1.0973000e+03 2.9884000e+02 1.1075000e+03  0.  .0  1
*
*
* component 600 - RFW Heater A1 Tubes
6000000  'HTRA1-p'      pipe
*
*       nv
6000001  10
*
*       varea          vn
6000101  2.8872         10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea          jn
6000201  2.8872         9
*
*       vlength        vn
6000301  1.3307         1       *
6000302  2.6667         2       *volume center = lower level tap
6000303  2.6667         3       *volume center = upper level tap
6000304  10.4596        7       *remaining 41.8' total tube length
6000305  2.6667         8       *volume center = lower level tap
6000306  2.6667         9       *volume center = upper level tap
6000307  1.3307         10      *
*
*       volume         vn
6000401  0.0            10
*
*       incl           vn
6000601  90.0           5
6000602  -90.0          10
*
*       roughness      dhyd   vn
6000801  1.0e-7         0.0439  10     *.527" ID
*
*       kf    kr    jn
6000901  0.0    0.0    9
*
*       pvbfe          vn
6001001  00000          10
*
*       fvcahs         jn
6001101  001000         9
*
*       ebt   press.   temp.                vn
```

```
6001201  3     1089.5   331.600 0.     0.      0.      1
6001202  3     1088.5   335.810 0.     0.      0.      2
6001203  3     1087.1   340.290 0.     0.      0.      3
6001204  3     1083.6   352.648 0.     0.      0.      4
6001205  3     1078.1   362.143 0.     0.      0.      5
6001206  3     1076.6   368.635 0.     0.      0.      6
6001207  3     1079.1   372.725 0.     0.      0.      7
6001208  3     1080.7   373.688 0.     0.      0.      8
6001209  3     1081.4   373.683 0.     0.      0.      9
6001210  3     1081.9   373.013 0.     0.      0.      10
*
*       vel/flow
6001300  1
*
*       liq-flo       vap-flo        int    jn
6001301  1232.9        0.0            0.     9
*
*
* component 601 - RFW Heater B1 Tubes
6010000  'HTRB1-p'      pipe
*
*       nv
6010001  10
*
*       varea         vn
6010101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea         jn
6010201  2.8872        9
*
*       vlength       vn
6010301  1.3307        1       *
6010302  2.6667        2       *volume center = lower level tap
6010303  2.6667        3       *volume center = upper level tap
6010304  10.4596       7        *remaining 41.8' total tube length
6010305  2.6667        8       *volume center = lower level tap
6010306  2.6667        9       *volume center = upper level tap
6010307  1.3307        10      *
*
*       volume        vn
6010401  0.0           10
*
*       incl          vn
6010601  90.0          5
```

```
6010602  -90.0         10
*
*       roughness      dhyd    vn
6010801  1.0e-7        0.0439  10      *.527" ID
*
*       kf     kr      jn
6010901  0.0    0.0     9
*
*       pvbfe          vn
6011001  00000         10
*
*       fvcahs         jn
6011101  001000         9
*
*       ebt   press.   temp.                      vn
6011201  3     1089.5   331.600 0.     0.      0.      1
6011202  3     1088.5   335.815 0.     0.      0.      2
6011203  3     1087.1   340.290 0.     0.      0.      3
6011204  3     1083.6   352.648 0.     0.      0.      4
6011205  3     1078.1   362.143 0.     0.      0.      5
6011206  3     1076.6   368.635 0.     0.      0.      6
6011207  3     1079.1   372.725 0.     0.      0.      7
6011208  3     1080.7   373.688 0.     0.      0.      8
6011209  3     1081.4   373.683 0.     0.      0.      9
6011210  3     1081.9   373.013 0.     0.      0.      10
*
*       vel/flow
6011300  1
*
*       liq-flo        vap-flo         int     jn
6011301  1232.9        0.0             0.      9
*
*
* component 602 - RFW Heater C1 Tubes
6020000  'HTRC1-p'      pipe
*
*       nv
6020001  10
*
*       varea          vn
6020101  2.8872        10      *1906 tubes, 5/8" OD, .049" wall, 18BWG
*
*       jarea          jn
6020201  2.8872         9
```

```
*
*       vlength       vn
6020301  1.3307        1      *
6020302  2.6667        2      *volume center = lower level tap
6020303  2.6667        3      *volume center = upper level tap
6020304  10.4596       7      *remaining 41.8' total tube length
6020305  2.6667        8      *volume center = lower level tap
6020306  2.6667        9      *volume center = upper level tap
6020307  1.3307        10     *
*
*       volume        vn
6020401  0.0          10
*
*       incl          vn
6020601  90.0         5
6020602  -90.0        10
*
*       roughness     dhyd    vn
6020801  1.0e-7       0.0439  10      *.527" ID
*
*       kf    kr     jn
6020901  0.0   0.0    9
*
*       pvbfe         vn
6021001  00000        10
*
*       fvcahs        jn
6021101  001000       9
*
*       ebt   press.   temp.                      vn
6021201  3     1089.5   331.600 0.    0.    0.    1
6021202  3     1088.5   335.815 0.    0.    0.    2
6021203  3     1087.1   340.290 0.    0.    0.    3
6021204  3     1083.6   352.648 0.    0.    0.    4
6021205  3     1078.1   362.143 0.    0.    0.    5
6021206  3     1076.6   368.635 0.    0.    0.    6
6021207  3     1079.1   372.725 0.    0.    0.    7
6021208  3     1080.7   373.688 0.    0.    0.    8
6021209  3     1081.4   373.683 0.    0.    0.    9
6021210  3     1081.9   373.013 0.    0.    0.    10
*
*       vel/flow
6021300  1
*
```

```
*       liq-flo       vap-flo        int     jn
6021301  1232.9        0.0           0.      9
*
*
*** piping from heaters 1 to reactor ***
*   geometry per ref. [215]
6050000 htr1_rx branch
6050001 4        0
6050101 5.0724 255.58 0. 0. 6.1 27.21 0.00015 1.7970 01000
6050200   0 1.0818000e+03 3.4728000e+02 1.1080000e+03  0.
6051101 600010000 605000000 0. 0. 0. 001000
6052101 601010000 605000000 0. 0. 0. 001000
6053101 602010000 605000000 0. 0. 0. 001000
6054101 605010000 150000000 5.0724 49. 0. 001000
*                          /     \
*         loss coef. specified to effect the flow losses attributable to
*         the feedwater sparger - see calc. of app. d.
*
6051201     7.9503999e+00  7.9503999e+00   0.
6052201     7.9503999e+00  7.9503999e+00   0.
6053201     7.9503999e+00  7.9503999e+00   0.
6054201     1.3383000e+01  1.3383000e+01   0.
*
*** miscellaneous junctures ***
*   no flow losses or area restrictions
6100000 misc_jun mtpljun
6100001 24 1
*
*      from      to       juna  kf  kr  fvcahs        incr1   incr2      jn
6100011 520010000 525000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 1
6100021 521010000 526000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 2
6100031 522010000 527000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 3
6100041 525010000 530000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 4
6100051 526010000 531000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 5
6100061 527010000 532000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 6
6100071 530010000 535000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 7
6100081 531010000 536000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 8
6100091 532010000 537000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 9
6100101 535010000 540000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 10
6100111 536010000 541000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 11
6100121 537010000 542000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 12
6100131 540010000 545000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 13
6100141 541010000 546000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 14
6100151 542010000 547000000 0.    0.  0.  001000 1. 1. 1. 0        0        0 15
```

```
6100161 545010000 550000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 16
6100171 546010000 551000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 17
6100181 547010000 552000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 18
6100191 590010000 595000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 19
6100201 591010000 596000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 20
6100211 592010000 597000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 21
6100221 595010000 600000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 22
6100231 596010000 601000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 23
6100241 597010000 602000000 0.    0.  0.  001000 1. 1. 1. 0       0       0 24
*
*     liq-flo    vap-flo    jn
6101011 1244.8     0.        1
6101021 1244.8     0.        2
6101031 1244.8     0.        3
6101041 1244.8     0.        4
6101051 1244.8     0.        5
6101061 1244.8     0.        6
6101071 1244.8     0.        7
6101081 1244.8     0.        8
6101091 1244.8     0.        9
6101101 1244.8     0.        10
6101111 1244.8     0.        11
6101121 1244.8     0.        12
6101131 1244.8     0.        13
6101141 1244.8     0.        14
6101151 1244.8     0.        15
6101161 1244.8     0.        16
6101171 1244.8     0.        17
6101181 1244.8     0.        18
6101191 1244.8     0.        19
6101201 1244.8     0.        20
6101211 1244.8     0.        21
6101221 1244.8     0.        22
6101231 1244.8     0.        23
6101241 1244.8     0.        24
*
*
*-------------------------------------------------------------------------
* Train A Feedwater Heaters - Shellside
*-------------------------------------------------------------------------
*
* component 701 - RFW HTR A1 Steam Supply
7010000 'STM-src1'     tmdpvol
*
```

```
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7010101 5.0     10.0    0.0     0.0     90.0    10.0    0.0     0.0     10
*
*      ebt     trip    variable
7010200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*      %pwr    press   qual.
7010201   0.0   7.545  0.9107        *extrapolated                   *prb 01-26-96 10:38pm
7010202  25.0   55.019  0.9022                                  *prb 01-26-96 10:38pm
7010203  50.0   110.02  0.8907                                  *prb 01-26-96 10:38pm
7010204  75.0   153.73  0.8837                                  *prb 01-26-96 10:38pm
7010205  90.0   186.86  0.8791                                  *prb 01-26-96 10:38pm
7010206 100.0   209.01  0.8765                                  *prb 01-26-96 10:38pm
*
*
* component 702 - RFW HTR A2 Steam Supply
7020000 'STM-src2'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7020101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
7020200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*      %pwr    press   qual.                                    *prb 01-26-96 11:55pm
7020201   0.0   3.43   0.9607        *extrapolated                   *prb 01-26-96 11:55pm
7020202  25.0    31.30  0.9587                                  *prb 01-26-96 11:55pm
7020203  50.0    61.70  0.9533                                  *prb 01-26-96 11:55pm
7020204  75.0    88.31  0.9530                                  *prb 01-26-96 11:55pm
7020205  90.0   107.20  0.9508                                  *prb 01-26-96 11:55pm
7020206 100.0   119.81  0.9495                                  *prb 01-26-96 11:55pm
*
*
* component 703 - RFW HTR A3 Steam Supply
7030000 'STM-src3'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
7030200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*      %pwr    press   qual.                                    *prb 01-26-96 11:55pm
7030201   0.0   1.99   0.9421        *extrapolated                   *prb 01-26-96 11:55pm
```

```
7030202  25.0   19.80   0.9389                                   *prb 01-26-96 11:55pm
7030203  50.0   38.70   0.9316                                   *prb 01-26-96 11:55pm
7030204  75.0   55.97   0.9305                                   *prb 01-26-96 11:55pm
7030205  90.0   67.71   0.9276                                   *prb 01-26-96 11:55pm
7030206 100.0   75.51   0.9259                                   *prb 01-26-96 11:55pm
*
*
* component 704 - RFW HTR A4 Steam Supply #1
7040000 'STMsrc4A'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7040101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
7040200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                       *prb 01-27-96 10:08am
*     %pwr    press   qual.                             *prb 01-27-96 10:08am
7040201   0.0    0.75   0.6576         *extrapolated                *prb 01-27-96 10:08am
7040202  25.0    7.66   0.7094                                   *prb 01-27-96 10:08am
7040203  50.0   14.80   0.8077                                   *prb 01-27-96 10:08am
7040204  75.0   21.59   0.8363                                   *prb 01-27-96 10:08am
7040205  90.0   26.05   0.8437                                   *prb 01-27-96 10:08am
7040206 100.0   29.00   0.8482                                   *prb 01-27-96 10:08am
*
*
* component 705 - RFW HTR A4 Steam Supply #2
7050000 'STMsrc4B'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
7050101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
7050200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                       *prb 01-27-96 10:08am
*     %pwr    press   qual.                             *prb 01-27-96 10:08am
7050201   0.0   1.127   0.3577         *extrapolated                *prb 01-27-96 10:08am
7050202  25.0   12.30   0.4394                                   *prb 01-27-96 10:08am
7050203  50.0   24.00   0.5701                                   *prb 01-27-96 10:08am
7050204  75.0   34.91   0.6273                                   *prb 01-27-96 10:08am
7050205  90.0   42.24   0.6434                                   *prb 01-27-96 10:08am
7050206 100.0   47.12   0.6485                                   *prb 01-27-96 10:08am
*
*
* component 706 - RFW HTR A5 Steam Supply #1 (From "B" LP Turbine, point MR5)
```

```
7060000 'STMsrc5A'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7060101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
7060200 002     0       cntrlvar 010    *RX Power, %                   *prb 01-27-96 12:31pm
*                                                          *prb 01-27-96 12:31pm
*      %pwr    press   qual.                                    *prb 01-27-96 12:31pm
7060201   0.0   0.30    0.064         *extrapolated                  *prb 01-27-96 12:31pm
7060202  25.0   4.59    0.1630                                   *prb 01-27-96 12:31pm
7060203  50.0   8.88    0.2620                                   *prb 01-27-96 12:31pm
7060204  75.0   13.01   0.5389                                   *prb 01-27-96 12:31pm
7060205  90.0   15.71   0.5008                                   *prb 01-27-96 12:31pm
7060206 100.0   17.49   0.4806                                   *prb 01-27-96 12:31pm
*
*
* component 707 - RFW HTR A5 Steam Supply #2 (From "C" LP Turbine, point #5)
7070000 'STMsrc5B'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
7070200 002     0       cntrlvar 010    *RX Power, %                   *prb 01-27-96 12:31pm
*                                                          *prb 01-27-96 12:31pm
*      %pwr    press   qual.                                    *prb 01-27-96 12:31pm
7070201   0.0   0.45    0.2807        *extrapolated                  *prb 01-27-96 12:31pm
7070202  25.0   2.69    0.4153                                   *prb 01-27-96 12:31pm
7070203  50.0   5.05    0.5633                                   *prb 01-27-96 12:31pm
7070204  75.0   7.23    0.6912                                   *prb 01-27-96 12:31pm
7070205  90.0   8.66    0.7368                                   *prb 01-27-96 12:31pm
7070206 100.0   9.60    0.7545                                   *prb 01-27-96 12:31pm
*
*
* component 708 - Moisture Separator
7080000 'Mois-Sep'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
7080101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable                                 *prb 01-26-96 11:47pm
7080200 001     0       cntrlvar 010    *RX Power, %                   *prb 01-26-96 11:47pm
*
```

```
*      %pwr    temp    qual.                                          *prb 01-26-96 11:47pm
7080201   0.0   253.12  0.0            *extrapolated                  *prb 01-26-96 11:47pm
7080202  25.0   286.00  0.0                                           *prb 01-26-96 11:47pm
7080203  50.0   333.40  0.0                                           *prb 01-26-96 11:47pm
7080204  75.0   359.02  0.0                                           *prb 01-26-96 11:47pm
7080205  90.0   374.74  0.0                                           *prb 01-26-96 11:47pm
7080206 100.0   384.07  0.0                                           *prb 01-26-96 11:47pm
*
*
* component 709: Moisture Separator Drain to HTR A2
7090000  'MS-drain'    tmdpjun
7090101  708000000     731000000      1.3963
*
*           trip    variable                                   *prb 01-26-96 11:47pm
*7090200  1      0      cntrlvar 010    *RX Power, %            *prb 01-26-96 11:47pm
7090200  1       632    cntrlvar 010    *RX Power, %            *jam 7-27-96
*
*       %pwr   liq.flow     .                                  *prb 01-26-96 11:47pm
7090201    0.0  0.0          0.0          0.0                   *prb 01-26-96 11:47pm
7090202   25.0  22.4352      0.0          0.0      *242,300/3 lb/hr      *prb 01-26-96 11:47pm
7090203   50.0  54.9444      0.0          0.0      *593,400/3 lb/hr      *prb 01-26-96 11:47pm
7090204   75.0  82.8714      0.0          0.0      *895,011/3 lb/hr      *prb 01-26-96 11:47pm
7090205   90.0  105.3094     0.0          0.0      *1,137,342/3 lb/hr    *prb 01-26-96 11:47pm
7090206  100.0  120.7569     0.0          0.0      *1,304,175/3 lb/hr    *prb 01-26-96
11:47pm
*
* component 710 - RFW Heater A1 steam supply vlv - jam 7-27-96
7100000 a1stmvlv       valve    *jam 7-27-96
*      from           to          juna    kf      kr      fvcahs
7100101 701000000      720000000      1.3417  15.7355  15.7355 000000        *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7100201 0    60.166       118.13          0.0                   *jam 7-26-96
7100300 trpvlv                                             *jam 7-26-96
7100301 632                                                *jam 7-26-96
*
* component 720 - RFW Heater A1 Steam Dome (top of vertical shell)
7200000 'HTRA1-s1'      branch
*
*      #juns   vel/flow
*7200001 2       0
7200001 1       0                                          *jam 7-27-96
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7200101 12.34   13.7904 0.      0.      -90.0 -13.7904  1.5e-4  0.0772  00100
```

```
*
*      ebt    press   Uf          Uv        voidv
7200200 000     198.29  354.09       1113.5     0.99410
*
*      from           to            juna    kf      kr      fvcahs
*7201101 701000000       720000000       1.3417  15.7355 15.7355 000000       *jam 7-27-96
*7202101 720010000       721000000       0.      0.      0.      101000       *jam 7-27-96
7201101 720010000       721000000       0.      0.      0.      101000        *jam 7-27-96
*
*      jun_Dh         flood   gas-int slope
*7201110 0.0            0.0     1.0     1.0                              *jam 7-27-96
*7202110 0.0772          0.0     1.0     1.0                             *jam 7-27-96
7201110 0.0772          0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
*7201201 60.166       118.13           0.                               *jam 7-27-96
*7202201 7.3903       8.4137           0.                               *jam 7-27-96
7201201 7.3903       8.4137           0.                                *jam 7-27-96
*
*
* component 721 - RFW Heater A1 Shellside middle volumes
7210000 'HTRA1-s2'      pipe
*
*      nv
7210001 3
*
*      flowa          vn
7210101 12.34           3       *Shell area (60.75" ID) minus tube area (5/8"OD)
*                         *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
7210301 10.4596         1
7210302 2.6667          3       *same as corresponding primary tube length
*
*      volume         vn
7210401 0.0             3
*
*      incl           vn
7210601 -90.0           3
*
*      roughness      dhyd    vn
7210801 1.5e-4          0.0772  3
*
*      kf      kr      jn
```

```
7210901 0.0     0.0     2
*
*       pvbfe          vn
7211001 00100          3
*
*       fvcahs         jn
7211101 101000         2
*
*       ebt    press.  Uf          Uv        voidv               VN
7211201 0      198.33  354.09      1113.5    0.99189        0.     1
7211202 0      198.36  354.05      1113.5    0.96348        0.     2
7211203 0      198.89  336.85      1113.6    2.33801e-02    0.     3
*
*       vel/flow
7211300 0
*
*       liq-flo    vap-flo    vel.int       jn
7211301 11.168      2.4853     0.            1
7211302 3.0088      5.32454e-02 0.           2
*
*       jun_Dh         flood          gas-int        slope   jn
7211401 0.0772         0.0            1.0            1.0     2
*
*
* component 722 - RFW Heater A1 Tubesheet Shellside (bottom of vertical shell)
7220000 'HTRA1-s3'     branch
*
*       #juns   vel/flow
7220001 1       0
*
*       area    length  vol    theta   phi   elev     rough   hyd     pvbfe
7220101 12.34   1.3307  0.     0.      -90.0 -1.3307  1.5e-4  0.0772  00100
*
*       ebt    press.  Uf          Uv        voidv
7220200 000    199.30  338.19      1113.6    0.0
*
*       from           to            juna    kf     kr     fvcahs
7221101 721010000      722000000     0.      0.0    0.     101000
*
*       jun_Dh         flood   gas-int slope
7221110 0.0772         0.0     1.0     1.0
*
*       liq_vel      vap_vel         vel.int.
7221201 0.11251      -1.1900         0.
```

```
*
*
* component 723 - RFW Heater A1 Drain Piping
7230000 'HTRA1drn'     branch
*
*     #juns   vel/flow
7230001 1       0
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
7230101 0.3474  10.0    0.      0.      82.6  9.9167    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv         voidv
7230200 000     199.30  338.19      1113.6     0.0
*
*     from            to              juna    kf     kr     fvcahs
7231101 722010000       723000000       0.3474  0.0    0.     000100
*
*     liq_vel      vap_vel         vel.int.
7231201 3.7345       3.7345          0.
*
*
* component 725 - RFW HTRA1 Drain Valve
7250000  'LCV6-1'      valve
*
*      from       to         juna      kf       kr       fvcahs
7250101  723010000  731000000   0.0873    39.0223   39.0223   000000
*
7250201  0          15.463       15.465   0.     *  819,483/3 lb/hr
*
7250300  srvvlv
*
7250301  0324  * valve position demand from htr A1 level control system
*
7250400  1.0       288.0       * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                              4" linear double-seated full-port
7250401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
7250402  1.0       1.0         1.0     * valve
*
* component 711 - RFW Heater A2 steam supply vlv - jam 7-27-96
7110000 a2stmvlv        valve    *jam 7-27-96
*     from            to              juna    kf     kr     fvcahs
7110101 702000000       730000000       0.7854  14.1087  14.1087 000000          *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7110201 0    74.200       202.58           0.0                          *jam 7-26-96
```

```
7110300 trpvlv                                          *jam 7-26-96
7110301 632                                             *jam 7-26-96
*
* component 730 - RFW Heater A2 Steam Dome (top of vertical shell)
7300000 'HTRA2-s1'     branch
*
*     #juns   vel/flow
*7300001 2      0                                       *jam 9-27-96
7300001 1      0                                        *jam 9-27-96
*
*     area    length  vol    theta   phi   elev      rough   hyd     pvbfe
7300101 12.34   10.2904 0.      0.      -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
7300200 000     109.21  304.89      1106.3     0.99832
*
*     from           to            juna    kf      kr      fvcahs
*7301101 702000000      730000000      0.7854  14.1087 14.1087 000001       *jam 9-27-96
*7302101 730010000      731000000      12.34   0.      0.      101000       *jam 9-27-96
7301101 730010000      731000000      12.34   0.      0.      101000        *jam 9-27-96
*
*     jun_Dh          flood   gas-int slope
*7301110 0.0            0.0     1.0     1.0                  *jam 9-27-96
*7302110 0.0772         0.0     1.0     1.0                  *jam 9-27-96
7301110 0.0772         0.0     1.0     1.0                   *jam 9-27-96
*
*     liq_vel      vap_vel          vel.int.
*7301201 74.200       202.58           0.                   *jam 9-27-96
*7302201 12.027       7.9267           0.                   *jam 9-27-96
7301201 12.027       7.9267           0.                    *jam 9-27-96
*
*
* component 731 - RFW Heater A2 drain junction volume
7310000 'HTRA2-s2'     branch
*
*     #juns   vel/flow
7310001 1      0
*
*     area    length  vol    theta   phi   elev      rough   hyd     pvbfe
7310101 12.34   8.8763  0.      0.      -90.0 -8.8763   1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
7310200 000     109.23  305.04      1106.4     0.97393
*
```

```
*      from           to            juna    kf      kr      fvcahs
7311101 731010000      732000000       12.34   0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
7311110 0.0772          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
7311201 10.895       3.4280            0.
*
*
* component 732 - RFW Heater A2 Shellside middle volumes
7320000 'HTRA2-s2'      pipe
*
*      nv
7320001 2
*
*      flowa          vn
7320101 12.34          2      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                             *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
7320301 3.0000         2      *same as corresponding primary tube length
*
*      volume         vn
7320401 0.0            2
*
*      incl           vn
7320601 -90.0          2
*
*      roughness      dhyd    vn
7320801 1.5e-4         0.0772  2
*
*      kf      kr      jn
7320901 0.0     0.0     1
*
*      pvbfe          vn
7321001 00100          2
*
*      fvcahs         jn
7321101 101000         1
*
*      ebt     press.  Uf          Uv        voidv                VN
7321201 000     109.25  304.86      1106.4    0.91724        0.     1
7321202 000     109.87  298.86      1106.4    5.89169e-02    0.     2
```

```
*
*      vel/flow
7321300 0
*
*      liq-flo    vap-flo    vel.int       jn
7321301 4.2183     0.30784    0.           1
*
*      jun_Dh        flood         gas-int       slope   jn
7321401 0.0772        0.0           1.0           1.0     1
*
*
* component 733 - RFW Heater A2 Tubesheet Shellside (bottom of vertical shell)
7330000 'HTRA2-s3'     branch
*
*      #juns   vel/flow
7330001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
7330101 12.34   5.4974  0.      0.      -90.0 -5.4974   1.5e-4  0.0772  00100
*
*      ebt     press.  Uf          Uv        voidv
7330200 000     111.52  291.80      1106.6    0.0
*
*      from           to             juna    kf     kr     fvcahs
7331101 732010000      733000000      12.34   0.0    0.     101000
*
*      jun_Dh        flood   gas-int slope
7331110 0.0772        0.0     1.0     1.0
*
*      liq_vel       vap_vel         vel.int.
7331201 0.42029     -0.82167          0.
*
*
* component 734 - RFW Heater A2 Drain Piping
7340000 'HTRA2drn'     branch
*
*      #juns   vel/flow
7340001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
7340101 0.5475  25.0    0.      0.      65.0  22.6667   1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
7340200 000     199.30  338.19      1113.6    0.0
```

```
*
*     from           to            juna   kf     kr     fvcahs
7341101 733010000      734000000      0.5475  0.0     0.     000100
*
*     liq_vel     vap_vel          vel.int.
7341201 8.2628      7.7109           0.
*
*
* component 735 - RFW HTRA2 Drain Valve
7350000  'LCV6-4A'      valve
*
*      from      to        juna     kf      kr      fvcahs
7350101  734010000  741000000   0.3491    22.8653   22.8653   000000
*
7350201  1         228.5294     0.0      0.    *2,468,117/3 lb/hr
*
7350300  srvvlv
*
7350301  0349  * valve position demand based from htr A2 level control
*
7350400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
7350401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
7350402  1.0       1.0        1.0     * valve
*
*
* component 737 - RFW HTRA2 Bypass Valve                           *prb 01-18-96
10:16am
7370000  'LCV6-4B'      valve                               *prb 01-18-96 10:16am
*                                                   *prb 01-18-96 10:16am
*      from      to        juna     kf      kr      fvcahs          *prb 01-18-96 10:16am
*7370101  734010000  738000000   0.3491    0.0       0.0      000000          *prb 01-18-96
10:16am
7370101  734010000  738000000   0.3491    22.8653   22.8653   000000          *jam 7-26-96
*                                                   *prb 01-18-96 10:16am
7370201  1         0.0         0.0      0.0                     *prb 01-18-96 10:16am
*                                                   *prb 01-18-96 10:16am
7370300  srvvlv                                             *prb 01-18-96 10:16am
*                                                   *prb 01-18-96 10:16am
7370301  0355  * valve position demand                              *prb 01-18-96 10:16am
*                                                   *prb 01-18-96 10:16am
7370400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb 01-18-96
10:16am
*                              8" linear double-seated full-port    *prb 01-18-96 10:16am
```

```
7370401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-18-96
10:16am
7370402  1.0       1.0        1.0    * valve                          *prb 01-18-96 10:16am


* component 738 - RFW bank 2 bypass drain piping to condenser              *prb 01-18-
96 10:28am
7380000 'HTR2byp'      branch                                 *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      #juns   vel/flow                                      *prb 01-18-96 10:28am
7380001 1      0                                          *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe  *prb 01-18-96 10:28am
*7380101 1.0472  50.0    0.      0.     -17.72 -37.887   1.5e-4  0.6667  00000   *prb 01-23-96
01:02pm
7380101 1.0472  10.0    0.      0.     -90.00 -10.000   1.5e-4  0.6667  00000   *jam 7-28-96
*                                                    *prb 01-18-96 10:28am
*      ebt     press.  temp                                  *prb 01-18-96 10:28am
7380200 003     1.0     101.14                                 *prb 01-18-96 10:28am
*                                                    *prb 01-18-96 10:28am
*      from           to            juna    kf      kr      fvcahs        *prb 01-18-96 10:28am
*7381101 738010000       969010000       1.0472  0.0     0.0     000000        *prb 01-18-96
10:28am
7381101 738010000       971000000       1.0472  0.0     0.0     001000        *jam  7-28-96
*                                                    *prb 01-18-96 10:28am
*      liq_vel      vap_vel           vel.int.                      *prb 01-18-96 10:28am
7381201 0.0          0.0              0.                          *prb 01-18-96 10:28am
*
* component 712 - RFW Heater A3 steam supply vlv - jam 7-27-96
7120000 a3stmvlv        valve    *jam 7-27-96
*      from           to            juna    kf      kr      fvcahs
7120101 703000000       740000000       3.1416  23.4899  23.4899 000000        *jam 7-27-96
*           liq_vel      vap_vel           vel.int.
7120201 0    7.7263       124.84            0.0                      *jam 7-26-96
7120300 trpvlv                                              *jam 7-26-96
7120301 632                                                *jam 7-26-96
*
* component 740 - RFW Heater A3 Steam Dome (top of vertical shell)
7400000 'HTRA3-s1'      branch
*
*      #juns   vel/flow
*7400001 2       0                                          *jam 7-26-96
7400001 1       0                                          *jam 7-26-96
*
```

```
*      area    length  vol    theta   phi   elev      rough   hyd     pvbfe
7400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*      ebt    press   Uf          Uv        voidv
7400200 000     69.300  271.84       1099.9     0.99613
*
*      from            to             juna    kf      kr      fvcahs
*7401101 703000000       740000000       3.1416  23.4899 23.4899 000000        *jam 7-26-96
*7402101 740010000       741000000       13.5335 0.      0.      101000        *jam 7-26-96
7401101 740010000       741000000       13.5335 0.      0.      101000        *jam 7-26-96
*
*      jun_Dh          flood   gas-int slope
*7401110 0.0            0.0     1.0     1.0                              *jam 7-26-96
*7402110 0.0864          0.0     1.0     1.0                             *jam 7-26-96
7401110 0.0864          0.0     1.0     1.0                              *jam 7-26-96
*
*      liq_vel      vap_vel          vel.int.
*7401201 7.7263       124.84           0.                                *jam 7-26-96
*7402201 8.9171       19.266           0.                                *jam 7-26-96
7401201 8.9171       19.266           0.                                 *jam 7-26-96
*
*
* component 741 - RFW Heater A3 drain junction volume
7410000 'HTRA3-s2'      branch
*
*      #juns   vel/flow
7410001 1       0
*
*      area    length  vol    theta   phi   elev      rough   hyd     pvbfe
7410101 13.5335 11.1133 0.      0.      -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt    press   Uf          Uv        voidv
7410200 000     69.309  271.88       1100.0     0.96083
*
*      from            to             juna    kf      kr      fvcahs
7411101 741010000       742000000       13.5335 0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
7411110 0.0864          0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
7411201 9.3922       5.8524           0.
*
*
```

```
* component 742 - RFW Heater A3 Shellside middle & lower volumes
7420000 'HTRA3-s3'      pipe
*
*       nv
7420001 4
*
*       flowa           vn
7420101 13.5335         1
7420102 6.7667          4       *volumes 2-4 share space with subcooling zone
*
*       flowl           vn
7420301 3.0000          2       *same as corresponding primary tube length
7420302 7.0534          4       *same as corresponding primary tube length
*
*       volume          vn
7420401 0.0             4
*
*       incl            vn
7420601 -90.0           4
*
*       roughness       dhyd    vn
7420801 1.5e-4          0.0864  4
*
*       kf      kr      jn
7420901 0.0     0.0     3
*
*       pvbfe           vn
7421001 00100           4
*
*       fvcahs          jn
7421101 101000          3
*
*       ebt     press.  Uf          Uv          voidv           VN
7421201 000     69.322  271.84      1100.0      0.98918         0.      1
7421202 000     69.529  271.38      1099.9      0.16248         0.      2
7421203 000     72.030  269.21      1100.5      2.68060e-06     0.      3
7421204 000     74.835  267.04      1101.0      8.83757e-06     0.      4
*
*       vel/flow
7421300 0
*
*       liq-flo     vap-flo         vel.int         jn
7421301  70.794     0.44862         0.              1
7421302 0.75643     -0.90429        0.              2
```

```
7421303 0.63162     0.77799          0.           3
*
*     jun_Dh        flood         gas-int       slope   jn
7421401 0.0864        0.0           1.0           1.0     3
*
*
* component 743 - RFW Heater A3 Subcooling Zone
7430000 'HTRA3-s4'      pipe
*
*     nv
7430001 3
*
*     flowa         vn
7430101 6.7667        3
*
*     flowl         vn
7430301 3.0000        1      *same as corresponding primary tube length
7430302 7.0534        3      *same as corresponding primary tube length
*
*     volume        vn
7430401 0.0           3
*
*     incl          vn
7430601 -90.0         3
*
*     roughness      dhyd    vn
7430801 1.5e-4        0.0864  3
*
*     kf     kr     jn
7430901 0.0    0.0    2
*
*     pvbfe         vn
7431001 00100         3
*
*     fvcahs        jn
7431101 101000        2
*
*     ebt    press.  Uf         Uv        voidv               VN
7431201 000    69.415  233.60     1100.1    8.99481e-02    0.     1
7431202 000    71.404  226.39     1100.4    1.57683e-07    0.     2
7431203 000    74.264  242.61     1100.9    3.17648e-06    0.     3
*
*     vel/flow
7431300 0
```

```
*
*     liq-flo     vap-flo          vel.int       jn
7431301 3.53376e-02  -1.6814          0.           1
7431302 3.03089e-02  3.099473e-02      0.           2
*
*     jun_Dh        flood          gas-int       slope   jn
7431401 0.0864         0.0           1.0           1.0     2
*
*
* component 744 - RFW Heater A3 Drain Piping
7440000 'HTRA3drn'     branch
*
*     #juns   vel/flow
7440001 1      1
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
7440101 0.5475  5.0     0.      0.      0.    0.       1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
7440200 000     199.30  338.19      1113.6     0.0
*
*     from           to           juna    kf     kr     fvcahs
7441101 743010000      744000000      0.5475  0.0     0.      000100
*
*     liq_vel     vap_vel          vel.int.
7441201 228.5294     0.0              0.
*
*
* component 745 - RFW HTRA3 Drain Valve
7450000  'LCV6-7'      valve
*
*      from       to        juna      kf       kr       fvcahs
7450101  744010000  752000000   0.3491    7.4816    7.4816    000000
*
7450201  0         12.689       44.886   0.     *2,468,117/3 lb/hr target
*
7450300  srvvlv
*
7450301  0379  * valve position demand based on htr A3 level error
*
7450400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                               8" linear double-seated full-port
7450401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
7450402  1.0       1.0         1.0     * valve
```

```
*
*
7470000 'HTRA3jun' mtpljun
7470001 2      0
*
*     from      to        juna    kf  kr  fvcahs        incr1   incr2   jn
7470011 742020004 743010003 .1      5.  5.  001000 1. 1. 1. 0      0     0 1
7470021 742040004 743030003 1.      5.  5.  001000 1. 1. 1. 0      0     0 2
*
*     liq-flo     vap-flo     jn
7471011 4.0946       4.0946     1
7471021 0.0          0.0        2
*
* component 713 - RFW Heater A4 steam supply vlv - jam 7-27-96
7130000 a4stvlv1       valve    *jam 7-27-96
*     from          to            juna    kf      kr      fvcahs
7130101 705000000      750000000      2.8229  6197.85  6197.85 000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7130201 0    0.83437      24.814           0.0                        *jam 7-26-96
7130300 trpvlv                                                   *jam 7-26-96
7130301 632                                                      *jam 7-26-96
*
*
* component 750 - RFW Heater A4 (top of shell nearest tubesheet)
7500000 'HTRA4-s1'      branch
*
*     #juns   vel/flow
*7500001 2      0                                               *jam 7-26-96
7500001 1       0                                               *jam 7-26-96
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
7500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
7500200 000     27.276  213.37       1086.4     0.99962
*
*     from          to            juna    kf      kr      fvcahs
*7501101 705000000      750000000      2.8229  6197.85 6197.85 000000         *jam 7-27-96
*7502101 750010000      751000000      9.7832  0.      0.      001003         *jam 7-27-96
7501101 750010000      751000000      9.7832  0.      0.      001003         *jam 7-27-96
*
*     jun_Dh          flood   gas-int slope
*7501110 0.0            0.0     1.0     1.0                             *jam 7-27-96
*7502110 0.1309          0.0     1.0     1.0                             *jam 7-27-96
```

```
7501110 0.1309         0.0     1.0     1.0                            *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*7501201 0.83437      24.814          0.                              *jam 7-27-96
*7502201  9.1016      8.7249          0.                              *jam 7-27-96
7501201  9.1016      8.7249          0.                               *jam 7-27-96
*
* component 714 - RFW Heater A4 steam supply vlv - jam 7-27-96
7140000 a4stvlv2       valve    *jam 7-27-96
*      from          to           juna    kf     kr     fvcahs
7140101 704000000      751000000      2.8229  4.4554   4.4554  000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
7140201 0    41.854       271.59            0.0                       *jam 7-26-96
7140300 trpvlv                                                   *jam 7-26-96
7140301 632                                                      *jam 7-26-96
*
*
* component 751 - RFW Heater A4 (top of shell furthest from tubesheet)
7510000 'HTRA4-s2'      branch
*
*      #juns   vel/flow
*7510001 2       0                                              *jam 7-27-96
7510001 1       0                                               *jam 7-27-96
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
7510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv         voidv
7510200 000     27.276  213.38       1086.4     0.99996
*
*      from          to           juna     kf      kr      fvcahs
*7511101 704000000      751000000       2.8229   4.4554  4.4554  000000       *jam 7-27-96
*7512101 751010000      752000000       153.4359 0.      0.      101000       *jam 7-27-96
7511101 751010000      752000000       153.4359 0.      0.      101000        *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*7511110 0.0            0.0     1.0     1.0                            *jam 7-27-96
*7512110 0.1309         0.0     1.0     1.0                            *jam 7-27-96
7511110 0.1309         0.0     1.0     1.0                             *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*7511201 41.854       271.59           0.                             *jam 7-27-96
*7512201 38.784       4.5911           0.                             *jam 7-27-96
7511201 38.784       4.5911           0.                              *jam 7-27-96
```

```
*
*
* component 752 - RFW Heater A4 (bottom of shell furthest from tubesheet)
7520000 'HTRA4-s3'      branch
*
*      #juns   vel/flow
7520001 0       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
7520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv        voidv
7520200 000     27.292  209.34       1086.4     0.52487
*
*
* component 753 - RFW Heater A4 Subcooling Zone
7530000 'HTRA4-s4'      branch
*
*      #juns   vel/flow
7530001 1       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
7530101 9.7832  15.6667 0.0      0.     0.0   0.0       1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv        voidv
7530200 000     26.746  170.92       1086.2     2.46992e-02
*
*      from            to              juna    kf      kr      fvcahs
7531101 752010000       753000000       1.7671   5.0     5.0     001000
*
*      jun_Dh          flood   gas-int slope
7531110 0.1309          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
7531201 6.4784       37.792            0.
*
*
* component 754 - RFW Heater A4 Drain Piping
7540000 'HTRA4drn'      branch
*
*      #juns   vel/flow
7540001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
```

```
7540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv         voidv
7540200 000     26.326  174.57       1085.9     7.05438e-04
*
*      from            to             juna    kf      kr      fvcahs
7541101 753010000       754000000       1.6230  0.0     0.      000100
*
*      liq_vel      vap_vel           vel.int.
7541201 3.1304       4.5777            0.
*
*
* component 755 - RFW HTRA4 Drain Valve
7550000  'LCV6-11A'     valve
*
*       from       to          juna      kf        kr        fvcahs
7550101  754010000  760010003   0.7854    23.7848   23.7848   000000
*
7550201  0          7.5514       7.5514   0.     *3,184,100/3 lb/hr target
*
7550300  srvvlv
*
7550301  0399  * valve position demand based on htr A4 level error
*
7550400  1.0        2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                               12" linear double-seated full-port
7550401  0.0        0.0001      0.0001  * Assume linear Cv vs stroke for globe
7550402  1.0        1.0         1.0     * valve
*
*
* component 757 - RFW HTRA4 Bypass Valve                                 *prb 01-24-96
10:22am
7570000  'LCV6-11B'     valve                                  *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
*       from       to          juna      kf        kr        fvcahs          *prb 01-24-96 10:22am
*7570101  754010000  758000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
7570101  754010000  758000000   0.7854    23.7848   23.7848   000000          *jam 7-26-96
*                                                    *prb 01-24-96 10:22am
7570201  1          0.0          0.0      0.0                    *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
7570300  srvvlv                                             *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
7570301  0405  * valve position demand                           *prb 01-24-96 10:22am
```

```
*                                              *prb 01-24-96 10:22am
7570400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-24-
96 10:22am
*                          12" linear double-seated full-port   *prb 01-24-96 10:22am
7570401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
7570402  1.0       1.0         1.0     * valve                         *prb 01-24-96 10:22am
*
*
* component 758 - RFW bank 4 bypass drain piping to condenser               *prb 01-24-
96 10:22am
7580000 'HTR4byp'      branch                              *prb 01-24-96 10:22am
*                                              *prb 01-24-96 10:22am
*      #juns   vel/flow                                *prb 01-24-96 10:22am
7580001 1      0                                     *prb 01-24-96 10:22am
*                                              *prb 01-24-96 10:22am
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe   *prb 01-24-96 10:22am
7580101 2.3562  25.0    0.      0.      -27.0  -11.40625 1.5e-4  1.0     00000   *prb 01-24-96
10:22am
*                                              *prb 01-24-96 10:22am
*      ebt     press.  temp                             *prb 01-24-96 10:22am
7580200 003     1.0     101.14                            *prb 01-24-96 10:22am
*                                              *prb 01-24-96 10:22am
*      from           to           juna    kf     kr     fvcahs        *prb 01-24-96 10:22am
*7581101 758010000       969010000       2.3562  0.0     0.0     000000        *prb 01-24-96
10:22am
7581101 758010000       969010000       2.3562  0.0     0.0     001000        *jam  7-26-96
*                                              *prb 01-24-96 10:22am
*      liq_vel     vap_vel          vel.int.                 *prb 01-24-96 10:22am
7581201 0.0         0.0             0.                      *prb 01-24-96 10:22am
*
*
* component 760 - RFW Heater A5 Flash Tank
7600000 'FL-TankA'      pipe
*
*      nv
7600001 4
*
*      flowa          vn
7600101 16.4988        4
*
*      flowl          vn
7600301 1.4583         1
7600302 2.9583         2
```

```
7600303 2.500          3
7600304 5.2188         4
*
*     volume        vn
7600401 0.0           4
*
*     incl          vn
7600601 -90.0         4
*
*     roughness      dhyd    vn
7600801 0.0            0.0     4
*
*     kf     kr     jn
7600901 0.0     0.0     3
*
*     pvbfe         vn
7601001 00010         4
*
*     fvcahs        jn
7601101 101000        3
*
*     ebt    press.  Uf          Uv         voidv                VN
7601201 000    9.6940  160.59      1071.8     0.98351        0.     1
7601202 000    9.6954  159.92      1071.8     0.99883        0.     2
7601203 000    9.9628  160.43      1072.2     0.53140        0.     3
7601204 000    12.394  159.48      1075.2     0.00000e+00    0.     4
*
*     vel/flow
7601300 0
*
*     liq-flo     vap-flo          vel.int        jn
7601301  19.581     0.27746          0.            1
7601302  282.58     0.63630          0.            2
7601303 0.63560     -4.2606          0.            3
*
*     jun_Dh         flood          gas-int        slope   jn
7601401 0.0            0.0           1.0            1.0     3
*
*
* component 761 - RFW Heater A5 Drain Piping
7610000 'HTRA5drn'     branch
*
*     #juns   vel/flow
7610001 1       0
```

```
*
*     area    length  vol     theta   phi    elev      rough   hyd     pvbfe
7610101 2.9483  10.0    0.      0.      0.0   0.0       1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv         voidv
7610200 000     13.552  159.14       1076.4     0.0
*
*     from            to             juna    kf      kr      fvcahs
7611101 760010000       761000000       2.9483  0.0     0.      000100
*
*     liq_vel      vap_vel           vel.int.
7611201 1.6705       1.9099            0.
*
* component 715 - RFW Heater A5 steam supply vlv - jam 7-27-96
7150000 a5stvlv1        valve    *jam 7-27-96
*     from            to             juna    kf      kr      fvcahs
7150101 706000000       762000000       9.0164  6243.8   6243.8  000000          *jam 7-27-96
*          liq_vel      vap_vel           vel.int.
7150201 0    0.49198       22.264            0.0                         *jam 7-26-96
7150300 trpvlv                                                  *jam 7-26-96
7150301 632                                                    *jam 7-26-96
*
*
* component 762 - RFW Heater A5 (top of shell nearest tubesheet)
7620000 'HTRA5-s1'      branch
*
*     #juns   vel/flow
*7620001 3       0                                              *jam 7-27-96
7620001 2       0                                              *jam 7-27-96
*
*     area    length  vol      theta  phi    elev      rough   hyd     pvbfe
7620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv         voidv
7620200 000     9.4593  158.61       1071.3     0.99998
*
*     from            to             juna    kf      kr      fvcahs
*7621101 706000000       762000000       9.0164  6243.8  6243.8  001000
*jam 7-27-96
*7622101 762010000       763000000       8.7069  0.      0.      001003
*jam 7-27-96
7621101 762010000       763000000       8.7069  0.      0.      001003
*jam 7-27-96
```

```
*7623101 760000000      762000000      0.7530  1.50    1.50    001000
*jam 7-27-96
7622101 760000000      762000000      0.7530  1.50    1.50    001000
*jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*7621110 2.3958         0.0     1.0     1.0                                                   *jam 7-27-96
*7622110 0.1128         0.0     1.0     1.0                                                   *jam 7-27-96
7621110 0.1128         0.0     1.0     1.0                                                   *jam 7-27-96
*7623110 0.0            0.0     1.0     1.0                                                   *jam 7-27-96
7622110 0.0            0.0     1.0     1.0                                                   *jam 7-27-96
*
*     liq_vel      vap_vel           vel.int.
*7621201 0.49198       22.264          0.                                                    *jam 7-27-96
*7622201 -31.397      -26.477          0.                                                    *jam 7-27-96
7621201 -31.397      -26.477          0.                                                    *jam 7-27-96
*7623201 -30.730       237.56          0.                                                    *jam 7-27-96
7622201 -30.730       237.56          0.                                                    *jam 7-27-96
*
* component 716 - RFW Heater A5 steam supply vlv - jam 7-27-96
7160000 a5stvlv2       valve    *jam 7-27-96
*     from           to            juna    kf     kr     fvcahs
7160101 707000000      763000000      9.0164  2.9489   2.9489  000000         *jam 7-27-96
*          liq_vel      vap_vel           vel.int.
7160201 0    26.337       161.50            0.0                        *jam 7-26-96
7160300 trpvlv                                               *jam 7-26-96
7160301 632                                                  *jam 7-26-96
*
*
* component 763 - RFW Heater A5 (top of shell furthest from tubesheet)
7630000 'HTRA5-s2'      branch
*
*     #juns   vel/flow
*7630001 2      0                                            *jam 7-27-96
7630001 1      0                                            *jam 7-27-96
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
7630101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
7630200 000     9.4589  158.60       1071.4     0.99992
*
*     from           to            juna    kf     kr     fvcahs
*7631101 707000000      763000000      9.0164   2.9489  2.9489  001000        *jam 9-27-96
```

```
*7632101 763010000      764000000      83.8342  0.      0.      001000        *jam 9-27-96
7631101 763010000      764000000      83.8342  0.      0.      001000        *jam 9-27-96
*
*      jun_Dh          flood   gas-int slope
*7631110 2.3958         0.0     1.0     1.0                               *jam 9-27-96
*7632110 0.1128         0.0     1.0     1.0                               *jam 9-27-96
7631110 0.1128         0.0     1.0     1.0                               *jam 9-27-96
*
*      liq_vel      vap_vel          vel.int.
*7631201 26.337      161.50           0.                                 *jam 9-27-96
*7632201 34.542      8.5995           0.                                 *jam 9-27-96
7631201 34.542      8.5995           0.                                 *jam 9-27-96
*
*
* component 764 - RFW Heater A5 (bottom of shell furthest from tubesheet)
7640000 'HTRA5-s3'      branch
*
*      #juns   vel/flow
7640001 2      0
*
*      area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv        voidv
7640200 000     9.6340  148.68       1071.7     0.39598
*
*      from            to            juna    kf     kr     fvcahs
7641101 764010004      765010003      8.7069  0.      0.      001000
7642101 764010000      766000000      0.8685   1.5    100.0   001001  * discourage reverse
flow
*
*      jun_Dh          flood   gas-int slope
7641110 0.1128         0.0     1.0     1.0
7642110 0.6651         0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
7641201  3.4725      -8.5376           0.
7642201 0.47271      -9.3520           0.
*
*
* component 765 - RFW Heater A5 (bottom of shell nearest tubesheet)
7650000 'HTRA5-s4'      branch
*
*      #juns   vel/flow
```

```
7650001 2       0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
7650200 000     9.4996  134.05       1071.5     0.44943
*
*     from           to            juna     kf      kr      fvcahs
7651101 762010000       765000000       110.9722 0.0     0.0     001000
7652101 765010000       766000000       0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*     jun_Dh          flood   gas-int slope
7651110 0.1128          0.0     1.0     1.0
7652110 0.6651          0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
7651201   37.265       5.8851          0.
7652201 -0.42722      -10.256          0.
*
*
* component 766 - RFW Heater A5 Collector
7660000 'Coll-A5'       branch
*
*     #juns   vel/flow
7660001 1       0
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
7660101 4.9087  0.0     145.2255 0.     0.0   0.0       1.5e-4  0.0     00000
*
*     ebt     press   Uf          Uv        voidv
7660200 000     9.9594  146.78       1072.2     0.10641
*
*     from           to            juna     kf      kr      fvcahs
7661101 766010002       760030003       4.9087   1.0     0.50    031000
*
*     jun_Dh          flood   gas-int slope
7661110 2.5             0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
7661201 -0.18014      -1.3910          0.
*
*
```

```
* component 767 - RFW HTRA5 Drain Valve
*
7670000  'LCV6-14A'     valve
*
*      from      to        juna     kf       kr       fvcahs
7670101  761010000  969000000   0.7854    5.6209    5.6209    001000
*
7670201  0         9.4         9.4      0.     *3,184,100/3 lb/hr target
*
7670300  srvvlv
*
7670301  0429  * valve position demand based on htr A5 level error
*
7670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
7670401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
7670402  1.0       1.0        1.0     * valve
*
*
* component 768 - RFW HTRA5 Bypass Valve                              *prb 01-24-96
10:22am
7680000  'LCV6-14B'     valve                                 *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
*      from      to        juna     kf       kr       fvcahs          *prb 01-24-96 10:22am
*7680101  761010000  969000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
7680101  761010000  969000000   0.7854    0.0       5.6209    001000          *jam 7-26-96
*                                                  *prb 01-24-96 10:22am
7680201  1         0.0         0.0      0.0                      *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
7680300  srvvlv                                            *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
7680301  0435  * valve position demand                            *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
7680400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-24-
96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
7680401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
7680402  1.0       1.0        1.0     * valve                          *prb 01-24-96 10:22am
*
*
*-------------------------------------------------------------------------
* Train B Feedwater Heaters - Shellside
```

```
*-----------------------------------------------------------------------
*
* component 801 - RFW HTR B1 Steam Supply
8010000 'STM-src1'    tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd    fe
8010101 5.0     10.0    0.0     0.0     90.0    10.0    0.0     0.0     10
*
*     ebt    trip    variable
8010200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-25-96 11:25pm
*
*     %pwr    press   qual.
8010201   0.0    7.545  0.9107          *extrapolated                  *prb 01-26-96 10:38pm
8010202  25.0   55.019  0.9022                                        *prb 01-26-96 10:38pm
8010203  50.0   110.02  0.8907                                        *prb 01-26-96 10:38pm
8010204  75.0   153.73  0.8837                                        *prb 01-26-96 10:38pm
8010205  90.0   186.86  0.8791                                        *prb 01-26-96 10:38pm
8010206 100.0   209.01  0.8765                                        *prb 01-26-96 10:38pm
*
*
* component 802 - RFW HTR B2 Steam Supply
8020000 'STM-src2'    tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd    fe
8020101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip    variable
8020200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                           *prb 01-26-96 11:55pm
8020201   0.0    3.43   0.9607          *extrapolated                  *prb 01-26-96 11:55pm
8020202  25.0    31.30  0.9587                                        *prb 01-26-96 11:55pm
8020203  50.0    61.70  0.9533                                        *prb 01-26-96 11:55pm
8020204  75.0    88.31  0.9530                                        *prb 01-26-96 11:55pm
8020205  90.0   107.20  0.9508                                        *prb 01-26-96 11:55pm
8020206 100.0   119.81  0.9495                                        *prb 01-26-96 11:55pm
*
*
* component 803 - RFW HTR B3 Steam Supply
8030000 'STM-src3'    tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd    fe
8030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
```

```
*      ebt     trip    variable
8030200 002     0       cntrlvar 010    *RX Power, %                        *prb 01-26-96 11:55pm
*
*      %pwr    press   qual.                                           *prb 01-26-96 11:55pm
8030201   0.0    1.99   0.9421        *extrapolated                     *prb 01-26-96 11:55pm
8030202  25.0   19.80   0.9389                                           *prb 01-26-96 11:55pm
8030203  50.0   38.70   0.9316                                           *prb 01-26-96 11:55pm
8030204  75.0   55.97   0.9305                                           *prb 01-26-96 11:55pm
8030205  90.0   67.71   0.9276                                           *prb 01-26-96 11:55pm
8030206 100.0   75.51   0.9259                                           *prb 01-26-96 11:55pm
*
*
* component 804 - RFW HTR B4 Steam Supply #1
8040000 'STMsrc4A'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
8040101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
8040200 002     0       cntrlvar 010    *RX Power, %                        *prb 01-27-96 10:08am
*                                                              *prb 01-27-96 10:08am
*      %pwr    press   qual.                                           *prb 01-27-96 10:08am
8040201   0.0    0.75   0.6576        *extrapolated                     *prb 01-27-96 10:08am
8040202  25.0    7.66   0.7094                                           *prb 01-27-96 10:08am
8040203  50.0   14.80   0.8077                                           *prb 01-27-96 10:08am
8040204  75.0   21.59   0.8363                                           *prb 01-27-96 10:08am
8040205  90.0   26.05   0.8437                                           *prb 01-27-96 10:08am
8040206 100.0   29.00   0.8482                                           *prb 01-27-96 10:08am
*
*
* component 805 - RFW HTR B4 Steam Supply #2
8050000 'STMsrc4B'      tmdpvol
*
*      area    length  vol     azmth   incl    elev    rough   hyd     fe
8050101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*      ebt     trip    variable
8050200 002     0       cntrlvar 010    *RX Power, %                        *prb 01-27-96 10:08am
*                                                              *prb 01-27-96 10:08am
*      %pwr    press   qual.                                           *prb 01-27-96 10:08am
8050201   0.0   1.127   0.3577        *extrapolated                     *prb 01-27-96 10:08am
8050202  25.0   12.30   0.4394                                           *prb 01-27-96 10:08am
8050203  50.0   24.00   0.5701                                           *prb 01-27-96 10:08am
8050204  75.0   34.91   0.6273                                           *prb 01-27-96 10:08am
```

```
8050205  90.0   42.24   0.6434                                    *prb 01-27-96 10:08am
8050206 100.0   47.12   0.6485                                    *prb 01-27-96 10:08am
*
*
* component 806 - RFW HTR B5 Steam Supply #1 (From "B" LP Turbine, point MR5)
8060000 'STMsrc5A'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8060101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8060200 002     0       cntrlvar 010    *RX Power, %                      *prb 01-27-96 12:31pm
*                                                          *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                     *prb 01-27-96 12:31pm
8060201   0.0   0.30    0.064          *extrapolated                  *prb 01-27-96 12:31pm
8060202  25.0   4.59    0.1630                                    *prb 01-27-96 12:31pm
8060203  50.0   8.88    0.2620                                    *prb 01-27-96 12:31pm
8060204  75.0   13.01   0.5389                                    *prb 01-27-96 12:31pm
8060205  90.0   15.71   0.5008                                    *prb 01-27-96 12:31pm
8060206 100.0   17.49   0.4806                                    *prb 01-27-96 12:31pm
*
*
* component 807 - RFW HTR B5 Steam Supply #2 (From "C" LP Turbine, point #5)
8070000 'STMsrc5B'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
8070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
8070200 002     0       cntrlvar 010    *RX Power, %                      *prb 01-27-96 12:31pm
*                                                          *prb 01-27-96 12:31pm
*     %pwr    press   qual.                                     *prb 01-27-96 12:31pm
8070201   0.0   0.45    0.2807          *extrapolated                 *prb 01-27-96 12:31pm
8070202  25.0   2.69    0.4153                                    *prb 01-27-96 12:31pm
8070203  50.0   5.05    0.5633                                    *prb 01-27-96 12:31pm
8070204  75.0   7.23    0.6912                                    *prb 01-27-96 12:31pm
8070205  90.0   8.66    0.7368                                    *prb 01-27-96 12:31pm
8070206 100.0   9.60    0.7545                                    *prb 01-27-96 12:31pm
*
*
* component 808 - Moisture Separator
8080000 'Mois-Sep'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
```

```
8080101 5.0    10.0   0.0    0.0    0.0    0.0    0.0    0.0    10
*
*     ebt    trip   variable                                    *prb 01-26-96 11:47pm
8080200 001    0      cntrlvar 010    *RX Power, %                     *prb 01-26-96 11:47pm
*
*     %pwr   temp   qual.                                       *prb 01-26-96 11:47pm
8080201   0.0  253.12  0.0          *extrapolated                  *prb 01-26-96 11:47pm
8080202  25.0   286.00  0.0                                      *prb 01-26-96 11:47pm
8080203  50.0   333.40  0.0                                      *prb 01-26-96 11:47pm
8080204  75.0   359.02  0.0                                      *prb 01-26-96 11:47pm
8080205  90.0   374.74  0.0                                      *prb 01-26-96 11:47pm
8080206 100.0   384.07  0.0                                      *prb 01-26-96 11:47pm
*
*
* component 809: Moisture Separator Drain to HTR B2
8090000  'MS-drain'    tmdpjun
8090101  808000000     831000000     1.3963
*
*           trip   variable                                     *prb 01-26-96 11:47pm
*8090200  1     0      cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:47pm
8090200  1      633    cntrlvar 010    *RX Power, %                    *jam 7-27-96
*
*      %pwr   liq.flow    .                                     *prb 01-26-96 11:47pm
8090201    0.0  0.0        0.0          0.0                      *prb 01-26-96 11:47pm
8090202   25.0  22.4352     0.0          0.0       *242,300/3 lb/hr      *prb 01-26-96 11:47pm
8090203   50.0  54.9444     0.0          0.0       *593,400/3 lb/hr      *prb 01-26-96 11:47pm
8090204   75.0  82.8714     0.0          0.0       *895,011/3 lb/hr      *prb 01-26-96 11:47pm
8090205   90.0  105.3094    0.0          0.0       *1,137,342/3 lb/hr    *prb 01-26-96 11:47pm
8090206  100.0  120.7569    0.0          0.0       *1,304,175/3 lb/hr    *prb 01-26-96
11:47pm
*
*
* component 810 - RFW Heater A1 steam supply vlv - jam 7-27-96
8100000 b1stmvlv       valve    *jam 7-27-96
*     from          to          juna   kf     kr     fvcahs
8100101 801000000      820000000      1.3417  15.7355  15.7355 000000        *jam 7-27-96
*         liq_vel     vap_vel          vel.int.
8100201 0    60.166      118.13          0.0                     *jam 7-26-96
8100300 trpvlv                                                 *jam 7-26-96
8100301 633                                                    *jam 7-26-96
*
* component 820 - RFW Heater A1 Steam Dome (top of vertical shell)
8200000 'HTRB1-s1'     branch
*
```

```
*      #juns   vel/flow
*8200001 2       0
8200001 1       0                                              *jam 7-27-96
*
*      area    length  vol    theta   phi   elev     rough   hyd     pvbfe
8200101 12.34   13.7904 0.      0.      -90.0 -13.7904  1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv        voidv
8200200 000     198.29  354.09       1113.5     0.99410
*
*      from           to            juna    kf      kr      fvcahs
*8201101 801000000       820000000       1.3417  15.7355 15.7355 000000       *jam 7-27-96
*8202101 820010000       821000000       0.      0.      0.      101000       *jam 7-27-96
8201101 820010000       821000000       0.      0.      0.      101000       *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*8201110 0.0            0.0     1.0     1.0                              *jam 7-27-96
*8202110 0.0772         0.0     1.0     1.0                              *jam 7-27-96
8201110 0.0772          0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
*8201201 60.166      118.13           0.                                 *jam 7-27-96
*8202201 7.3903      8.4137           0.                                 *jam 7-27-96
8201201 7.3903       8.4137           0.                                 *jam 7-27-96
*
* component 821 - RFW Heater B1 Shellside middle volumes
8210000 'HTRB1-s2'      pipe
*
*      nv
8210001 3
*
*      flowa          vn
8210101 12.34          3      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                             *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
8210301 10.4596        1
8210302 2.6667         3      *same as corresponding primary tube length
*
*      volume         vn
8210401 0.0            3
*
*      incl           vn
8210601 -90.0          3
```

```
*
*     roughness      dhyd    vn
8210801 1.5e-4         0.0772  3
*
*     kf      kr      jn
8210901 0.0     0.0     2
*
*     pvbfe          vn
8211001 00100          3
*
*     fvcahs         jn
8211101 101000         2
*
*     ebt     press.  Uf          Uv        voidv                VN
8211201 0       198.33  354.09      1113.5     0.99189        0.     1
8211202 0       198.36  354.05      1113.5     0.96348        0.     2
8211203 0       198.89  336.85      1113.6     2.33801e-02    0.     3
*
*     vel/flow
8211300 0
*
*     liq-flo     vap-flo     vel.int        jn
8211301 11.168      2.4853     0.           1
8211302 3.0088      5.32454e-02 0.           2
*
*     jun_Dh         flood          gas-int        slope   jn
8211401 0.0772         0.0            1.0            1.0     2
*
*
* component 822 - RFW Heater B1 Tubesheet Shellside (bottom of vertical shell)
8220000 'HTRB1-s3'      branch
*
*     #juns   vel/flow
8220001 1       0
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8220101 12.34   1.3307  0.      0.      -90.0 -1.3307   1.5e-4  0.0772  00100
*
*     ebt     press.  Uf          Uv        voidv
8220200 000     199.30  338.19      1113.6     0.0
*
*     from            to              juna    kf      kr      fvcahs
8221101 821010000       822000000       0.      0.0     0.      101000
*
```

```
*      jun_Dh          flood   gas-int slope
8221110 0.0772          0.0     1.0     1.0
*
*      liq_vel       vap_vel          vel.int.
8221201 0.11251      -1.1900           0.
*
*
* component 823 - RFW Heater B1 Drain Piping
8230000 'HTRB1drn'      branch
*
*      #juns   vel/flow
8230001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8230101 0.3474  10.0    0.      0.      82.6  9.9167    1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv         voidv
8230200 000     199.30  338.19      1113.6     0.0
*
*      from            to             juna    kf      kr      fvcahs
8231101 822010000       823000000       0.3474  0.0     0.      000100
*
*      liq_vel       vap_vel          vel.int.
8231201 3.7345        3.7345           0.
*
*
* component 825 - RFW HTRB1 Drain Valve
8250000  'LCV6-19'      valve
*
*       from       to          juna      kf        kr        fvcahs
8250101  823010000  831000000   0.0873    39.0223   39.0223   000000
*
8250201  0          15.463       15.465   0.     *  819,483/3 lb/hr
*
8250300  srvvlv
*
8250301  0450  * valve position demand from htr B1 level control system
*
8250400  1.0        288.0       * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                              4" linear double-seated full-port
8250401  0.0        0.0001      0.0001  * Assume linear Cv vs stroke for globe
8250402  1.0        1.0         1.0     * valve
*
* component 811 - RFW Heater B2 steam supply vlv - jam 7-27-96
```

```
8110000 b2stmvlv      valve   *jam 7-27-96
*     from          to          juna   kf     kr     fvcahs
8110101 802000000     830000000     0.7854  14.1087  14.1087 000000        *jam 7-27-96
*        liq_vel     vap_vel         vel.int.
8110201 0   74.200      202.58          0.0                         *jam 7-26-96
8110300 trpvlv                                                   *jam 7-26-96
8110301 633                                                      *jam 7-26-96
*
* component 830 - RFW Heater A2 Steam Dome (top of vertical shell)
8300000 'HTRB2-s1'     branch
*
*     #juns   vel/flow
*8300001 2      0                                              *jam 9-27-96
8300001 1      0                                              *jam 9-27-96
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8300101 12.34   10.2904 0.      0.      -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
8300200 000     109.21  304.89      1106.3    0.99832
*
*     from          to          juna   kf     kr     fvcahs
*8301101 802000000      830000000      0.7854  14.1087 14.1087 000001        *jam 9-27-96
*8302101 830010000      831000000      12.34   0.      0.      101000        *jam 9-27-96
8301101 830010000      831000000      12.34   0.      0.      101000        *jam 9-27-96
*
*     jun_Dh         flood   gas-int slope
*8301110 0.0            0.0     1.0     1.0                               *jam 9-27-96
*8302110 0.0772         0.0     1.0     1.0                               *jam 9-27-96
8301110 0.0772         0.0     1.0     1.0                               *jam 9-27-96
*
*     liq_vel     vap_vel         vel.int.
*8301201 74.200      202.58          0.                               *jam 9-27-96
*8302201 12.027      7.9267          0.                               *jam 9-27-96
8301201 12.027      7.9267          0.                               *jam 9-27-96
*
*
* component 831 - RFW Heater B2 drain junction volume
8310000 'HTRB2-s2'     branch
*
*     #juns   vel/flow
8310001 1      0
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
```

```
8310101 12.34   8.8763  0.      0.      -90.0 -8.8763   1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv        voidv
8310200 000     109.23  305.04      1106.4     0.97393
*
*      from            to            juna    kf      kr      fvcahs
8311101 831010000      832000000      12.34   0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
8311110 0.0772          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
8311201 10.895       3.4280            0.
*
*
* component 832 - RFW Heater B2 Shellside middle volumes
8320000 'HTRB2-s2'      pipe
*
*      nv
8320001 2
*
*      flowa          vn
8320101 12.34          2       *Shell area (60.75" ID) minus tube area (5/8"OD)
*                             *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
8320301 3.0000         2       *same as corresponding primary tube length
*
*      volume         vn
8320401 0.0            2
*
*      incl           vn
8320601 -90.0          2
*
*      roughness      dhyd    vn
8320801 1.5e-4         0.0772  2
*
*      kf      kr      jn
8320901 0.0     0.0     1
*
*      pvbfe          vn
8321001 00100          2
*
*      fvcahs         jn
```

```
8321101 101000         1
*
*      ebt     press.  Uf          Uv        voidv                VN
8321201 000     109.25  304.86      1106.4     0.91724        0.     1
8321202 000     109.87  298.86      1106.4     5.89169e-02     0.     2
*
*      vel/flow
8321300 0
*
*      liq-flo     vap-flo     vel.int       jn
8321301 4.2183      0.30784     0.           1
*
*      jun_Dh         flood          gas-int        slope   jn
8321401 0.0772         0.0            1.0            1.0     1
*
*
* component 833 - RFW Heater B2 Tubesheet Shellside (bottom of vertical shell)
8330000 'HTRB2-s3'      branch
*
*      #juns   vel/flow
8330001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8330101 12.34   5.4974  0.      0.      -90.0 -5.4974   1.5e-4  0.0772  00100
*
*      ebt     press.  Uf          Uv        voidv
8330200 000     111.52  291.80      1106.6     0.0
*
*      from           to            juna    kf      kr      fvcahs
8331101 832010000       833000000       12.34   0.0     0.      101000
*
*      jun_Dh         flood   gas-int slope
8331110 0.0772         0.0     1.0     1.0
*
*      liq_vel       vap_vel          vel.int.
8331201 0.42029     -0.82167           0.
*
*
* component 834 - RFW Heater B2 Drain Piping
8340000 'HTRB2drn'      branch
*
*      #juns   vel/flow
8340001 1       0
*
```

```
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8340101 0.5475  25.0    0.      0.      65.0  22.6667   1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv        voidv
8340200 000     199.30  338.19      1113.6     0.0
*
*      from            to             juna    kf      kr      fvcahs
8341101 833010000       834000000       0.5475  0.0     0.      000100
*
*      liq_vel      vap_vel           vel.int.
8341201 8.2628       7.7109            0.
*
*
* component 835 - RFW HTRB2 Drain Valve
8350000  'LCV6-22A'     valve
*
*       from       to         juna      kf       kr       fvcahs
8350101  834010000  841000000   0.3491    22.8653   22.8653   000000
*
8350201  1          228.5294     0.0      0.     *2,468,117/3 lb/hr
*
8350300  srvvlv
*
8350301  0458  * valve position demand based from htr B2 level control          *prb 01-24-
96 10:40am
*
8350400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
8350401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
8350402  1.0       1.0         1.0     * valve
*
*
* component 837 - RFW HTRB2 Bypass Valve                              *prb 01-23-96
01:05pm
8370000  'LCV6-4B'      valve                                  *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
*       from       to         juna      kf       kr       fvcahs          *prb 01-23-96 01:05pm
*8370101  834010000  738000000   0.3491    0.0       0.0       000000            *prb 01-23-96
01:05pm
8370101  834010000  738000000   0.3491    22.8653   22.8653   000000          *prb 01-23-96
01:05pm
*                                                    *prb 01-23-96 01:05pm
8370201  1          0.0          0.0      0.0                          *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
```

```
8370300  srvvlv                                             *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
8370301  0460  * valve position demand                          *prb 01-23-96 01:05pm
*                                                    *prb 01-23-96 01:05pm
8370400  1.0       950.0      * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb 01-23-96
01:05pm
*                          8" linear double-seated full-port    *prb 01-23-96 01:05pm
8370401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-23-96
01:05pm
8370402  1.0       1.0        1.0     * valve                          *prb 01-23-96 01:05pm
*
* component 812 - RFW Heater B3 steam supply vlv - jam 7-27-96
8120000 b3stmvlv        valve    *jam 7-27-96
*      from           to           juna    kf     kr     fvcahs
8120101 803000000       840000000      3.1416  23.4899  23.4899 000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
8120201 0    7.7263       124.84            0.0                      *jam 7-26-96
8120300 trpvlv                                              *jam 7-26-96
8120301 633                                                 *jam 7-26-96
*
* component 840 - RFW Heater A3 Steam Dome (top of vertical shell)
8400000 'HTRB3-s1'      branch
*
*      #juns   vel/flow
*8400001 2      0                                           *jam 7-26-96
8400001 1       0                                          *jam 7-26-96
*
*      area    length  vol     theta   phi   elev     rough   hyd     pvbfe
8400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv        voidv
8400200 000     69.300  271.84       1099.9     0.99613
*
*      from           to           juna    kf     kr     fvcahs
*8401101 803000000       840000000       3.1416  23.4899 23.4899 000000         *jam 7-26-96
*8402101 840010000       841000000       13.5335 0.      0.      101000         *jam 7-26-96
8401101 840010000       841000000       13.5335 0.      0.      101000         *jam 7-26-96
*
*      jun_Dh          flood   gas-int slope
*8401110 0.0             0.0     1.0     1.0                            *jam 7-26-96
*8402110 0.0864          0.0     1.0     1.0                            *jam 7-26-96
8401110 0.0864          0.0     1.0     1.0                            *jam 7-26-96
*
*      liq_vel      vap_vel          vel.int.
```

```
*8401201 7.7263      124.84          0.                              *jam 7-26-96
*8402201 8.9171      19.266          0.                              *jam 7-26-96
8401201 8.9171      19.266          0.                              *jam 7-26-96
*
*
* component 841 - RFW Heater B3 drain junction volume
8410000 'HTRB3-s2'      branch
*
*      #juns   vel/flow
8410001 1       0
*
*      area    length  vol     theta   phi    elev      rough   hyd      pvbfe
8410101 13.5335 11.1133 0.      0.      -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv         voidv
8410200 000     69.309  271.88      1100.0     0.96083
*
*      from           to             juna    kf     kr     fvcahs
8411101 841010000      842000000      13.5335 0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
8411110 0.0864          0.0     1.0     1.0
*
*      liq_vel      vap_vel            vel.int.
8411201 9.3922       5.8524             0.
*
*
* component 842 - RFW Heater B3 Shellside middle & lower volumes
8420000 'HTRB3-s3'      pipe
*
*      nv
8420001 4
*
*      flowa          vn
8420101 13.5335         1
8420102 6.7667          4       *volumes 2-4 share space with subcooling zone
*
*      flowl          vn
8420301 3.0000          2       *same as corresponding primary tube length
8420302 7.0534          4       *same as corresponding primary tube length
*
*      volume         vn
8420401 0.0             4
*
```

```
*      incl          vn
8420601 -90.0          4
*
*      roughness      dhyd    vn
8420801 1.5e-4         0.0864  4
*
*      kf      kr      jn
8420901 0.0     0.0     3
*
*      pvbfe          vn
8421001 00100          4
*
*      fvcahs         jn
8421101 101000         3
*
*      ebt    press.  Uf          Uv        voidv               VN
8421201 000     69.322  271.84      1100.0    0.98918        0.     1
8421202 000     69.529  271.38      1099.9    0.16248        0.     2
8421203 000     72.030  269.21      1100.5    2.68060e-06    0.     3
8421204 000     74.835  267.04      1101.0    8.83757e-06    0.     4
*
*      vel/flow
8421300 0
*
*      liq-flo     vap-flo           vel.int        jn
8421301  70.794     0.44862           0.           1
8421302 0.75643     -0.90429          0.           2
8421303 0.63162     0.77799           0.           3
*
*      jun_Dh         flood          gas-int        slope   jn
8421401 0.0864         0.0            1.0            1.0     3
*
*
* component 843 - RFW Heater B3 Subcooling Zone
8430000 'HTRB3-s4'      pipe
*
*      nv
8430001 3
*
*      flowa          vn
8430101 6.7667         3
*
*      flowl          vn
8430301 3.0000         1       *same as corresponding primary tube length
```

```
8430302 7.0534         3       *same as corresponding primary tube length
*
*      volume          vn
8430401 0.0            3
*
*      incl            vn
8430601 -90.0          3
*
*      roughness       dhyd    vn
8430801 1.5e-4         0.0864  3
*
*      kf      kr      jn
8430901 0.0    0.0     2
*
*      pvbfe           vn
8431001 00100          3
*
*      fvcahs          jn
8431101 101000         2
*
*      ebt    press.  Uf         Uv        voidv               VN
8431201 000    69.415  233.60     1100.1    8.99481e-02    0.    1
8431202 000    71.404  226.39     1100.4    1.57683e-07    0.    2
8431203 000    74.264  242.61     1100.9    3.17648e-06    0.    3
*
*      vel/flow
8431300 0
*
*      liq-flo     vap-flo          vel.int       jn
8431301 3.53376e-02  -1.6814          0.            1
8431302 3.03089e-02  3.099473e-02      0.            2
*
*      jun_Dh        flood          gas-int       slope   jn
8431401 0.0864        0.0            1.0           1.0     2
*
*
* component 844 - RFW Heater B3 Drain Piping
8440000 'HTRB3drn'     branch
*
*      #juns   vel/flow
8440001 1      1
*
*      area    length  vol    theta   phi   elev     rough   hyd    pvbfe
8440101 0.5475  5.0     0.     0.      0.    0.       1.5e-4  0.0    00000
```

```
*
*     ebt    press.  Uf         Uv        voidv
8440200 000     199.30  338.19      1113.6     0.0
*
*     from           to            juna   kf     kr     fvcahs
8441101 843010000       844000000       0.5475  0.0     0.     000100
*
*     liq_vel     vap_vel          vel.int.
8441201 228.5294     0.0              0.
*
*
* component 845 - RFW HTRB3 Drain Valve
8450000  'LCV6-23'     valve
*
*      from       to         juna      kf       kr       fvcahs
8450101  844010000  852000000   0.3491    7.4816    7.4816    000000
*
8450201  0          12.689       44.886   0.     *2,468,117/3 lb/hr target
*
8450300  srvvlv
*
8450301  0472  * valve position demand based on htr B3 level error
*
8450400  1.0       950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
8450401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
8450402  1.0       1.0        1.0     * valve
*
*
8470000 'HTRB3jun' mtpljun
8470001 2       0
*
*     from      to       juna    kf  kr  fvcahs        incr1   incr2   jn
8470011 842020004 843010003 .1      5.  5.  001000 1. 1. 1. 0       0     0 1
8470021 842040004 843030003 1.      5.  5.  001000 1. 1. 1. 0       0     0 2
*
*     liq-flo     vap-flo     jn
8471011 4.0946       4.0946     1
8471021 0.0          0.0        2
*
* component 813 - RFW Heater B4 steam supply vlv - jam 7-27-96
8130000 b4stvlv1        valve    *jam 7-27-96
*     from           to            juna   kf     kr     fvcahs
8130101 805000000       850000000       2.8229  6197.85  6197.85 000000          *jam 7-27-96
```

```
*         liq_vel     vap_vel          vel.int.
8130201 0    0.83437      24.814            0.0                         *jam 7-26-96
8130300 trpvlv                                                       *jam 7-26-96
8130301 633                                                          *jam 7-26-96
*
*
* component 850 - RFW Heater A4 (top of shell nearest tubesheet)
8500000 'HTRB4-s1'      branch
*
*      #juns   vel/flow
*8500001 2       0                                                   *jam 7-26-96
8500001 1       0                                                    *jam 7-26-96
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv         voidv
8500200 000     27.276  213.37       1086.4     0.99962
*
*      from            to            juna    kf      kr      fvcahs
*8501101 805000000      850000000      2.8229  6197.85 6197.85 000000         *jam 7-27-96
*8502101 850010000      851000000      9.7832  0.      0.      001003         *jam 7-27-96
8501101 850010000      851000000      9.7832  0.      0.      001003         *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*8501110 0.0            0.0     1.0     1.0                              *jam 7-27-96
*8502110 0.1309         0.0     1.0     1.0                              *jam 7-27-96
8501110 0.1309         0.0     1.0     1.0                              *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*8501201 0.83437      24.814           0.                               *jam 7-27-96
*8502201  9.1016      8.7249           0.                               *jam 7-27-96
8501201  9.1016      8.7249           0.                               *jam 7-27-96
*
* component 814 - RFW Heater B4 steam supply vlv - jam 7-27-96
8140000 b4stvlv2        valve    *jam 7-27-96
*      from            to            juna    kf      kr      fvcahs
8140101 804000000      851000000      2.8229  4.4554   4.4554  000000         *jam 7-27-96
*         liq_vel     vap_vel          vel.int.
8140201 0    41.854      271.59           0.0                         *jam 7-26-96
8140300 trpvlv                                                       *jam 7-26-96
8140301 633                                                          *jam 7-26-96
*
*
```

```
* component 851 - RFW Heater A4 (top of shell furthest from tubesheet)
8510000 'HTRB4-s2'     branch
*
*     #juns   vel/flow
*8510001 2      0                                    *jam 7-27-96
8510001 1      0                                    *jam 7-27-96
*
*     area   length  vol     theta  phi   elev     rough   hyd     pvbfe
8510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt    press   Uf         Uv        voidv
8510200 000     27.276  213.38      1086.4     0.99996
*
*     from           to            juna    kf     kr     fvcahs
*8511101 804000000      851000000      2.8229   4.4554  4.4554  000000      *jam 7-27-96
*8512101 851010000      852000000      153.4359 0.     0.     101000      *jam 7-27-96
8511101 851010000      852000000      153.4359 0.     0.     101000      *jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*8511110 0.0            0.0     1.0     1.0                          *jam 7-27-96
*8512110 0.1309          0.0     1.0     1.0                          *jam 7-27-96
8511110 0.1309          0.0     1.0     1.0                          *jam 7-27-96
*
*     liq_vel      vap_vel          vel.int.
*8511201 41.854      271.59           0.                          *jam 7-27-96
*8512201 38.784      4.5911           0.                          *jam 7-27-96
8511201 38.784      4.5911           0.                          *jam 7-27-96
*
*
* component 852 - RFW Heater B4 (bottom of shell furthest from tubesheet)
8520000 'HTRB4-s3'     branch
*
*     #juns   vel/flow
8520001 0      0
*
*     area   length  vol     theta  phi   elev     rough   hyd     pvbfe
8520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*     ebt    press   Uf         Uv        voidv
8520200 000     27.292  209.34      1086.4     0.52487
*
*
* component 853 - RFW Heater B4 Subcooling Zone
8530000 'HTRB4-s4'     branch
```

```
*
*     #juns   vel/flow
8530001 1       0
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8530101 9.7832  15.6667 0.0      0.     0.0   0.0       1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv         voidv
8530200 000     26.746  170.92       1086.2     2.46992e-02
*
*     from            to             juna    kf      kr      fvcahs
8531101 852010000       853000000       1.7671   5.0     5.0     001000
*
*     jun_Dh          flood   gas-int slope
8531110 0.1309          0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
8531201 6.4784       37.792            0.
*
*
* component 854 - RFW Heater B4 Drain Piping
8540000 'HTRB4drn'      branch
*
*     #juns   vel/flow
8540001 1       0
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
8540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv         voidv
8540200 000     26.326  174.57       1085.9     7.05438e-04
*
*     from            to             juna    kf      kr      fvcahs
8541101 853010000       854000000       1.6230  0.0     0.      000100
*
*     liq_vel      vap_vel           vel.int.
8541201 3.1304       4.5777            0.
*
*
* component 855 - RFW HTRB4 Drain Valve
8550000  'LCV6-29A'     valve
*
*      from       to         juna      kf        kr        fvcahs
8550101  854010000  860010003   0.7854    23.7848   23.7848   000000
```

```
*
8550201  0        7.5514      7.5514   0.    *3,184,100/3 lb/hr target
*
8550300  srvvlv
*
8550301  0482  * valve position demand based on htr B4 level error
*
8550400  1.0      2180.0     * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                            12" linear double-seated full-port
8550401  0.0      0.0001     0.0001  * Assume linear Cv vs stroke for globe
8550402  1.0      1.0        1.0     * valve
*
*
* component 857 - RFW HTRB4 Bypass Valve                          *prb 01-24-96
10:22am
8570000  'LCV6-29B'    valve                                    *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
*      from      to        juna     kf       kr      fvcahs        *prb 01-24-96 10:22am
*8570101  854010000  758000000   0.7854    0.0      0.0      000000          *prb 01-24-96
10:22am
8570101  854010000  758000000   0.7854    23.7848   23.7848   000000          *jam 7-26-96
*                                                        *prb 01-24-96 10:22am
8570201  1        0.0        0.0      0.0                        *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570300  srvvlv                                                *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570301  0460  * valve position demand                           *prb 01-24-96 10:22am
*                                                        *prb 01-24-96 10:22am
8570400  1.0      2180.0     * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-24-
96 10:22am
*                            12" linear double-seated full-port   *prb 01-24-96 10:22am
8570401  0.0      0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
8570402  1.0      1.0        1.0     * valve                      *prb 01-24-96 10:22am
*
*
* component 860 - RFW Heater B5 Flash Tank
8600000 'FL-TankB'     pipe
*
*      nv
8600001 4
*
*      flowa         vn
8600101 16.4988        4
```

```
*
*      flowl          vn
8600301 1.4583         1
8600302 2.9583         2
8600303 2.500          3
8600304 5.2188         4
*
*      volume         vn
8600401 0.0            4
*
*      incl           vn
8600601 -90.0          4
*
*      roughness      dhyd    vn
8600801 0.0            0.0     4
*
*      kf      kr      jn
8600901 0.0     0.0     3
*
*      pvbfe          vn
8601001 00010          4
*
*      fvcahs         jn
8601101 101000         3
*
*      ebt     press.  Uf          Uv         voidv                VN
8601201 000     9.6940  160.59      1071.8     0.98351         0.      1
8601202 000     9.6954  159.92      1071.8     0.99883         0.      2
8601203 000     9.9628  160.43      1072.2     0.53140         0.      3
8601204 000     12.394  159.48      1075.2     0.00000e+00     0.      4
*
*      vel/flow
8601300 0
*
*      liq-flo     vap-flo          vel.int        jn
8601301  19.581      0.27746          0.            1
8601302  282.58      0.63630          0.            2
8601303 0.63560      -4.2606          0.            3
*
*      jun_Dh         flood          gas-int        slope   jn
8601401 0.0            0.0            1.0            1.0     3
*
*
* component 861 - RFW Heater B5 Drain Piping
```

```
8610000 'HTRB5drn'     branch
*
*     #juns   vel/flow
8610001 1      0
*
*     area    length  vol     theta   phi    elev      rough   hyd     pvbfe
8610101 2.9483  10.0    0.      0.      0.0    0.0       1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv         voidv
8610200 000     13.552  159.14      1076.4     0.0
*
*     from            to            juna    kf      kr      fvcahs
8611101 860010000       861000000       2.9483  0.0     0.      000100
*
*     liq_vel      vap_vel           vel.int.
8611201 1.6705       1.9099            0.
*
* component 815 - RFW Heater B5 steam supply vlv - jam 7-27-96
8150000 b5stvlv1        valve    *jam 7-27-96
*     from            to            juna    kf      kr      fvcahs
8150101 806000000       862000000       9.0164  6243.8   6243.8  000000          *jam 7-27-96
*          liq_vel      vap_vel           vel.int.
8150201 0    0.49198      22.264            0.0                          *jam 7-26-96
8150300 trpvlv                                                  *jam 7-26-96
8150301 633                                                     *jam 7-26-96
*
*
* component 862 - RFW Heater B5 (top of shell nearest tubesheet)
8620000 'HTRB5-s1'      branch
*
*     #juns   vel/flow
*8620001 3      0                                              *jam 7-27-96
8620001 2      0                                              *jam 7-27-96
*
*     area    length  vol      theta  phi    elev      rough   hyd     pvbfe
8620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv         voidv
8620200 000     9.4593  158.61      1071.3     0.99998
*
*     from            to            juna    kf      kr      fvcahs
*8621101 806000000       862000000       9.0164  6243.8  6243.8  001000
*jam 7-27-96
```

```
*8622101 862010000      863000000      8.7069  0.      0.      001003
*jam 7-27-96
8621101 862010000      863000000      8.7069  0.      0.      001003
*jam 7-27-96
*8623101 860000000      862000000      0.7530  1.50    1.50    001000
*jam 7-27-96
8622101 860000000      862000000      0.7530  1.50    1.50    001000
*jam 7-27-96
*
*     jun_Dh         flood   gas-int slope
*8621110 2.3958         0.0     1.0     1.0                                    *jam 7-27-96
*8622110 0.1128         0.0     1.0     1.0                                    *jam 7-27-96
8621110 0.1128         0.0     1.0     1.0                                    *jam 7-27-96
*8623110 0.0            0.0     1.0     1.0                                    *jam 7-27-96
8622110 0.0            0.0     1.0     1.0                                    *jam 7-27-96
*
*     liq_vel      vap_vel          vel.int.
*8621201 0.49198       22.264          0.                                     *jam 7-27-96
*8622201 -31.397      -26.477          0.                                     *jam 7-27-96
8621201 -31.397      -26.477          0.                                     *jam 7-27-96
*8623201 -30.730       237.56          0.                                     *jam 7-27-96
8622201 -30.730       237.56          0.                                     *jam 7-27-96
*
* component 816 - RFW Heater B5 steam supply vlv - jam 7-27-96
8160000 b5stvlv2       valve   *jam 7-27-96
*     from           to           juna    kf     kr     fvcahs
8160101 807000000      863000000      9.0164  2.9489   2.9489  000000         *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
8160201 0    26.337       161.50           0.0                       *jam 7-26-96
8160300 trpvlv                                                  *jam 7-26-96
8160301 633                                                     *jam 7-26-96
*
*
* component 863 - RFW Heater B5 (top of shell furthest from tubesheet)
8630000 'HTRB5-s2'      branch
*
*     #juns   vel/flow
*8630001 2      0                                               *jam 7-27-96
8630001 1      0                                               *jam 7-27-96
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8630101 0.0      2.8333  128.8119 0.      -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt    press   Uf          Uv        voidv
```

```
8630200 000    9.4589  158.60      1071.4     0.99992
*
*     from          to          juna    kf     kr     fvcahs
*8631101 807000000      863000000      9.0164   2.9489  2.9489  001000       *jam 9-27-96
*8632101 863010000      864000000      83.8342  0.     0.     001000       *jam 9-27-96
8631101 863010000      864000000      83.8342  0.     0.     001000       *jam 9-27-96
*
*     jun_Dh        flood   gas-int slope
*8631110 2.3958         0.0     1.0     1.0                              *jam 9-27-96
*8632110 0.1128         0.0     1.0     1.0                              *jam 9-27-96
8631110 0.1128         0.0     1.0     1.0                              *jam 9-27-96
*
*     liq_vel      vap_vel          vel.int.
*8631201 26.337      161.50          0.                                  *jam 9-27-96
*8632201 34.542      8.5995          0.                                  *jam 9-27-96
8631201 34.542      8.5995          0.                                  *jam 9-27-96
*
*
* component 864 - RFW Heater B5 (bottom of shell furthest from tubesheet)
8640000 'HTRB5-s3'      branch
*
*     #juns   vel/flow
8640001 2      0
*
*     area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
8640200 000    9.6340  148.68      1071.7     0.39598
*
*     from          to          juna    kf     kr     fvcahs
8641101 864010004      865010003      8.7069  0.     0.     001000
8642101 864010000      866000000      0.8685   1.5    100.0   001001  * discourage reverse
flow
*
*     jun_Dh        flood   gas-int slope
8641110 0.1128         0.0     1.0     1.0
8642110 0.6651         0.0     1.0     1.0
*
*     liq_vel      vap_vel          vel.int.
8641201  3.4725      -8.5376          0.
8642201 0.47271      -9.3520          0.
*
*
```

```
* component 865 - RFW Heater B5 (bottom of shell nearest tubesheet)
8650000 'HTRB5-s4'      branch
*
*      #juns   vel/flow
8650001 2       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt     press   Uf          Uv        voidv
8650200 000     9.4996  134.05       1071.5     0.44943
*
*      from            to             juna     kf      kr      fvcahs
8651101 862010000       865000000       110.9722 0.0     0.0     001000
8652101 865010000       866000000       0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*      jun_Dh          flood   gas-int slope
8651110 0.1128          0.0     1.0     1.0
8652110 0.6651          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
8651201   37.265       5.8851          0.
8652201 -0.42722      -10.256          0.
*
*
* component 866 - RFW Heater B5 Collector
8660000 'Coll-B5'       branch
*
*      #juns   vel/flow
8660001 1       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
8660101 4.9087  0.0     145.2255 0.     0.0   0.0       1.5e-4  0.0     00000
*
*      ebt     press   Uf          Uv        voidv
8660200 000     9.9594  146.78       1072.2     0.10641
*
*      from            to             juna     kf      kr      fvcahs
8661101 866010002       860030003       4.9087   1.0     0.50    031000
*
*      jun_Dh          flood   gas-int slope
8661110 2.5             0.0     1.0     1.0
*
```

```
*      liq_vel      vap_vel           vel.int.
8661201 -0.18014      -1.3910          0.
*
*
* component 867 - RFW HTRB5 Drain Valve
*
8670000  'LCV6-32A'     valve
*
*      from       to         juna      kf       kr       fvcahs
8670101  861010000  969000000   0.7854    5.6209    5.6209    001000
*
8670201  0         9.4         9.4      0.     *3,184,100/3 lb/hr target
*
8670300  srvvlv
*
8670301  0493  * valve position demand based on htr B5 level error
*
8670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
8670401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe
8670402  1.0       1.0         1.0     * valve
*
*
* component 868 - RFW HTRB5 Bypass Valve                              *prb 01-24-96
10:22am
8680000  'LCV6-32B'     valve                                   *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
*      from       to         juna      kf       kr       fvcahs          *prb 01-24-96 10:22am
*8680101  861010000  969000000   0.7854    0.0       0.0       000000           *prb 01-24-96
10:22am
8680101  861010000  969000000   0.7854    0.0       5.6209    001000          *jam 7-26-96
*                                                    *prb 01-24-96 10:22am
8680201  1         0.0         0.0      0.0                        *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
8680300  srvvlv                                              *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
8680301  0495  * valve position demand                              *prb 01-24-96 10:22am
*                                                    *prb 01-24-96 10:22am
8680400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-24-
96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
8680401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
8680402  1.0       1.0         1.0     * valve                          *prb 01-24-96 10:22am
```

```
*
*
*------------------------------------------------------------------------
* Train C Feedwater Heaters - Shellside
*------------------------------------------------------------------------
*
* component 901 - RFW HTR C1 Steam Supply
9010000 'STM-src1'     tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd    fe
9010101 5.0    10.0    0.0     0.0     90.0    10.0    0.0     0.0    10
*
*     ebt    trip    variable
9010200 002    0     cntrlvar 010    *RX Power, %                   *prb 01-25-96 11:25pm
*
*     %pwr    press   qual.
9010201   0.0    7.545  0.9107        *extrapolated                  *prb 01-26-96 10:38pm
9010202  25.0   55.019  0.9022                                       *prb 01-26-96 10:38pm
9010203  50.0   110.02  0.8907                                       *prb 01-26-96 10:38pm
9010204  75.0   153.73  0.8837                                       *prb 01-26-96 10:38pm
9010205  90.0   186.86  0.8791                                       *prb 01-26-96 10:38pm
9010206 100.0   209.01  0.8765                                       *prb 01-26-96 10:38pm
*
*
* component 902 - RFW HTR C2 Steam Supply
9020000 'STM-src2'     tmdpvol
*
*     area   length  vol    azmth   incl    elev    rough   hyd    fe
9020101 5.0    10.0    0.0     0.0     0.0     0.0     0.0     0.0    10
*
*     ebt    trip    variable
9020200 002    0     cntrlvar 010    *RX Power, %                   *prb 01-26-96 11:55pm
*
*     %pwr    press   qual.                                 *prb 01-26-96 11:55pm
9020201   0.0    3.43   0.9607        *extrapolated                  *prb 01-26-96 11:55pm
9020202  25.0    31.30  0.9587                                       *prb 01-26-96 11:55pm
9020203  50.0    61.70  0.9533                                       *prb 01-26-96 11:55pm
9020204  75.0    88.31  0.9530                                       *prb 01-26-96 11:55pm
9020205  90.0   107.20  0.9508                                       *prb 01-26-96 11:55pm
9020206 100.0   119.81  0.9495                                       *prb 01-26-96 11:55pm
*
*
* component 903 - RFW HTR C3 Steam Supply
9030000 'STM-src3'     tmdpvol
```

```
*
*     area   length vol   azmth  incl   elev   rough  hyd    fe
9030101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip   variable
9030200 002     0      cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:55pm
*
*     %pwr   press   qual.                                   *prb 01-26-96 11:55pm
9030201   0.0    1.99   0.9421        *extrapolated                *prb 01-26-96 11:55pm
9030202  25.0   19.80   0.9389                               *prb 01-26-96 11:55pm
9030203  50.0   38.70   0.9316                               *prb 01-26-96 11:55pm
9030204  75.0   55.97   0.9305                               *prb 01-26-96 11:55pm
9030205  90.0   67.71   0.9276                               *prb 01-26-96 11:55pm
9030206 100.0   75.51   0.9259                               *prb 01-26-96 11:55pm
*
*
* component 904 - RFW HTR C4 Steam Supply #1
9040000 'STMsrc4A'      tmdpvol
*
*     area   length vol   azmth  incl   elev   rough  hyd    fe
9040101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip   variable
9040200 002     0      cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                     *prb 01-27-96 10:08am
*     %pwr   press   qual.                                   *prb 01-27-96 10:08am
9040201   0.0    0.75   0.6576        *extrapolated                *prb 01-27-96 10:08am
9040202  25.0    7.66   0.7094                               *prb 01-27-96 10:08am
9040203  50.0   14.80   0.8077                               *prb 01-27-96 10:08am
9040204  75.0   21.59   0.8363                               *prb 01-27-96 10:08am
9040205  90.0   26.05   0.8437                               *prb 01-27-96 10:08am
9040206 100.0   29.00   0.8482                               *prb 01-27-96 10:08am
*
*
* component 905 - RFW HTR C4 Steam Supply #2
9050000 'STMsrc4B'      tmdpvol
*
*     area   length vol   azmth  incl   elev   rough  hyd    fe
9050101 2.8229  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt    trip   variable
9050200 002     0      cntrlvar 010    *RX Power, %                    *prb 01-27-96 10:08am
*                                                     *prb 01-27-96 10:08am
*     %pwr   press   qual.                                   *prb 01-27-96 10:08am
```

```
9050201   0.0   1.127   0.3577         *extrapolated                    *prb 01-27-96 10:08am
9050202  25.0   12.30   0.4394                                          *prb 01-27-96 10:08am
9050203  50.0   24.00   0.5701                                          *prb 01-27-96 10:08am
9050204  75.0   34.91   0.6273                                          *prb 01-27-96 10:08am
9050205  90.0   42.24   0.6434                                          *prb 01-27-96 10:08am
9050206 100.0   47.12   0.6485                                          *prb 01-27-96 10:08am
*
*
* component 906 - RFW HTR C5 Steam Supply #1 (From "B" LP Turbine, point MR5)
9060000 'STMsrc5A'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9060101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9060200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 12:31pm
*                                                 *prb 01-27-96 12:31pm
*     %pwr    press   qual.                               *prb 01-27-96 12:31pm
9060201   0.0   0.30    0.064          *extrapolated                    *prb 01-27-96 12:31pm
9060202  25.0   4.59    0.1630                                          *prb 01-27-96 12:31pm
9060203  50.0   8.88    0.2620                                          *prb 01-27-96 12:31pm
9060204  75.0   13.01   0.5389                                          *prb 01-27-96 12:31pm
9060205  90.0   15.71   0.5008                                          *prb 01-27-96 12:31pm
9060206 100.0   17.49   0.4806                                          *prb 01-27-96 12:31pm
*
*
* component 907 - RFW HTR C5 Steam Supply #2 (From "C" LP Turbine, point #5)
9070000 'STMsrc5B'      tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
9070101 9.0164  10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable
9070200 002     0       cntrlvar 010    *RX Power, %                    *prb 01-27-96 12:31pm
*                                                 *prb 01-27-96 12:31pm
*     %pwr    press   qual.                               *prb 01-27-96 12:31pm
9070201   0.0   0.45    0.2807         *extrapolated                    *prb 01-27-96 12:31pm
9070202  25.0   2.69    0.4153                                          *prb 01-27-96 12:31pm
9070203  50.0   5.05    0.5633                                          *prb 01-27-96 12:31pm
9070204  75.0   7.23    0.6912                                          *prb 01-27-96 12:31pm
9070205  90.0   8.66    0.7368                                          *prb 01-27-96 12:31pm
9070206 100.0   9.60    0.7545                                          *prb 01-27-96 12:31pm
*
*
```

```
* component 908 - Moisture Separator
9080000 'Mois-Sep'     tmdpvol
*
*     area    length  vol     azmth   incl    elev    rough   hyd     fe
9080101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
*
*     ebt     trip    variable                                *prb 01-26-96 11:47pm
9080200 001     0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:47pm
*
*     %pwr    temp    qual.                                    *prb 01-26-96 11:47pm
9080201   0.0  253.12  0.0          *extrapolated                       *prb 01-26-96 11:47pm
9080202  25.0   286.00  0.0                                    *prb 01-26-96 11:47pm
9080203  50.0   333.40  0.0                                    *prb 01-26-96 11:47pm
9080204  75.0   359.02  0.0                                    *prb 01-26-96 11:47pm
9080205  90.0   374.74  0.0                                    *prb 01-26-96 11:47pm
9080206 100.0   384.07  0.0                                    *prb 01-26-96 11:47pm
*
*
* component 909: Moisture Separator Drain to HTR C2
9090000  'MS-drain'     tmdpjun
9090101  908000000      931000000       1.3963
*
*            trip    variable                                  *prb 01-26-96 11:47pm
*9090200  1      0       cntrlvar 010    *RX Power, %                    *prb 01-26-96 11:47pm
9090200  1       634     cntrlvar 010    *RX Power, %                    *jam 7-27-96
*
*      %pwr   liq.flow     .                                   *prb 01-26-96 11:47pm
9090201    0.0  0.0        0.0         0.0                     *prb 01-26-96 11:47pm
9090202   25.0  22.4352     0.0         0.0     *242,300/3 lb/hr     *prb 01-26-96 11:47pm
9090203   50.0  54.9444     0.0         0.0     *593,400/3 lb/hr     *prb 01-26-96 11:47pm
9090204   75.0  82.8714     0.0         0.0     *895,011/3 lb/hr     *prb 01-26-96 11:47pm
9090205   90.0  105.3094    0.0         0.0     *1,137,342/3 lb/hr     *prb 01-26-96 11:47pm
9090206  100.0  120.7569    0.0         0.0     *1,304,175/3 lb/hr     *prb 01-26-96
11:47pm
*
* component 910 - RFW Heater C1 steam supply vlv - jam 7-27-96
9100000 c1stmvlv       valve    *jam 7-27-96
*     from          to          juna    kf      kr      fvcahs
9100101 901000000      920000000      1.3417  15.7355  15.7355 000000        *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
9100201 0    60.166       118.13           0.0                     *jam 7-26-96
9100300 trpvlv                                        *jam 7-26-96
9100301 634                                           *jam 7-26-96
*
```

```
* component 920 - RFW Heater C1 Steam Dome (top of vertical shell)
9200000 'HTRC1-s1'      branch
*
*      #juns   vel/flow
*9200001 2       0
9200001 1       0                                              *jam 7-27-96
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9200101 12.34   13.7904 0.      0.      -90.0 -13.7904  1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv         voidv
9200200 000     198.29  354.09       1113.5     0.99410
*
*      from            to             juna    kf      kr      fvcahs
*9201101 901000000       920000000       1.3417  15.7355 15.7355 000000       *jam 7-27-96
*9202101 920010000       921000000       0.      0.      0.      101000       *jam 7-27-96
9201101 920010000       921000000       0.      0.      0.      101000        *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*9201110 0.0             0.0     1.0     1.0                              *jam 7-27-96
*9202110 0.0772          0.0     1.0     1.0                              *jam 7-27-96
9201110 0.0772          0.0     1.0     1.0
*
*      liq_vel       vap_vel           vel.int.
*9201201 60.166       118.13            0.                               *jam 7-27-96
*9202201 7.3903       8.4137            0.                               *jam 7-27-96
9201201 7.3903       8.4137            0.                               *jam 7-27-96
*
*
* component 921 - RFW Heater C1 Shellside middle volumes
9210000 'HTRC1-s2'      pipe
*
*      nv
9210001 3
*
*      flowa          vn
9210101 12.34          3      *Shell area (60.75" ID) minus tube area (5/8"OD)
*                            *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
9210301 10.4596        1
9210302 2.6667         3      *same as corresponding primary tube length
*
*      volume          vn
```

```
9210401 0.0        3
*
*     incl         vn
9210601 -90.0      3
*
*     roughness    dhyd    vn
9210801 1.5e-4     0.0772  3
*
*     kf    kr    jn
9210901 0.0    0.0    2
*
*     pvbfe        vn
9211001 00100      3
*
*     fvcahs       jn
9211101 101000     2
*
*     ebt    press.  Uf        Uv       voidv             VN
9211201 0      198.33  354.09    1113.5   0.99189      0.    1
9211202 0      198.36  354.05    1113.5   0.96348      0.    2
9211203 0      198.89  336.85    1113.6   2.33801e-02  0.    3
*
*     vel/flow
9211300 0
*
*     liq-flo    vap-flo    vel.int      jn
9211301 11.168     2.4853     0.         1
9211302 3.0088     5.32454e-02 0.        2
*
*     jun_Dh       flood        gas-int      slope   jn
9211401 0.0772       0.0          1.0          1.0    2
*
*
* component 922 - RFW Heater C1 Tubesheet Shellside (bottom of vertical shell)
9220000 'HTRC1-s3'     branch
*
*     #juns   vel/flow
9220001 1      0
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9220101 12.34   1.3307  0.     0.     -90.0 -1.3307   1.5e-4  0.0772  00100
*
*     ebt    press.  Uf        Uv       voidv
9220200 000     199.30  338.19     1113.6    0.0
```

```
*
*     from          to            juna   kf     kr     fvcahs
9221101 921010000      922000000      0.      0.0     0.      101000
*
*     jun_Dh         flood   gas-int slope
9221110 0.0772         0.0     1.0     1.0
*
*     liq_vel      vap_vel         vel.int.
9221201 0.11251      -1.1900           0.
*
*
* component 923 - RFW Heater C1 Drain Piping
9230000 'HTRC1drn'     branch
*
*     #juns   vel/flow
9230001 1       0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
9230101 0.3474  10.0    0.      0.      82.6  9.9167    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
9230200 000     199.30  338.19       1113.6     0.0
*
*     from          to            juna   kf     kr     fvcahs
9231101 922010000      923000000      0.3474  0.0     0.      000100
*
*     liq_vel      vap_vel         vel.int.
9231201 3.7345       3.7345           0.
*
*
* component 925 - RFW HTRC1 Drain Valve
9250000  'LCV6-37'     valve
*
*      from       to        juna      kf       kr       fvcahs
9250101  923010000  931000000   0.0873    39.0223   39.0223   000000
*
9250201  0          15.463       15.465   0.     *  819,483/3 lb/hr
*
9250300  srvvlv
*
9250301  0950  * valve position demand from htr C1 level control system
*
9250400  1.0        288.0       * max Cv = 288.0 per BFN-VTD-K125-0060 for
*                               4" linear double-seated full-port
```

```
9250401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9250402  1.0       1.0        1.0     * valve
*
* component 911 - RFW Heater C2 steam supply vlv - jam 7-27-96
9110000 c2stmvlv       valve    *jam 7-27-96
*     from          to           juna   kf     kr     fvcahs
9110101 902000000      930000000     0.7854  14.1087  14.1087 000000        *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
9110201 0    74.200      202.58           0.0                        *jam 7-26-96
9110300 trpvlv                                                  *jam 7-26-96
9110301 634                                                    *jam 7-26-96
*
* component 930 - RFW Heater C2 Steam Dome (top of vertical shell)
9300000 'HTRC2-s1'      branch
*
*     #juns   vel/flow
*9300001 2      0                                              *jam 9-27-96
9300001 1      0                                               *jam 9-27-96
*
*     area    length  vol    theta   phi   elev     rough   hyd     pvbfe
9300101 12.34   10.2904 0.     0.      -90.0 -10.2904  1.5e-4  0.0772  00100
*
*     ebt     press   Uf          Uv        voidv
9300200 000     109.21  304.89       1106.3     0.99832
*
*     from          to           juna   kf     kr     fvcahs
*9301101 902000000      930000000      0.7854  14.1087 14.1087 000001        *jam 9-27-96
*9302101 930010000      931000000      12.34   0.      0.      101000        *jam 9-27-96
9301101 930010000      931000000      12.34   0.      0.      101000        *jam 9-27-96
*
*     jun_Dh         flood   gas-int slope
*9301110 0.0            0.0     1.0     1.0                        *jam 9-27-96
*9302110 0.0772         0.0     1.0     1.0                        *jam 9-27-96
9301110 0.0772         0.0     1.0     1.0                         *jam 9-27-96
*
*     liq_vel      vap_vel          vel.int.
*9301201 74.200      202.58           0.                           *jam 9-27-96
*9302201 12.027      7.9267           0.                           *jam 9-27-96
9301201 12.027      7.9267           0.                            *jam 9-27-96
*
*
* component 931 - RFW Heater C2 drain junction volume
9310000 'HTRC2-s2'      branch
*
```

```
*      #juns   vel/flow
9310001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9310101 12.34   8.8763  0.      0.      -90.0 -8.8763   1.5e-4  0.0772  00100
*
*      ebt     press   Uf          Uv        voidv
9310200 000     109.23  305.04      1106.4    0.97393
*
*      from            to             juna    kf     kr     fvcahs
9311101 931010000       932000000       12.34   0.     0.     101000
*
*      jun_Dh          flood   gas-int slope
9311110 0.0772          0.0     1.0     1.0
*
*      liq_vel     vap_vel          vel.int.
9311201 10.895      3.4280           0.
*
*
* component 932 - RFW Heater C2 Shellside middle volumes
9320000 'HTRC2-s2'      pipe
*
*      nv
9320001 2
*
*      flowa          vn
9320101 12.34          2      *Shell area (60.75'' ID) minus tube area (5/8"OD)
*                            *tube area = (2)(1906 tubes)(tube area)
*
*      flowl          vn
9320301 3.0000         2      *same as corresponding primary tube length
*
*      volume         vn
9320401 0.0            2
*
*      incl           vn
9320601 -90.0          2
*
*      roughness      dhyd    vn
9320801 1.5e-4         0.0772  2
*
*      kf     kr     jn
9320901 0.0    0.0    1
*
```

```
*      pvbfe         vn
9321001 00100        2
*
*      fvcahs        jn
9321101 101000       1
*
*      ebt    press.  Uf        Uv       voidv              VN
9321201 000    109.25  304.86    1106.4   0.91724        0.    1
9321202 000    109.87  298.86    1106.4   5.89169e-02    0.    2
*
*      vel/flow
9321300 0
*
*      liq-flo    vap-flo    vel.int       jn
9321301 4.2183     0.30784    0.          1
*
*      jun_Dh        flood        gas-int       slope   jn
9321401 0.0772        0.0          1.0          1.0    1
*
*
* component 933 - RFW Heater C2 Tubesheet Shellside (bottom of vertical shell)
9330000 'HTRC2-s3'     branch
*
*      #juns   vel/flow
9330001 1      0
*
*      area   length  vol    theta   phi   elev     rough   hyd    pvbfe
9330101 12.34   5.4974  0.     0.      -90.0 -5.4974   1.5e-4  0.0772  00100
*
*      ebt    press.  Uf        Uv       voidv
9330200 000    111.52  291.80    1106.6   0.0
*
*      from          to           juna    kf     kr     fvcahs
9331101 932010000      933000000      12.34   0.0    0.     101000
*
*      jun_Dh        flood   gas-int slope
9331110 0.0772        0.0     1.0     1.0
*
*      liq_vel      vap_vel         vel.int.
9331201 0.42029    -0.82167          0.
*
*
* component 934 - RFW Heater C2 Drain Piping
9340000 'HTRC2drn'     branch
```

```
*
*      #juns   vel/flow
9340001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9340101 0.5475  25.0    0.      0.      65.0  22.6667   1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv         voidv
9340200 000     199.30  338.19      1113.6     0.0
*
*      from            to              juna    kf      kr      fvcahs
9341101 933010000       934000000       0.5475  0.0     0.      000100
*
*      liq_vel      vap_vel           vel.int.
9341201 8.2628       7.7109            0.
*
*
* component 935 - RFW HTRC2 Drain Valve
9350000  'LCV6-40A'     valve
*
*       from       to         juna      kf        kr        fvcahs
9350101  934010000  941000000   0.3491    22.8653   22.8653   000000
*
9350201  1          228.5294     0.0      0.     *2,468,117/3 lb/hr
*
9350300  srvvlv
*
9350301  0958  * valve position demand based from htr C2 level control
*
9350400  1.0        950.0        * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
9350401  0.0        0.0001      0.0001  * Assume linear Cv vs stroke for globe
9350402  1.0        1.0         1.0     * valve
*
*
* component 937 - RFW HTRB2 Bypass Valve                              *prb 01-23-96
01:05pm
9370000  'LCV6-4B'      valve                                 *prb 01-23-96 01:05pm
*                                                   *prb 01-23-96 01:05pm
*       from       to         juna      kf        kr        fvcahs          *prb 01-23-96 01:05pm
*9370101  934010000  738000000   0.3491    0.0       0.0       000000          *prb 01-23-96
01:05pm
9370101  934010000  738000000   0.3491    22.8653   22.8653   000000          *jam 7-26-96
*                                                   *prb 01-23-96 01:05pm
```

```
9370201  1         0.0         0.0      0.0                          *prb 01-23-96 01:05pm
*                                                     *prb 01-23-96 01:05pm
9370300  srvvlv                                             *prb 01-23-96 01:05pm
*                                                     *prb 01-23-96 01:05pm
9370301  0960  * valve position demand                          *prb 01-23-96 01:05pm
*                                                     *prb 01-23-96 01:05pm
9370400  1.0       950.0      * max Cv = 950.0 per BFN-VTD-K125-0060 for      *prb 01-23-96
01:05pm
*                          8" linear double-seated full-port    *prb 01-23-96 01:05pm
9370401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-23-96
01:05pm
9370402  1.0       1.0        1.0     * valve                         *prb 01-23-96 01:05pm
*
* component 912 - RFW Heater C3 steam supply vlv - jam 7-27-96
9120000 c3stmvlv       valve    *jam 7-27-96
*     from          to           juna    kf     kr     fvcahs
9120101 903000000      940000000      3.1416  23.4899  23.4899 000000         *jam 7-27-96
*        liq_vel     vap_vel          vel.int.
9120201 0    7.7263       124.84           0.0                        *jam 7-26-96
9120300 trpvlv                                              *jam 7-26-96
9120301 634                                                 *jam 7-26-96
*
* component 940 - RFW Heater C3 Steam Dome (top of vertical shell)
9400000 'HTRC3-s1'      branch
*
*     #juns   vel/flow
*9400001 2      0                                           *jam 7-26-96
9400001 1      0                                            *jam 7-26-96
*
*     area    length  vol     theta   phi   elev      rough   hyd     pvbfe
9400101 13.5335 12.4284 0.      0.      -90.0 -12.4284  1.5e-4  0.0864  00100
*
*     ebt     press   Uf          Uv        voidv
9400200 000     69.300  271.84       1099.9     0.99613
*
*     from          to           juna    kf     kr     fvcahs
*9401101 903000000      940000000      3.1416  23.4899 23.4899 000000        *jam 7-26-96
*9402101 940010000      941000000      13.5335 0.      0.      101000        *jam 7-26-96
9401101 940010000      941000000      13.5335 0.      0.      101000        *jam 7-26-96
*
*     jun_Dh          flood   gas-int slope
*9401110 0.0            0.0     1.0     1.0                         *jam 7-26-96
*9402110 0.0864         0.0     1.0     1.0                         *jam 7-26-96
9401110 0.0864         0.0     1.0     1.0                          *jam 7-26-96
```

```
*
*      liq_vel      vap_vel           vel.int.
*9401201 7.7263       124.84           0.                              *jam 7-26-96
*9402201 8.9171       19.266           0.                              *jam 7-26-96
9401201 8.9171       19.266           0.                              *jam 7-26-96
*
*
* component 941 - RFW Heater C3 drain junction volume
9410000 'HTRC3-s2'      branch
*
*      #juns   vel/flow
9410001 1       0
*
*      area    length  vol     theta   phi   elev      rough   hyd      pvbfe
9410101 13.5335 11.1133 0.      0.      -90.0 -11.1133  1.5e-4  0.0864  00100
*
*      ebt     press   Uf          Uv         voidv
9410200 000     69.309  271.88       1100.0     0.96083
*
*      from            to             juna    kf      kr      fvcahs
9411101 941010000       942000000       13.5335 0.      0.      101000
*
*      jun_Dh          flood   gas-int slope
9411110 0.0864          0.0     1.0     1.0
*
*      liq_vel      vap_vel           vel.int.
9411201 9.3922       5.8524           0.
*
*
* component 942 - RFW Heater C3 Shellside middle & lower volumes
9420000 'HTRC3-s3'      pipe
*
*      nv
9420001 4
*
*      flowa           vn
9420101 13.5335         1
9420102 6.7667          4       *volumes 2-4 share space with subcooling zone
*
*      flowl           vn
9420301 3.0000          2       *same as corresponding primary tube length
9420302 7.0534          4       *same as corresponding primary tube length
*
*      volume          vn
```

```
9420401 0.0          4
*
*     incl          vn
9420601 -90.0        4
*
*     roughness      dhyd    vn
9420801 1.5e-4       0.0864  4
*
*     kf     kr     jn
9420901 0.0    0.0    3
*
*     pvbfe          vn
9421001 00100        4
*
*     fvcahs         jn
9421101 101000       3
*
*     ebt    press.  Uf        Uv       voidv            VN
9421201 000    69.322  271.84    1100.0   0.98918       0.    1
9421202 000    69.529  271.38    1099.9   0.16248       0.    2
9421203 000    72.030  269.21    1100.5   2.68060e-06   0.    3
9421204 000    74.835  267.04    1101.0   8.83757e-06   0.    4
*
*     vel/flow
9421300 0
*
*     liq-flo    vap-flo         vel.int       jn
9421301  70.794     0.44862         0.           1
9421302 0.75643     -0.90429        0.           2
9421303 0.63162     0.77799         0.           3
*
*     jun_Dh        flood         gas-int       slope   jn
9421401 0.0864        0.0           1.0           1.0     3
*
*
* component 943 - RFW Heater C3 Subcooling Zone
9430000 'HTRC3-s4'      pipe
*
*     nv
9430001 3
*
*     flowa          vn
9430101 6.7667        3
*
```

```
*      flowl          vn
9430301 3.0000         1       *same as corresponding primary tube length
9430302 7.0534         3       *same as corresponding primary tube length
*
*      volume         vn
9430401 0.0            3
*
*      incl           vn
9430601 -90.0          3
*
*      roughness      dhyd    vn
9430801 1.5e-4         0.0864  3
*
*      kf     kr     jn
9430901 0.0    0.0    2
*
*      pvbfe          vn
9431001 00100          3
*
*      fvcahs         jn
9431101 101000         2
*
*      ebt    press.  Uf          Uv        voidv               VN
9431201 000    69.415  233.60      1100.1    8.99481e-02    0.     1
9431202 000    71.404  226.39      1100.4    1.57683e-07    0.     2
9431203 000    74.264  242.61      1100.9    3.17648e-06    0.     3
*
*      vel/flow
9431300 0
*
*      liq-flo     vap-flo         vel.int       jn
9431301 3.53376e-02  -1.6814          0.            1
9431302 3.03089e-02  3.099473e-02      0.            2
*
*      jun_Dh         flood          gas-int        slope   jn
9431401 0.0864         0.0            1.0            1.0     2
*
*
* component 944 - RFW Heater C3 Drain Piping
9440000 'HTRC3drn'     branch
*
*      #juns   vel/flow
9440001 1      1
*
```

```
*      area    length  vol    theta   phi   elev      rough   hyd     pvbfe
9440101 0.5475  5.0     0.      0.      0.    0.        1.5e-4  0.0     00000
*
*      ebt     press.  Uf          Uv         voidv
9440200 000     199.30  338.19       1113.6     0.0
*
*      from            to              juna    kf      kr      fvcahs
9441101 943010000       944000000       0.5475  0.0     0.      000100
*
*      liq_vel      vap_vel           vel.int.
9441201 228.5294     0.0               0.
*
*
* component 945 - RFW HTRC3 Drain Valve
9450000  'LCV6-43'     valve
*
*       from       to         juna      kf        kr        fvcahs
9450101  944010000  952000000   0.3491    7.4816    7.4816    000000
*
9450201  0          12.689       44.886   0.     *2,468,117/3 lb/hr target
*
9450300  srvvlv
*
9450301  0972  * valve position demand based on htr C3 level error
*
9450400  1.0        950.0       * max Cv = 950.0 per BFN-VTD-K125-0060 for
*                              8" linear double-seated full-port
9450401  0.0        0.0001      0.0001  * Assume linear Cv vs stroke for globe
9450402  1.0        1.0         1.0     * valve
*
*
9470000 'HTRC3jun' mtpljun
9470001 2       0
*
*      from      to        juna    kf  kr  fvcahs         incr1   incr2   jn
9470011 942020004 943010003 .1      5.  5.  001000 1. 1. 1. 0       0     0 1
9470021 942040004 943030003 1.      5.  5.  001000 1. 1. 1. 0       0     0 2
*
*      liq-flo     vap-flo     jn
9471011 4.0946       4.0946     1
9471021 0.0          0.0        2
*
* component 913 - RFW Heater C4 steam supply vlv - jam 7-27-96
9130000 c4stvlv1        valve    *jam 7-27-96
```

```
*      from           to            juna    kf     kr     fvcahs
9130101 905000000      950000000      2.8229  6197.85  6197.85 000000          *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9130201 0    0.83437      24.814            0.0                         *jam 7-26-96
9130300 trpvlv                                               *jam 7-26-96
9130301 634                                                  *jam 7-26-96
*
*
* component 950 - RFW Heater C4 (top of shell nearest tubesheet)
9500000 'HTRC4-s1'      branch
*
*      #juns   vel/flow
*9500001 2       0                                           *jam 7-26-96
9500001 1       0                                            *jam 7-26-96
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9500101 0.0     2.9375  153.2704 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv        voidv
9500200 000     27.276  213.37       1086.4     0.99962
*
*      from           to            juna    kf     kr     fvcahs
*9501101 905000000      950000000      2.8229  6197.85 6197.85 000000          *jam 7-27-96
*9502101 950010000      951000000      9.7832  0.      0.      001003          *jam 7-27-96
9501101 950010000      951000000      9.7832  0.      0.      001003          *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*9501110 0.0            0.0     1.0     1.0                         *jam 7-27-96
*9502110 0.1309         0.0     1.0     1.0                         *jam 7-27-96
9501110 0.1309         0.0     1.0     1.0                          *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*9501201 0.83437      24.814           0.                           *jam 7-27-96
*9502201  9.1016      8.7249           0.                           *jam 7-27-96
9501201  9.1016      8.7249           0.                            *jam 7-27-96
*
* component 914 - RFW Heater C4 steam supply vlv - jam 7-27-96
9140000 c4stvlv2        valve    *jam 7-27-96
*      from           to            juna    kf     kr     fvcahs
9140101 904000000      951000000      2.8229  4.4554   4.4554  000000          *jam 7-27-96
*          liq_vel     vap_vel          vel.int.
9140201 0    41.854       271.59            0.0                         *jam 7-26-96
9140300 trpvlv                                               *jam 7-26-96
9140301 634                                                  *jam 7-26-96
```

```
*
*
* component 951 - RFW Heater C4 (top of shell furthest from tubesheet)
9510000 'HTRC4-s2'      branch
*
*      #juns   vel/flow
*9510001 2       0                                             *jam 7-27-96
9510001 1       0                                             *jam 7-27-96
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9510101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv         voidv
9510200 000     27.276  213.38       1086.4     0.99996
*
*      from            to             juna     kf      kr      fvcahs
*9511101 904000000       951000000       2.8229   4.4554  4.4554  000000       *jam 7-27-96
*9512101 951010000       952000000       153.4359 0.      0.      101000       *jam 7-27-96
9511101 951010000       952000000       153.4359 0.      0.      101000       *jam 7-27-96
*
*      jun_Dh          flood   gas-int slope
*9511110 0.0             0.0     1.0     1.0                              *jam 7-27-96
*9512110 0.1309          0.0     1.0     1.0                              *jam 7-27-96
9511110 0.1309          0.0     1.0     1.0                              *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*9511201 41.854       271.59           0.                               *jam 7-27-96
*9512201 38.784       4.5911           0.                               *jam 7-27-96
9511201 38.784       4.5911           0.                               *jam 7-27-96
*
*
* component 952 - RFW Heater C4 (bottom of shell furthest from tubesheet)
9520000 'HTRC4-s3'      branch
*
*      #juns   vel/flow
9520001 0       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9520101 0.0     2.9375  265.4972 0.     -90.0 -2.9375   1.5e-4  0.1309  00100
*
*      ebt     press   Uf          Uv         voidv
9520200 000     27.292  209.34       1086.4     0.52487
*
*
```

```
* component 953 - RFW Heater C4 Subcooling Zone
9530000 'HTRC4-s4'      branch
*
*     #juns   vel/flow
9530001 1       0
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
9530101 9.7832  15.6667 0.0      0.     0.0   0.0       1.5e-4  0.1309  00100
*
*     ebt     press   Uf          Uv        voidv
9530200 000     26.746  170.92       1086.2     2.46992e-02
*
*     from            to             juna    kf      kr      fvcahs
9531101 952010000       953000000       1.7671   5.0     5.0     001000
*
*     jun_Dh          flood   gas-int slope
9531110 0.1309          0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
9531201 6.4784       37.792            0.
*
*
* component 954 - RFW Heater C4 Drain Piping
9540000 'HTRC4drn'      branch
*
*     #juns   vel/flow
9540001 1       0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
9540101 1.6230  10.0    0.      0.      50.15 7.6771    1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
9540200 000     26.326  174.57       1085.9     7.05438e-04
*
*     from            to             juna   kf      kr      fvcahs
9541101 953010000       954000000       1.6230  0.0     0.      000100
*
*     liq_vel      vap_vel           vel.int.
9541201 3.1304       4.5777            0.
*
*
* component 955 - RFW HTRC4 Drain Valve
9550000  'LCV6-47A'     valve
*
```

```
*       from      to        juna     kf       kr       fvcahs
9550101  954010000  960010003   0.7854    23.7848   23.7848   000000
*
9550201  0         7.5514       7.5514   0.     *3,184,100/3 lb/hr target
*
9550300  srvvlv
*
9550301  0982  * valve position demand based on htr C4 level error
*
9550400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                              12" linear double-seated full-port
9550401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9550402  1.0       1.0        1.0     * valve
*
*
* component 957 - RFW HTRC4 Bypass Valve                          *prb 01-24-96
10:22am
9570000  'LCV6-47B'     valve                                *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
*       from      to        juna     kf       kr       fvcahs         *prb 01-24-96 10:22am
*9570101  954010000  758000000   0.7854    0.0       0.0       000000          *prb 01-24-96
10:22am
9570101  954010000  758000000   0.7854    23.7848   23.7848   000000          *jam 7-26-96
*                                                  *prb 01-24-96 10:22am
9570201  1         0.0         0.0      0.0                      *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
9570300  srvvlv                                          *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
9570301  0984  * valve position demand                         *prb 01-24-96 10:22am
*                                                  *prb 01-24-96 10:22am
9570400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-24-
96 10:22am
*                              12" linear double-seated full-port   *prb 01-24-96 10:22am
9570401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe  *prb 01-24-96
10:22am
9570402  1.0       1.0        1.0     * valve                         *prb 01-24-96 10:22am
*
*
* component 960 - RFW Heater C5 Flash Tank
9600000 'FL-TankC'      pipe
*
*      nv
9600001 4
*
```

```
*      flowa          vn
9600101 16.4988        4
*
*      flowl          vn
9600301 1.4583         1
9600302 2.9583         2
9600303 2.500          3
9600304 5.2188         4
*
*      volume         vn
9600401 0.0            4
*
*      incl           vn
9600601 -90.0          4
*
*      roughness      dhyd    vn
9600801 0.0            0.0     4
*
*      kf      kr      jn
9600901 0.0     0.0     3
*
*      pvbfe          vn
9601001 00010          4
*
*      fvcahs         jn
9601101 101000         3
*
*      ebt     press.  Uf          Uv         voidv               VN
9601201 000     9.6940  160.59      1071.8     0.98351        0.     1
9601202 000     9.6954  159.92      1071.8     0.99883        0.     2
9601203 000     9.9628  160.43      1072.2     0.53140        0.     3
9601204 000     12.394  159.48      1075.2     0.00000e+00    0.     4
*
*      vel/flow
9601300 0
*
*      liq-flo     vap-flo         vel.int        jn
9601301  19.581      0.27746          0.            1
9601302  282.58      0.63630          0.            2
9601303 0.63560      -4.2606          0.            3
*
*      jun_Dh         flood          gas-int        slope   jn
9601401 0.0            0.0            1.0            1.0     3
*
```

```
*
* component 961 - RFW Heater C5 Drain Piping
9610000 'HTRC5drn'     branch
*
*     #juns   vel/flow
9610001 1       0
*
*     area    length  vol     theta   phi   elev     rough   hyd     pvbfe
9610101 2.9483  10.0    0.      0.      0.0   0.0      1.5e-4  0.0     00000
*
*     ebt     press.  Uf          Uv        voidv
9610200 000     13.552  159.14      1076.4    0.0
*
*     from           to             juna    kf      kr      fvcahs
9611101 960010000      961000000      2.9483  0.0     0.      000100
*
*     liq_vel      vap_vel          vel.int.
9611201 1.6705       1.9099           0.
*
* component 915 - RFW Heater C5 steam supply vlv - jam 7-27-96
9150000 c5stvlv1       valve    *jam 7-27-96
*     from           to             juna    kf      kr      fvcahs
9150101 906000000      962000000      9.0164  6243.8   6243.8  000000        *jam 7-27-96
*          liq_vel      vap_vel          vel.int.
9150201 0    0.49198      22.264           0.0                         *jam 7-26-96
9150300 trpvlv                                                 *jam 7-26-96
9150301 634                                                    *jam 7-26-96
*
*
* component 962 - RFW Heater C5 (top of shell nearest tubesheet)
9620000 'HTRC5-s1'     branch
*
*     #juns   vel/flow
*9620001 3       0                                              *jam 7-27-96
9620001 2       0                                              *jam 7-27-96
*
*     area    length  vol       theta  phi    elev      rough   hyd     pvbfe
9620101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
9620200 000     9.4593  158.61      1071.3    0.99998
*
*     from           to             juna    kf      kr      fvcahs
```

```
*9621101 906000000      962000000      9.0164  6243.8  6243.8  001000
*jam 7-27-96
*9622101 962010000      963000000      8.7069  0.      0.      001003
*jam 7-27-96
9621101 962010000      963000000      8.7069  0.      0.      001003
*jam 7-27-96
*9623101 960000000      962000000      0.7530  1.50    1.50    001000
*jam 7-27-96
9622101 960000000      962000000      0.7530  1.50    1.50    001000
*jam 7-27-96
*
*      jun_Dh         flood   gas-int slope
*9621110 2.3958         0.0     1.0     1.0                                                  *jam 7-27-96
*9622110 0.1128         0.0     1.0     1.0                                                  *jam 7-27-96
9621110 0.1128         0.0     1.0     1.0                                                  *jam 7-27-96
*9623110 0.0           0.0     1.0     1.0                                                  *jam 7-27-96
9622110 0.0           0.0     1.0     1.0                                                  *jam 7-27-96
*
*      liq_vel      vap_vel          vel.int.
*9621201 0.49198       22.264          0.                                                   *jam 7-27-96
*9622201 -31.397      -26.477          0.                                                   *jam 7-27-96
9621201 -31.397      -26.477          0.                                                   *jam 7-27-96
*9623201 -30.730       237.56          0.                                                   *jam 7-27-96
9622201 -30.730       237.56          0.                                                   *jam 7-27-96
*
* component 916 - RFW Heater C5 steam supply vlv - jam 7-27-96
9160000 c5stvlv2        valve    *jam 7-27-96
*      from            to            juna    kf      kr      fvcahs
9160101 907000000      963000000      9.0164  2.9489   2.9489  000000          *jam 7-27-96
*           liq_vel      vap_vel          vel.int.
9160201 0    26.337       161.50            0.0                         *jam 7-26-96
9160300 trpvlv                                                  *jam 7-26-96
9160301 634                                                     *jam 7-26-96
*
*
* component 963 - RFW Heater C5 (top of shell furthest from tubesheet)
9630000 'HTRC5-s2'      branch
*
*      #juns   vel/flow
*9630001 2       0                                               *jam 7-27-96
9630001 1       0                                               *jam 7-27-96
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9630101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
```

```
*
*      ebt    press   Uf          Uv        voidv
9630200 000     9.4589  158.60      1071.4     0.99992
*
*      from           to            juna    kf     kr     fvcahs
*9631101 907000000      963000000      9.0164   2.9489  2.9489  001000       *jam 9-27-96
*9632101 963010000      964000000      83.8342  0.      0.      001000       *jam 9-27-96
9631101 963010000      964000000      83.8342  0.      0.      001000       *jam 9-27-96
*
*      jun_Dh         flood   gas-int slope
*9631110 2.3958         0.0     1.0     1.0                                   *jam 9-27-96
*9632110 0.1128         0.0     1.0     1.0                                   *jam 9-27-96
9631110 0.1128         0.0     1.0     1.0                                   *jam 9-27-96
*
*      liq_vel      vap_vel          vel.int.
*9631201 26.337      161.50          0.                                   *jam 9-27-96
*9632201 34.542      8.5995          0.                                   *jam 9-27-96
9631201 34.542      8.5995          0.                                   *jam 9-27-96
*
*
* component 964 - RFW Heater C5 (bottom of shell furthest from tubesheet)
9640000 'HTRC5-s3'      branch
*
*      #juns   vel/flow
9640001 2       0
*
*      area    length  vol      theta  phi   elev      rough   hyd     pvbfe
9640101 0.0     2.8333  128.8119 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*      ebt    press   Uf          Uv        voidv
9640200 000     9.6340  148.68      1071.7     0.39598
*
*      from           to            juna    kf     kr     fvcahs
9641101 964010004      965010003      8.7069  0.      0.      001000
9642101 964010000      966000000      0.8685   1.5    100.0   001001  * discourage reverse
flow
*
*      jun_Dh         flood   gas-int slope
9641110 0.1128         0.0     1.0     1.0
9642110 0.6651         0.0     1.0     1.0
*
*      liq_vel      vap_vel          vel.int.
9641201  3.4725      -8.5376          0.
9642201 0.47271      -9.3520          0.
```

```
*
*
* component 965 - RFW Heater C5 (bottom of shell nearest tubesheet)
9650000 'HTRC5-s4'     branch
*
*     #juns   vel/flow
9650001 2      0
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
9650101 0.0     2.8333  170.5096 0.     -90.0 -2.8333   1.5e-4  0.1128  00100
*
*     ebt     press   Uf          Uv        voidv
9650200 000     9.4996  134.05       1071.5     0.44943
*
*     from            to            juna    kf      kr      fvcahs
9651101 962010000       965000000       110.9722 0.0     0.0     001000
9652101 965010000       966000000       0.8685   1.5     100.0   001001 * discourage reverse
flow
*
*     jun_Dh          flood   gas-int slope
9651110 0.1128          0.0     1.0     1.0
9652110 0.6651          0.0     1.0     1.0
*
*     liq_vel      vap_vel           vel.int.
9651201   37.265       5.8851           0.
9652201 -0.42722       -10.256           0.
*
*
* component 966 - RFW Heater C5 Collector
9660000 'Coll-C5'      branch
*
*     #juns   vel/flow
9660001 1      0
*
*     area    length  vol      theta  phi   elev     rough   hyd     pvbfe
9660101 4.9087  0.0     145.2255 0.     0.0   0.0       1.5e-4  0.0     00000
*
*     ebt     press   Uf          Uv        voidv
9660200 000     9.9594  146.78       1072.2     0.10641
*
*     from            to            juna    kf      kr      fvcahs
9661101 966010002       960030003       4.9087   1.0     0.50    031000
*
*     jun_Dh          flood   gas-int slope
```

```
9661110 2.5          0.0    1.0    1.0
*
*     liq_vel     vap_vel         vel.int.
9661201 -0.18014     -1.3910        0.
*
*
* component 967 - RFW HTR C5 Drain Valve
*
9670000  'LCV6-50A'    valve
*
*      from      to        juna     kf      kr      fvcahs
9670101  961010000  969000000   0.7854    5.6209    5.6209    001000
*
9670201  0        9.4        9.4     0.    *3,184,100/3 lb/hr target
*
9670300  srvvlv
*
9670301  0993  * valve position demand based on htr C5 level error
*
9670400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for
*                             12" linear double-seated full-port
9670401  0.0       0.0001     0.0001  * Assume linear Cv vs stroke for globe
9670402  1.0       1.0        1.0     * valve
*
*
* component 968 - RFW HTRC5 Bypass Valve                              *prb 01-25-96
09:19pm
9680000  'LCV6-50B'    valve                                    *prb 01-25-96 09:19pm
*                                                  *prb 01-25-96 09:19pm
*      from      to        juna     kf      kr      fvcahs         *prb 01-25-96 09:19pm
*9680101  961010000  969000000   0.7854    0.0      0.0      000000          *prb 01-25-96
09:19pm
9680101  961010000  969000000   0.7854    0.0      5.6209    001000          *jam 7-26-96
*                                                  *prb 01-25-96 09:19pm
9680201  1        0.0        0.0     0.0                        *prb 01-25-96 09:19pm
*                                                  *prb 01-25-96 09:19pm
9680300  srvvlv                                            *prb 01-25-96 09:19pm
*                                                  *prb 01-25-96 09:19pm
9680301  0995  * valve position demand                              *prb 01-25-96 09:19pm
*                                                  *prb 01-25-96 09:19pm
9680400  1.0       2180.0      * max Cv = 2180.0 per BFN-VTD-K125-0060 for     *prb 01-25-
96 09:19pm
*                             12" linear double-seated full-port   *prb 01-25-96 09:19pm
```

```
9680401  0.0       0.0001      0.0001  * Assume linear Cv vs stroke for globe  *prb 01-25-96
09:19pm
9680402  1.0       1.0        1.0     * valve                          *prb 01-25-96 09:19pm
*
*
* component 969 - RFW Heater sump header
9690000 'HTR-sump'     branch
*
*     #juns   vel/flow
9690001 1      1
*
*     area    length  vol     theta  phi   elev     rough   hyd     pvbfe
*9690101 5.0     10.0    0.0      0.     0.0   0.0      1.5e-4  0.0     00000
9690101 8.0     50.0    0.0      0.     0.0   0.0      1.5e-4  0.0     00000 *jam 7-28-96
*
*     ebt     press   temp
9690200 003     1.0     101.14
*
*     from          to           juna    kf     kr     fvcahs
9691101 969010000      970000000      0.0      1.0     0.50    001000
*
*     liq_vel     vap_vel          vel.int.
9691201 884.4722     0.0             0.
*
*
* component 970 - HTR sump / condenser
* ----------------------------------------
9700000 'HTR-cond'     tmdpvol
*
*     area    length  vol    azmth   incl    elev    rough   hyd     fe
*9700101 5.0     10.0    0.0     0.0     0.0     0.0     0.0     0.0     10
9700101 8.0     50.0    0.0     0.0     0.0     0.0     0.0     0.0     10 *jam 7-28-96
*
*     ebt     trip    variable
9700200 003
*
*     time    press   temp.
9700201 0.0     0.9823  101.14
*
* component 971 - HTR sump / condenser                              *jam 7-28-96
* ----------------------------------------                   *jam 7-28-96
9710000 'HTR2cond'     tmdpvol                                 *jam 7-28-96
*                                                      *jam 7-28-96
*     area    length  vol    azmth   incl    elev    rough   hyd     fe     *jam 7-28-96
```

```
9710101 1.0     50.0    0.0     0.0     0.0     0.0     0.0     0.0     10      *jam 7-28-96
*                                                                     *jam 7-28-96
*      ebt     trip    variable                                       *jam 7-28-96
9710200 003                                                           *jam 7-28-96
*                                                                     *jam 7-28-96
*      time    press   temp.                                          *jam 7-28-96
9710201 0.0     0.9823  101.14                                        *jam 7-28-96
*
*
*-------------------------------------------------------------------
* feedwater train heat structures
*-------------------------------------------------------------------
*
* heat structure geometry per vendor spec shts. included with app. d
*
*** drain cooler A tubes ***
15201000    1    2    2    0   2.84000e-02
15201100 0 1
15201101 1 0.0313
15201201 4 1
15201301 1. 1
15201400  -1
15201401 1.3759e+02 1.3950e+02
15201501 520010000 0 1 1 6.66e4 1
15201601         0 0 0 1 6.66e4 1
15201701 10816 1. 0. 0. 1
15201801 0. 10. 10. 0. 0. 0. 0. 1. 1
15201901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*** drain cooler B tubes ***
15211000    1    2    2    0   2.84000e-02
15211100 0 1
15211101 1 0.0313
15211201 4 1
15211301 1. 1
15211400  -1
15211401 1.3759e+02 1.3950e+02
15211501 521010000 0 1 1 6.66e4 1
15211601         0 0 0 1 6.66e4 1
15211701 10816 1. 0. 0. 1
15211801 0. 10. 10. 0. 0. 0. 0. 1. 1
15211901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*** drain cooler C tubes ***
```

```
15221000    1    2    2    0   2.84000e-02
15221100 0 1
15221101 1 0.0313
15221201 4 1
15221301 1. 1
15221400  -1
15221401 1.3759e+02 1.3950e+02
15221501 522010000 0 1 1 6.66e4 1
15221601         0 0 0 1 6.66e4 1
15221701 10816 1. 0. 0. 1
15221801 0. 10. 10. 0. 0. 0. 0. 1. 1
15221901 0. 10. 10. 0. 0. 0. 0. 1. 1
*
*
* heat structure 530-1  RFW Heater A5 Tubes
*       nh     np     geom   init   lt.coord
15301000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15301100 0            1
*
*       # intervals   rt.coord
15301101 2            0.0260
*
*       comp #       inter#(in)
15301201 004          2
*
*       rel. source   interval
15301301 1.           2
*
15301400 -1
*
*       mesh point temperatures
15301401 148.87      158.13      172.26
15301402 161.67      165.87      172.99
15301403 170.81      171.20      171.81
15301404 175.92      172.87      171.76
15301405 181.78      186.13      189.06
15301406 185.58      187.62      189.36
15301407 187.29      188.05      189.65
15301408 188.65      188.95      189.53
*
*       lt.boundary    incr    bdry    code    factor  hs#
15301501 530010000      0       1       1       12556.8 1   *(0.7) 17938.3
```

```
15301502 530020000     0      1      1      12556.8 2   *(0.7) 17938.3
15301503 530030000     0      1      1      12556.8 3   *(0.7) 17938.3
15301504 530040000     0      1      1      12556.8 4   *(0.7) 17938.3
15301505 530050000     0      1      1      12556.8 5   *(0.7) 17938.3
15301506 530060000     0      1      1      12556.8 6   *(0.7) 17938.3
15301507 530070000     0      1      1      12556.8 7   *(0.7) 17938.3
15301508 530080000     0      1      1      12556.8 8   *(0.7) 17938.3
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15301601 765010000     0      1      1      12556.8 1   *(0.7) 17938.3
15301602 765010000     0      1      1      12556.8 2   *(0.7) 17938.3
15301603 764010000     0      1      1      12556.8 3   *(0.7) 17938.3
15301604 764010000     0      1      1      12556.8 4   *(0.7) 17938.3
15301605 763010000     0      1      1      12556.8 5   *(0.7) 17938.3
15301606 763010000     0      1      1      12556.8 6   *(0.7) 17938.3
15301607 762010000     0      1      1      12556.8 7   *(0.7) 17938.3
15301608 762010000     0      1      1      12556.8 8   *(0.7) 17938.3
*
*       src.type       s.mult  dh-lt   dh-rt   hs#
15301701 0             0.0     0.0     0.0     8
*
*       hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15301801 0.0      5.4844  100.0  100.0  100.0  0.0  0.0  1.0   1
15301802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   7
15301803 0.0      100.0   5.4844 100.0  100.0  0.0  0.0  1.0   8
*
15301901 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   8
*
*
* heat structure 531-1  RFW Heater B5 Tubes
*       nh     np     geom   init   lt.coord
15311000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15311100 0            1
*
*       # intervals   rt.coord
15311101 2            0.0260
*
*       comp #        inter#(in)
15311201 004          2
*
*       rel. source   interval
```

```
15311301 1.          2
*
15311400 -1
*
*       mesh point temperatures
15311401 152.71      158.09      163.24
15311402 153.75      159.06      164.11
15311403 162.74      168.34      173.74
15311404 168.95      173.40      177.69
15311405 176.29      179.73      182.98
15311406 181.27      183.49      185.58
15311407 184.14      185.46      186.70
15311408 185.89      186.61      187.28
*
*       lt.boundary    incr    bdry    code    factor  hs#
15311501 531010000     0       1       1       12556.8 1   *(0.7) 17938.3
15311502 531020000     0       1       1       12556.8 2   *(0.7) 17938.3
15311503 531030000     0       1       1       12556.8 3   *(0.7) 17938.3
15311504 531040000     0       1       1       12556.8 4   *(0.7) 17938.3
15311505 531050000     0       1       1       12556.8 5   *(0.7) 17938.3
15311506 531060000     0       1       1       12556.8 6   *(0.7) 17938.3
15311507 531070000     0       1       1       12556.8 7   *(0.7) 17938.3
15311508 531080000     0       1       1       12556.8 8   *(0.7) 17938.3
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15311601 865010000     0       1       1       12556.8 1   *(0.7) 17938.3
15311602 865010000     0       1       1       12556.8 2   *(0.7) 17938.3
15311603 864010000     0       1       1       12556.8 3   *(0.7) 17938.3
15311604 864010000     0       1       1       12556.8 4   *(0.7) 17938.3
15311605 863010000     0       1       1       12556.8 5   *(0.7) 17938.3
15311606 863010000     0       1       1       12556.8 6   *(0.7) 17938.3
15311607 862010000     0       1       1       12556.8 7   *(0.7) 17938.3
15311608 862010000     0       1       1       12556.8 8   *(0.7) 17938.3
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15311701 0            0.0     0.0     0.0     8
*
*       hed     hlf     hlr     gslf    gslr    gkf  gkr  lbf   hs#
15311801 0.0    5.4844  100.0   100.0   100.0   0.0  0.0  1.0   1
15311802 0.0    100.0   100.0   100.0   100.0   0.0  0.0  1.0   7
15311803 0.0    100.0   5.4844  100.0   100.0   0.0  0.0  1.0   8
*
15311901 0.0    100.0   100.0   100.0   100.0   0.0  0.0  1.0   8
```

```
*
*
* heat structure 532-1  RFW Heater C5 Tubes
*       nh     np     geom   init   lt.coord
15321000 8      3      2      1      0.0231
*
*       mesh loc'n    format
15321100 0            1
*
*       # intervals   rt.coord
15321101 2            0.0260
*
*       comp #        inter#(in)
15321201 004          2
*
*       rel. source   interval
15321301 1.           2
*
15321400 -1
*
*       mesh point temperatures
15321401 136.71      137.95      139.07
15321402 136.55      137.75      138.87
15321403 138.78      139.81      140.79
15321404 140.92      141.87      142.77
15321405 159.80      167.15      174.08
15321406 170.62      175.64      180.38
15321407 176.32      179.08      181.68
15321408 180.69      182.69      184.57
*
*       lt.boundary    incr    bdry    code    factor  hs#
15321501 532010000      0       1       1       12556.8 1   *(0.7) 17938.3
15321502 532020000      0       1       1       12556.8 2   *(0.7) 17938.3
15321503 532030000      0       1       1       12556.8 3   *(0.7) 17938.3
15321504 532040000      0       1       1       12556.8 4   *(0.7) 17938.3
15321505 532050000      0       1       1       12556.8 5   *(0.7) 17938.3
15321506 532060000      0       1       1       12556.8 6   *(0.7) 17938.3
15321507 532070000      0       1       1       12556.8 7   *(0.7) 17938.3
15321508 532080000      0       1       1       12556.8 8   *(0.7) 17938.3
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15321601 965010000      0       1       1       12556.8 1   *(0.7) 17938.3
15321602 965010000      0       1       1       12556.8 2   *(0.7) 17938.3
```

```
15321603 964010000     0      1      1       12556.8 3   *(0.7) 17938.3
15321604 964010000     0      1      1       12556.8 4   *(0.7) 17938.3
15321605 963010000     0      1      1       12556.8 5   *(0.7) 17938.3
15321606 963010000     0      1      1       12556.8 6   *(0.7) 17938.3
15321607 962010000     0      1      1       12556.8 7   *(0.7) 17938.3
15321608 962010000     0      1      1       12556.8 8   *(0.7) 17938.3
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15321701 0             0.0     0.0     0.0     8
*
*       hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15321801 0.0      5.4844  100.0  100.0  100.0  0.0  0.0  1.0   1
15321802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   7
15321803 0.0      100.0   5.4844 100.0  100.0  0.0  0.0  1.0   8
*
15321901 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   8
*
*
* heat structure 540-1  RFW Heater A4 Tubes
*       nh     np     geom   init   lt.coord
15401000 10     3      2      1      0.0231
*
*       mesh loc'n    format
15401100 0            1
*
*       # intervals   rt.coord
15401101 2            0.0260
*
*       comp #        inter#(in)
15401201 004          2
*
*       rel. source   interval
15401301 1.           2
*
15401400 -1
*
*       mesh point temperatures
15401401 196.10      198.57      200.90
15401402 196.69      198.94      201.05
15401403 214.70      221.16      227.25
15401404 225.70      230.12      234.28
15401405 232.97      235.92      238.70
15401406 238.11      240.19      242.15
15401407 240.94      242.10      243.09
```

```
15401408 242.41      243.03      243.55
15401409 243.10      243.41      243.71
15401410 243.58      243.77      243.95
*
*       lt.boundary    incr    bdry    code    factor  hs#
15401501 540010000      0       1       1       14906.7 1   *(1.5) 14906.7
15401502 540020000      0       1       1       13865.0 2   *(1.5) 13865.0
15401503 540030000      0       1       1       13865.0 3   *(1.0) 13865.0
15401504 540040000      0       1       1       13865.0 4   *(1.0) 13865.0
15401505 540050000      0       1       1       13865.0 5   *(1.0) 13865.0
15401506 540060000      0       1       1       13865.0 6   *(1.0) 13865.0
15401507 540070000      0       1       1       13865.0 7   *(1.0) 13865.0
15401508 540080000      0       1       1       13865.0 8   *(1.0) 13865.0
15401509 540090000      0       1       1       13865.0 9   *(1.0) 13865.0
15401510 540100000      0       1       1       14906.7 10  *(1.0) 13865.0
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15401601 753010000      0       1       1       14906.7 1   *(1.5) 14906.7
15401602 753010000      0       1       1       13865.0 2   *(1.5) 13865.0
15401603 752010000      0       1       1       13865.0 3   *(1.0) 13865.0
15401604 752010000      0       1       1       13865.0 4   *(1.0) 13865.0
15401605 752010000      0       1       1       13865.0 5   *(1.0) 13865.0
15401606 751010000      0       1       1       13865.0 6   *(1.0) 13865.0
15401607 751010000      0       1       1       13865.0 7   *(1.0) 13865.0
15401608 751010000      0       1       1       13865.0 8   *(1.0) 13865.0
15401609 750010000      0       1       1       13865.0 9   *(1.0) 13865.0
15401610 750010000      0       1       1       14906.7 10  *(1.0) 14906.7
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15401701 0             0.0     0.0     0.0     10
*
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15401801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15401802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15401803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15401901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 541-1  RFW Heater B4 Tubes
*       nh     np    geom   init   lt.coord
15411000 10     3      2      1      0.0231
*
```

```
*       mesh loc'n    format
15411100 0            1
*
*       # intervals   rt.coord
15411101 2            0.0260
*
*       comp #       inter#(in)
15411201 004          2
*
*       rel. source   interval
15411301 1.           2
*
15411400 -1
*
*       mesh point temperatures
15411401 196.10      198.57      200.90
15411402 196.69      198.94      201.05
15411403 214.70      221.16      227.25
15411404 225.70      230.12      234.28
15411405 232.97      235.92      238.70
15411406 238.11      240.19      242.15
15411407 240.94      242.10      243.09
15411408 242.41      243.03      243.55
15411409 243.10      243.41      243.71
15411410 243.58      243.77      243.95
*
*       lt.boundary    incr    bdry    code    factor  hs#
15411501 541010000      0       1       1       14906.7 1   *(1.5) 14906.7
15411502 541020000      0       1       1       13865.0 2   *(1.5) 13865.0
15411503 541030000      0       1       1       13865.0 3   *(1.0) 13865.0
15411504 541040000      0       1       1       13865.0 4   *(1.0) 13865.0
15411505 541050000      0       1       1       13865.0 5   *(1.0) 13865.0
15411506 541060000      0       1       1       13865.0 6   *(1.0) 13865.0
15411507 541070000      0       1       1       13865.0 7   *(1.0) 13865.0
15411508 541080000      0       1       1       13865.0 8   *(1.0) 13865.0
15411509 541090000      0       1       1       13865.0 9   *(1.0) 13865.0
15411510 541100000      0       1       1       14906.7 10  *(1.0) 13865.0
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15411601 853010000      0       1       1       14906.7 1   *(1.5) 14906.7
15411602 853010000      0       1       1       13865.0 2   *(1.5) 13865.0
15411603 852010000      0       1       1       13865.0 3   *(1.0) 13865.0
15411604 852010000      0       1       1       13865.0 4   *(1.0) 13865.0
```

```
15411605 852010000     0      1      1       13865.0 5   *(1.0) 13865.0
15411606 851010000     0      1      1       13865.0 6   *(1.0) 13865.0
15411607 851010000     0      1      1       13865.0 7   *(1.0) 13865.0
15411608 851010000     0      1      1       13865.0 8   *(1.0) 13865.0
15411609 850010000     0      1      1       13865.0 9   *(1.0) 13865.0
15411610 850010000     0      1      1       14906.7 10  *(1.0) 14906.7
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15411701 0            0.0     0.0     0.0     10
*
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15411801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15411802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15411803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15411901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 542-1  RFW Heater C4 Tubes
*       nh     np     geom   init   lt.coord
15421000 10     3      2      1      0.0231
*
*       mesh loc'n    format
15421100 0            1
*
*       # intervals   rt.coord
15421101 2            0.0260
*
*       comp #        inter#(in)
15421201 004          2
*
*       rel. source   interval
15421301 1.           2
*
15421400 -1
*
*       mesh point temperatures
15421401 196.10      198.57      200.90
15421402 196.69      198.94      201.05
15421403 214.70      221.16      227.25
15421404 225.70      230.12      234.28
15421405 232.97      235.92      238.70
15421406 238.11      240.19      242.15
15421407 240.94      242.10      243.09
```

```
15421408 242.41      243.03      243.55
15421409 243.10      243.41      243.71
15421410 243.58      243.77      243.95
*
*       lt.boundary    incr    bdry    code    factor  hs#
15421501 542010000      0       1       1       14906.7 1   *(1.5) 14906.7
15421502 542020000      0       1       1       13865.0 2   *(1.5) 13865.0
15421503 542030000      0       1       1       13865.0 3   *(1.0) 13865.0
15421504 542040000      0       1       1       13865.0 4   *(1.0) 13865.0
15421505 542050000      0       1       1       13865.0 5   *(1.0) 13865.0
15421506 542060000      0       1       1       13865.0 6   *(1.0) 13865.0
15421507 542070000      0       1       1       13865.0 7   *(1.0) 13865.0
15421508 542080000      0       1       1       13865.0 8   *(1.0) 13865.0
15421509 542090000      0       1       1       13865.0 9   *(1.0) 13865.0
15421510 542100000      0       1       1       14906.7 10  *(1.0) 13865.0
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15421601 953010000      0       1       1       14906.7 1   *(1.5) 14906.7
15421602 953010000      0       1       1       13865.0 2   *(1.5) 13865.0
15421603 952010000      0       1       1       13865.0 3   *(1.0) 13865.0
15421604 952010000      0       1       1       13865.0 4   *(1.0) 13865.0
15421605 952010000      0       1       1       13865.0 5   *(1.0) 13865.0
15421606 951010000      0       1       1       13865.0 6   *(1.0) 13865.0
15421607 951010000      0       1       1       13865.0 7   *(1.0) 13865.0
15421608 951010000      0       1       1       13865.0 8   *(1.0) 13865.0
15421609 950010000      0       1       1       13865.0 9   *(1.0) 13865.0
15421610 950010000      0       1       1       14906.7 10  *(1.0) 14906.7
*
*       src.type       s.mult  dh-lt   dh-rt   hs#
15421701 0              0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf   gslr   gkf  gkr  lbf   hs#
15421801 0.0      4.5052  100.0  100.0  100.0  0.0  0.0  1.0   01
15421802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15421803 0.0      100.0   4.5052 100.0  100.0  0.0  0.0  1.0   10
*
15421901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 550-1  RFW Heater A3 Tubes
*       nh     np     geom   init   lt.coord
15501000 12     3      2      1      0.0231
*
```

```
*       mesh loc'n    format
15501100 0            1
*
*       # intervals   rt.coord
15501101 2            0.026
*
*       comp #        inter#(in)
15501201 004          2
*
*       rel. source   interval
15501301 1.           2
*
15501400 -1
*
*       mesh point temperatures
15501401 246.43     247.53     248.56
15501402 246.17     246.52     246.83
15501403 247.68     248.25     248.78
15501404 269.73     276.87     283.59
15501405 281.70     286.31     290.65
15501406 289.69     292.67     295.49
15501407 294.81     296.72     298.52
15501408 297.99     299.19     300.32
15501409 298.66     299.68     300.63
15501410 298.35     298.90     299.40
15501411 297.82     297.95     298.06
15501412 297.58     297.58     297.58
*
*       lt.boundary    incr    bdry    code    factor  hs#
15501501 550010000     0       1       1       21221.2 1   *(1.5) 14147.5
15501502 550020000     0       1       1       19721.3 2   *(1.5) 13147.5
15501503 550030000     0       1       1       8388.0  3   *(1.0) 5592.0
15501504 550040000     0       1       1       5592.0  4   *(1.0) 5592.0
15501505 550050000     0       1       1       20715.2 5   *(1.0) 20715.2
15501506 550060000     0       1       1       20715.2 6   *(1.0) 20715.2
15501507 550070000     0       1       1       20715.2 7   *(1.0) 20715.2
15501508 550080000     0       1       1       20715.2 8   *(1.0) 20715.2
15501509 550090000     0       1       1       5592.0  9   *(1.0) 5592.0
15501510 550100000     0       1       1       5592.0  10  *(1.0) 5592.0
15501511 550110000     0       1       1       13147.5 11  *(1.0) 13147.5
15501512 550120000     0       1       1       14147.5 12  *(1.0) 14147.5
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
```

```
15501601 743030000     0      1      1      21221.2 1   *(1.5) 14147.5
15501602 743020000     0      1      1      19721.3 2   *(1.5) 13147.5
15501603 743010000     0      1      1      8388.0  3   *(1.0) 5592.0
15501604 742010000     0      1      1      5592.0  4   *(1.0) 5592.0
15501605 741010000     0      1      1      20715.2 5   *(1.0) 20715.2
15501606 740010000     0      1      1      20715.2 6   *(1.0) 20715.2
15501607 740010000     0      1      1      20715.2 7   *(1.0) 20715.2
15501608 741010000     0      1      1      20715.2 8   *(1.0) 20715.2
15501609 742010000     0      1      1      5592.0  9   *(1.0) 5592.0
15501610 742020000     0      1      1      5592.0  10  *(1.0) 5592.0
15501611 742030000     0      1      1      13147.5 11  *(1.0) 13147.5
15501612 742040000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15501701 0            0.0     0.0     0.0     12
*
*       hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15501801 0.0      4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15501802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
15501803 0.0      100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15501901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 551-1  RFW Heater B3 Tubes
*       nh     np     geom   init   lt.coord
15511000 12     3      2      1      0.0231
*
*       mesh loc'n    format
15511100 0            1
*
*       # intervals   rt.coord
15511101 2            0.026
*
*       comp #        inter#(in)
15511201 004          2
*
*       rel. source   interval
15511301 1.           2
*
15511400 -1
*
*       mesh point temperatures
15511401 246.43      247.53      248.56
```

```
15511402 246.17     246.52     246.83
15511403 247.68     248.25     248.78
15511404 269.73     276.87     283.59
15511405 281.70     286.31     290.65
15511406 289.69     292.67     295.49
15511407 294.81     296.72     298.52
15511408 297.99     299.19     300.32
15511409 298.66     299.68     300.63
15511410 298.35     298.90     299.40
15511411 297.82     297.95     298.06
15511412 297.58     297.58     297.58
*
*      lt.boundary   incr   bdry   code   factor  hs#
15511501 551010000     0      1      1      21221.2 1   *(1.5) 14147.5
15511502 551020000     0      1      1      19721.3 2   *(1.5) 13147.5
15511503 551030000     0      1      1      8388.0  3   *(1.0) 5592.0
15511504 551040000     0      1      1      5592.0  4   *(1.0) 5592.0
15511505 551050000     0      1      1      20715.2 5   *(1.0) 20715.2
15511506 551060000     0      1      1      20715.2 6   *(1.0) 20715.2
15511507 551070000     0      1      1      20715.2 7   *(1.0) 20715.2
15511508 551080000     0      1      1      20715.2 8   *(1.0) 20715.2
15511509 551090000     0      1      1      5592.0  9   *(1.0) 5592.0
15511510 551100000     0      1      1      5592.0  10  *(1.0) 5592.0
15511511 551110000     0      1      1      13147.5 11  *(1.0) 13147.5
15511512 551120000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*
*      rt.boundary   incr   bdry   code   factor  hs#
15511601 843030000     0      1      1      21221.2 1   *(1.5) 14147.5
15511602 843020000     0      1      1      19721.3 2   *(1.5) 13147.5
15511603 843010000     0      1      1      8388.0  3   *(1.0) 5592.0
15511604 842010000     0      1      1      5592.0  4   *(1.0) 5592.0
15511605 841010000     0      1      1      20715.2 5   *(1.0) 20715.2
15511606 840010000     0      1      1      20715.2 6   *(1.0) 20715.2
15511607 840010000     0      1      1      20715.2 7   *(1.0) 20715.2
15511608 841010000     0      1      1      20715.2 8   *(1.0) 20715.2
15511609 842010000     0      1      1      5592.0  9   *(1.0) 5592.0
15511610 842020000     0      1      1      5592.0  10  *(1.0) 5592.0
15511611 842030000     0      1      1      13147.5 11  *(1.0) 13147.5
15511612 842040000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15511701 0            0.0     0.0     0.0     12
*
```

```
*       hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15511801 0.0      4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15511802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
15511803 0.0      100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15511901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 552-1  RFW Heater C3 Tubes
*       nh     np     geom   init   lt.coord
15521000 12     3      2      1      0.0231
*
*       mesh loc'n    format
15521100 0             1
*
*       # intervals   rt.coord
15521101 2             0.026
*
*       comp #       inter#(in)
15521201 004          2
*
*       rel. source   interval
15521301 1.            2
*
15521400 -1
*
*       mesh point temperatures
15521401 246.43      247.53      248.56
15521402 246.17      246.52      246.83
15521403 247.68      248.25      248.78
15521404 269.73      276.87      283.59
15521405 281.70      286.31      290.65
15521406 289.69      292.67      295.49
15521407 294.81      296.72      298.52
15521408 297.99      299.19      300.32
15521409 298.66      299.68      300.63
15521410 298.35      298.90      299.40
15521411 297.82      297.95      298.06
15521412 297.58      297.58      297.58
*
*       lt.boundary    incr    bdry    code    factor  hs#
15521501 552010000      0       1       1       21221.2 1   *(1.5) 14147.5
15521502 552020000      0       1       1       19721.3 2   *(1.5) 13147.5
15521503 552030000      0       1       1       8388.0  3   *(1.0) 5592.0
```

```
15521504 552040000     0      1      1      5592.0  4   *(1.0) 5592.0
15521505 552050000     0      1      1      20715.2 5   *(1.0) 20715.2
15521506 552060000     0      1      1      20715.2 6   *(1.0) 20715.2
15521507 552070000     0      1      1      20715.2 7   *(1.0) 20715.2
15521508 552080000     0      1      1      20715.2 8   *(1.0) 20715.2
15521509 552090000     0      1      1      5592.0  9   *(1.0) 5592.0
15521510 552100000     0      1      1      5592.0  10  *(1.0) 5592.0
15521511 552110000     0      1      1      13147.5 11  *(1.0) 13147.5
15521512 552120000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*
*       rt.boundary   incr   bdry   code   factor  hs#
15521601 943030000     0      1      1      21221.2 1   *(1.5) 14147.5
15521602 943020000     0      1      1      19721.3 2   *(1.5) 13147.5
15521603 943010000     0      1      1      8388.0  3   *(1.0) 5592.0
15521604 942010000     0      1      1      5592.0  4   *(1.0) 5592.0
15521605 941010000     0      1      1      20715.2 5   *(1.0) 20715.2
15521606 940010000     0      1      1      20715.2 6   *(1.0) 20715.2
15521607 940010000     0      1      1      20715.2 7   *(1.0) 20715.2
15521608 941010000     0      1      1      20715.2 8   *(1.0) 20715.2
15521609 942010000     0      1      1      5592.0  9   *(1.0) 5592.0
15521610 942020000     0      1      1      5592.0  10  *(1.0) 5592.0
15521611 942030000     0      1      1      13147.5 11  *(1.0) 13147.5
15521612 942040000     0      1      1      14147.5 12  *(1.0) 14147.5
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
15521701 0             0.0     0.0     0.0     12
*
*       hed     hlf     hlr    gslf   gslr   gkf  gkr  lbf   hs#
15521801 0.0      4.0632  100.0  100.0  100.0  0.0  0.0  1.0   01
15521802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   11
15521803 0.0      100.0   4.0632 100.0  100.0  0.0  0.0  1.0   12
*
15521901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   12
*
*
* heat structure 590-1  RFW Heater A2 Tubes
*       nh    np    geom   init   lt.coord
15901000 10    3     2      1      0.022
*
*       mesh loc'n   format
15901100 0           1
*
*       # intervals   rt.coord
```

```
15901101 2          0.026
*
*       comp #      inter#(in)
15901201 004          2
*
*       rel. source   interval
15901301 1.          2
*
15901400 -1
*
*       mesh point temperatures
15901401 303.62     304.79     305.86
15901402 306.11     307.75     309.25
15901403 318.82     324.86     330.41
15901404 328.06     331.84     335.32
15901405 333.40     335.65     337.72
15901406 336.33     337.62     338.81
15901407 337.88     338.59     339.25
15901408 338.29     338.84     339.35
15901409 337.26     337.13     337.02
15901410 335.67     335.19     334.76
*
*       lt.boundary    incr    bdry    code    factor  hs#
15901501 590010000     0       1       1       14896.8 1   *(1.5) 11917.5
15901502 590020000     0       1       1       7147.5  2   *(1.5) 5718.0
15901503 590030000     0       1       1       7147.5  3   *(1.5) 5718.0
15901504 590040000     0       1       1       21147.8 4   *(1.5) 16918.2
15901505 590050000     0       1       1       21147.8 5   *(1.5) 16918.2
15901506 590060000     0       1       1       21147.8 6   *(1.5) 16918.2
15901507 590070000     0       1       1       21147.8 7   *(1.5) 16918.2
15901508 590080000     0       1       1       7147.5  8   *(1.5) 5718.0
15901509 590090000     0       1       1       7147.5  9   *(1.5) 5718.0
15901510 590100000     0       1       1       14896.8 10  *(1.5) 11917.5
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15901601 733010000     0       1       1       14896.8 1   *(1.5) 11917.5
15901602 732020000     0       1       1       7147.5  2   *(1.5) 5718.0
15901603 732010000     0       1       1       7147.5  3   *(1.5) 5718.0
15901604 731010000     0       1       1       21147.8 4   *(1.5) 16918.2
15901605 730010000     0       1       1       21147.8 5   *(1.5) 16918.2
15901606 730010000     0       1       1       21147.8 6   *(1.5) 16918.2
15901607 731010000     0       1       1       21147.8 7   *(1.5) 16918.2
15901608 732010000     0       1       1       7147.5  8   *(1.5) 5718.0
```

```
15901609 732020000     0      1      1      7147.5  9   *(1.5) 5718.0
15901610 733010000     0      1      1      14896.8 10  *(1.5) 11917.5
*
*      src.type      s.mult  dh-lt   dh-rt   hs#
15901701 0            0.0     0.0     0.0     10
*
*      hed     hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15901801 0.0      3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15901802 0.0      100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15901803 0.0      100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15901901 0.0      100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 591-1  RFW Heater B2 Tubes
*      nh     np     geom   init   lt.coord
15911000 10     3      2      1      0.022
*
*      mesh loc'n    format
15911100 0           1
*
*      # intervals   rt.coord
15911101 2           0.026
*
*      comp #       inter#(in)
15911201 004          2
*
*      rel. source   interval
15911301 1.          2
*
15911400 -1
*
*      mesh point temperatures
15911401 303.62      304.79      305.86
15911402 306.11      307.75      309.25
15911403 318.82      324.86      330.41
15911404 328.06      331.84      335.32
15911405 333.40      335.65      337.72
15911406 336.33      337.62      338.81
15911407 337.88      338.59      339.25
15911408 338.29      338.84      339.35
15911409 337.26      337.13      337.02
15911410 335.67      335.19      334.76
*
```

```
*       lt.boundary    incr    bdry    code    factor  hs#
15911501 591010000      0       1       1       14896.8 1   *(1.5) 11917.5
15911502 591020000      0       1       1       7147.5  2   *(1.5) 5718.0
15911503 591030000      0       1       1       7147.5  3   *(1.5) 5718.0
15911504 591040000      0       1       1       21147.8 4   *(1.5) 16918.2
15911505 591050000      0       1       1       21147.8 5   *(1.5) 16918.2
15911506 591060000      0       1       1       21147.8 6   *(1.5) 16918.2
15911507 591070000      0       1       1       21147.8 7   *(1.5) 16918.2
15911508 591080000      0       1       1       7147.5  8   *(1.5) 5718.0
15911509 591090000      0       1       1       7147.5  9   *(1.5) 5718.0
15911510 591100000      0       1       1       14896.8 10  *(1.5) 11917.5
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
15911601 833010000      0       1       1       14896.8 1   *(1.5) 11917.5
15911602 832020000      0       1       1       7147.5  2   *(1.5) 5718.0
15911603 832010000      0       1       1       7147.5  3   *(1.5) 5718.0
15911604 831010000      0       1       1       21147.8 4   *(1.5) 16918.2
15911605 830010000      0       1       1       21147.8 5   *(1.5) 16918.2
15911606 830010000      0       1       1       21147.8 6   *(1.5) 16918.2
15911607 831010000      0       1       1       21147.8 7   *(1.5) 16918.2
15911608 832010000      0       1       1       7147.5  8   *(1.5) 5718.0
15911609 832020000      0       1       1       7147.5  9   *(1.5) 5718.0
15911610 833010000      0       1       1       14896.8 10  *(1.5) 11917.5
*
*       src.type       s.mult  dh-lt   dh-rt   hs#
15911701 0              0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf    gslr    gkf  gkr  lbf   hs#
15911801 0.0     3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15911802 0.0     100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15911803 0.0     100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15911901 0.0     100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 592-1  RFW Heater C2 Tubes
*       nh     np     geom   init   lt.coord
15921000 10     3      2      1      0.022
*
*       mesh loc'n    format
15921100 0             1
*
*       # intervals   rt.coord
```

```
15921101 2          0.026
*
*      comp #      inter#(in)
15921201 004         2
*
*      rel. source   interval
15921301 1.          2
*
15921400 -1
*
*      mesh point temperatures
15921401 303.62     304.79     305.86
15921402 306.11     307.75     309.25
15921403 318.82     324.86     330.41
15921404 328.06     331.84     335.32
15921405 333.40     335.65     337.72
15921406 336.33     337.62     338.81
15921407 337.88     338.59     339.25
15921408 338.29     338.84     339.35
15921409 337.26     337.13     337.02
15921410 335.67     335.19     334.76
*
*      lt.boundary    incr    bdry    code    factor  hs#
15921501 592010000     0       1       1      14896.8 1   *(1.5) 11917.5
15921502 592020000     0       1       1      7147.5  2   *(1.5) 5718.0
15921503 592030000     0       1       1      7147.5  3   *(1.5) 5718.0
15921504 592040000     0       1       1      21147.8 4   *(1.5) 16918.2
15921505 592050000     0       1       1      21147.8 5   *(1.5) 16918.2
15921506 592060000     0       1       1      21147.8 6   *(1.5) 16918.2
15921507 592070000     0       1       1      21147.8 7   *(1.5) 16918.2
15921508 592080000     0       1       1      7147.5  8   *(1.5) 5718.0
15921509 592090000     0       1       1      7147.5  9   *(1.5) 5718.0
15921510 592100000     0       1       1      14896.8 10  *(1.5) 11917.5
*
*
*      rt.boundary    incr    bdry    code    factor  hs#
15921601 933010000     0       1       1      14896.8 1   *(1.5) 11917.5
15921602 932020000     0       1       1      7147.5  2   *(1.5) 5718.0
15921603 932010000     0       1       1      7147.5  3   *(1.5) 5718.0
15921604 931010000     0       1       1      21147.8 4   *(1.5) 16918.2
15921605 930010000     0       1       1      21147.8 5   *(1.5) 16918.2
15921606 930010000     0       1       1      21147.8 6   *(1.5) 16918.2
15921607 931010000     0       1       1      21147.8 7   *(1.5) 16918.2
15921608 932010000     0       1       1      7147.5  8   *(1.5) 5718.0
```

```
15921609 932020000    0    1    1    7147.5  9   *(1.5) 5718.0
15921610 933010000    0    1    1    14896.8 10  *(1.5) 11917.5
*
*    src.type    s.mult  dh-lt   dh-rt   hs#
15921701 0          0.0     0.0     0.0     10
*
*    hed    hlf    hlr    gslf   gslr   gkf  gkr  lbf   hs#
15921801 0.0    3.5039  100.0  100.0  100.0  0.0  0.0  1.0   01
15921802 0.0    100.0   100.0  100.0  100.0  0.0  0.0  1.0   09
15921803 0.0    100.0   3.5039 100.0  100.0  0.0  0.0  1.0   10
*
15921901 0.0    100.0   100.0  5.0    5.0    0.1  0.1  1.0   10
*
*
* heat structure 600-1  RFW Heater A1 Tubes
*    nh    np    geom   init   lt.coord
16001000 10    3    2    1    0.022
*
*    mesh loc'n    format
16001100 0          1
*
*    # intervals   rt.coord
16001101 2          0.026
*
*    comp #      inter#(in)
16001201 004        2
*
*    rel. source   interval
16001301 1.         2
*
16001400 -1
*
*    mesh point temperatures
16001401 334.73    337.01    339.10
16001402 342.92    348.65    353.94
16001403 350.65    358.47    365.67
16001404 361.40    366.91    372.00
16001405 370.28    374.50    378.38
16001406 375.68    378.54    381.17
16001407 378.82    380.63    382.30
16001408 379.67    381.32    382.84
16001409 377.60    377.59    377.59
16001410 374.79    373.19    371.71
*
```

```
*       lt.boundary    incr    bdry    code    factor  hs#
16001501 600010000     0       1       1       5963.7  1   *(1.5) 3975.8
16001502 600020000     0       1       1       7624.0  2   *(1.5) 5082.7
16001503 600030000     0       1       1       7624.0  3   *(1.5) 5082.7
16001504 600040000     0       1       1       29904.1 4   *(1.5) 19936.1
16001505 600050000     0       1       1       29904.1 5   *(1.5) 19936.1
16001506 600060000     0       1       1       29904.1 6   *(1.5) 19936.1
16001507 600070000     0       1       1       29904.1 7   *(1.5) 19936.1
16001508 600080000     0       1       1       7624.0  8   *(1.5) 5082.7
16001509 600090000     0       1       1       7624.0  9   *(1.5) 5082.7
16001510 600100000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
16001601 722010000     0       1       1       5963.7  1   *(1.5) 3975.8
16001602 721030000     0       1       1       7624.0  2   *(1.5) 5082.7
16001603 721020000     0       1       1       7624.0  3   *(1.5) 5082.7
16001604 721010000     0       1       1       29904.1 4   *(1.5) 19936.1
16001605 720010000     0       1       1       29904.1 5   *(1.5) 19936.1
16001606 720010000     0       1       1       29904.1 6   *(1.5) 19936.1
16001607 721010000     0       1       1       29904.1 7   *(1.5) 19936.1
16001608 721020000     0       1       1       7624.0  8   *(1.5) 5082.7
16001609 721030000     0       1       1       7624.0  9   *(1.5) 5082.7
16001610 722010000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*       src.type       s.mult  dh-lt   dh-rt   hs#
16001701 0             0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf    gslr    gkf  gkr  lbf   hs#
16001801 0.0    1.4206  100.0   100.0   100.0   0.0  0.0  1.0   01
16001802 0.0    100.0   100.0   100.0   100.0   0.0  0.0  1.0   09
16001803 0.0    100.0   1.4206  100.0   100.0   0.0  0.0  1.0   10
*
16001901 0.0    100.0   100.0   5.0     5.0     0.1  0.1  1.0   10
*
*
* heat structure 601-1  RFW Heater B1 Tubes
*       nh      np      geom    init    lt.coord
16011000 10     3       2       1       0.022
*
*       mesh loc'n     format
16011100 0             1
*
*       # intervals    rt.coord
```

```
16011101 2          0.026
*
*       comp #       inter#(in)
16011201 004          2
*
*       rel. source   interval
16011301 1.           2
*
16011400 -1
*
*       mesh point temperatures
16011401 334.73      337.01      339.10
16011402 342.92      348.65      353.94
16011403 350.65      358.47      365.67
16011404 361.40      366.91      372.00
16011405 370.28      374.50      378.38
16011406 375.68      378.54      381.17
16011407 378.82      380.63      382.30
16011408 379.67      381.32      382.84
16011409 377.60      377.59      377.59
16011410 374.79      373.19      371.71
*
*       lt.boundary    incr    bdry    code    factor  hs#
16011501 601010000     0       1       1       5963.7  1   *(1.5) 3975.8
16011502 601020000     0       1       1       7624.0  2   *(1.5) 5082.7
16011503 601030000     0       1       1       7624.0  3   *(1.5) 5082.7
16011504 601040000     0       1       1       29904.1 4   *(1.5) 19936.1
16011505 601050000     0       1       1       29904.1 5   *(1.5) 19936.1
16011506 601060000     0       1       1       29904.1 6   *(1.5) 19936.1
16011507 601070000     0       1       1       29904.1 7   *(1.5) 19936.1
16011508 601080000     0       1       1       7624.0  8   *(1.5) 5082.7
16011509 601090000     0       1       1       7624.0  9   *(1.5) 5082.7
16011510 601100000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
16011601 822010000     0       1       1       5963.7  1   *(1.5) 3975.8
16011602 821030000     0       1       1       7624.0  2   *(1.5) 5082.7
16011603 821020000     0       1       1       7624.0  3   *(1.5) 5082.7
16011604 821010000     0       1       1       29904.1 4   *(1.5) 19936.1
16011605 820010000     0       1       1       29904.1 5   *(1.5) 19936.1
16011606 820010000     0       1       1       29904.1 6   *(1.5) 19936.1
16011607 821010000     0       1       1       29904.1 7   *(1.5) 19936.1
16011608 821020000     0       1       1       7624.0  8   *(1.5) 5082.7
```

```
16011609 821030000    0     1     1     7624.0  9   *(1.5) 5082.7
16011610 822010000    0     1     1     5963.7  10  *(1.5) 3975.8
*
*       src.type      s.mult  dh-lt   dh-rt   hs#
16011701 0            0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf    gslr    gkf  gkr  lbf   hs#
16011801 0.0    1.4206  100.0   100.0   100.0   0.0  0.0  1.0   01
16011802 0.0    100.0   100.0   100.0   100.0   0.0  0.0  1.0   09
16011803 0.0    100.0   1.4206  100.0   100.0   0.0  0.0  1.0   10
*
16011901 0.0    100.0   100.0   5.0     5.0     0.1  0.1  1.0   10
*
*
* heat structure 602-1  RFW Heater C1 Tubes
*       nh    np    geom   init   lt.coord
16021000 10   3     2      1      0.022
*
*       mesh loc'n   format
16021100 0           1
*
*       # intervals  rt.coord
16021101 2           0.026
*
*       comp #       inter#(in)
16021201 004         2
*
*       rel. source  interval
16021301 1.          2
*
16021400 -1
*
*       mesh point temperatures
16021401 334.73   337.01   339.10
16021402 342.92   348.65   353.94
16021403 350.65   358.47   365.67
16021404 361.40   366.91   372.00
16021405 370.28   374.50   378.38
16021406 375.68   378.54   381.17
16021407 378.82   380.63   382.30
16021408 379.67   381.32   382.84
16021409 377.60   377.59   377.59
16021410 374.79   373.19   371.71
*
```

```
*       lt.boundary    incr    bdry    code    factor  hs#
16021501 602010000     0       1       1       5963.7  1   *(1.5) 3975.8
16021502 602020000     0       1       1       7624.0  2   *(1.5) 5082.7
16021503 602030000     0       1       1       7624.0  3   *(1.5) 5082.7
16021504 602040000     0       1       1       29904.1 4   *(1.5) 19936.1
16021505 602050000     0       1       1       29904.1 5   *(1.5) 19936.1
16021506 602060000     0       1       1       29904.1 6   *(1.5) 19936.1
16021507 602070000     0       1       1       29904.1 7   *(1.5) 19936.1
16021508 602080000     0       1       1       7624.0  8   *(1.5) 5082.7
16021509 602090000     0       1       1       7624.0  9   *(1.5) 5082.7
16021510 602100000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*
*       rt.boundary    incr    bdry    code    factor  hs#
16021601 922010000     0       1       1       5963.7  1   *(1.5) 3975.8
16021602 921030000     0       1       1       7624.0  2   *(1.5) 5082.7
16021603 921020000     0       1       1       7624.0  3   *(1.5) 5082.7
16021604 921010000     0       1       1       29904.1 4   *(1.5) 19936.1
16021605 920010000     0       1       1       29904.1 5   *(1.5) 19936.1
16021606 920010000     0       1       1       29904.1 6   *(1.5) 19936.1
16021607 921010000     0       1       1       29904.1 7   *(1.5) 19936.1
16021608 921020000     0       1       1       7624.0  8   *(1.5) 5082.7
16021609 921030000     0       1       1       7624.0  9   *(1.5) 5082.7
16021610 922010000     0       1       1       5963.7  10  *(1.5) 3975.8
*
*       src.type       s.mult  dh-lt   dh-rt   hs#
16021701 0             0.0     0.0     0.0     10
*
*       hed     hlf     hlr     gslf    gslr    gkf  gkr  lbf   hs#
16021801 0.0    1.4206  100.0   100.0   100.0   0.0  0.0  1.0   01
16021802 0.0    100.0   100.0   100.0   100.0   0.0  0.0  1.0   09
16021803 0.0    100.0   1.4206  100.0   100.0   0.0  0.0  1.0   10
*
16021901 0.0    100.0   100.0   5.0     5.0     0.1  0.1  1.0   10
*
*
* heater tube thermal properties (type 304 stainless steel)
*---------------------------------------------------------
*
20100400 tbl/fctn 1 1
* thermal conductivity (btu/s-ft-degf)
20100401 2.26e-3
*
* volumetric heat capacity (btu/ft**3-degf)
```

```
20100451 53.7
*
*
* tables of heater-tube heat flux [w/m**2] vs rx power [w]
*----------------------------------------------------------
*
* tables derived from refs. [188 - 193, 204, & 205] as per calcs. of app. d
*
* drain coolers
20258000 reac-t
20258009 3.293e9  31374. * jam
20258008 3.1284e9 29002. * jam
20258007 2.9637e9 26666. * jam
20258006 2.7991e9 24368. * jam
20258005 2.6344e9 21872. * jam
20258004 2.4698e9 19382. * jam
20258003 1.8384e9  9524. * jam
20258002 9.775e8   2047. * jam
20258001 0.        0.
*
*
*
* heater related control variables (tube powers [w])
*---------------------------------------------------
*
* tube power = surface area * heat flux
*
* reactor power [w] = % rated power * rated power [w]
20580100  rxpower     mult  3.293e+07  3.3125499e+09 0
20580101 cntrlvar 010
*
* drain cooler (single)
20581600  pwrdc_s function  1.217e+03  3.8182160e+07 0
20581601 cntrlvar 801 580
*
* drain cooler (double)
*20508260  pwrdc_d function  2.433e+03  7.6332944e+07 0
*20508261 cntrlvar 801 580
*
* cntrlvar 0815: HTRA5 power (BTU/HR)
20581500  'HTR5-PWR' sum   3.414426   250700000.       0
20581501  0.0     1.0  q 530010000      1.0  q 530050000
20581502          1.0  q 530020000      1.0  q 530060000
20581503          1.0  q 530030000      1.0  q 530070000
```

```
20581504         1.0  q 530040000      1.0  q 530080000
*
* heater 5 (double)
*20508250 pwhtr5_d function  3.804e+03  1.3729779e+08 0
*20508251 cntrlvar 801 620
*
* cntrlvar 0814: HTRA4 power (BTU/HR)
20581400  'HTR4-PWR' sum   3.414426   266000000.       0
20581401  0.0     1.0  q 540010000      1.0  q 540060000
20581402         1.0  q 540020000      1.0  q 540070000
20581403         1.0  q 540030000      1.0  q 540080000
20581404         1.0  q 540040000      1.0  q 540090000
20581405         1.0  q 540050000      1.0  q 540100000
*
* heater 4 (double)
*20508240 pwhtr4_d function  4.233e+03  1.4764280e+08 0
*20508241 cntrlvar 801 660
*
* cntrlvar 0813: HTRA3 power (BTU/HR)
20581300  'HTR3-PWR' sum   3.414426   283000000.       0
20581301  0.0     1.0  q 550010000      1.0  q 550070000
20581302         1.0  q 550020000      1.0  q 550080000
20581303         1.0  q 550030000      1.0  q 550090000
20581304         1.0  q 550040000      1.0  q 550100000
20581305         1.0  q 550050000      1.0  q 550110000
20581306         1.0  q 550060000      1.0  q 550120000
*
* heater 3 (double)
*20508230 pwhtr3_d function  4.826e+03  1.5564330e+08 0
*20508231 cntrlvar 801 700
*
* cntrlvar 0812: HTRA2 power (BTU/HR)
20581200  'HTR2-PWR' sum   3.414426   150800000.       0
20581201  0.0     1.0  q 590010000      1.0  q 590060000
20581202         1.0  q 590020000      1.0  q 590070000
20581203         1.0  q 590030000      1.0  q 590080000
20581204         1.0  q 590040000      1.0  q 590090000
20581205         1.0  q 590050000      1.0  q 590100000
*
* heater 2 (double)
*20508220 pwhtr2_d function  3.403e+03  8.3856728e+07 0
*20508221 cntrlvar 801 770
*
* cntrlvar 811: HTRA1 power (BTU/HR)
```

```
20581100  'HTR1-PWR' sum   3.414426   227800000.       0
20581101  0.0     1.0  q 600010000     1.0  q 600060000
20581102          1.0  q 600020000     1.0  q 600070000
20581103          1.0  q 600030000     1.0  q 600080000
20581104          1.0  q 600040000     1.0  q 600090000
20581105          1.0  q 600050000     1.0  q 600100000
*
*
* heater 1 (double)
*20508210 pwhtr1_d function  3.431e+03  1.2596570e+08 0
*20508211 cntrlvar 801 810
.
```

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