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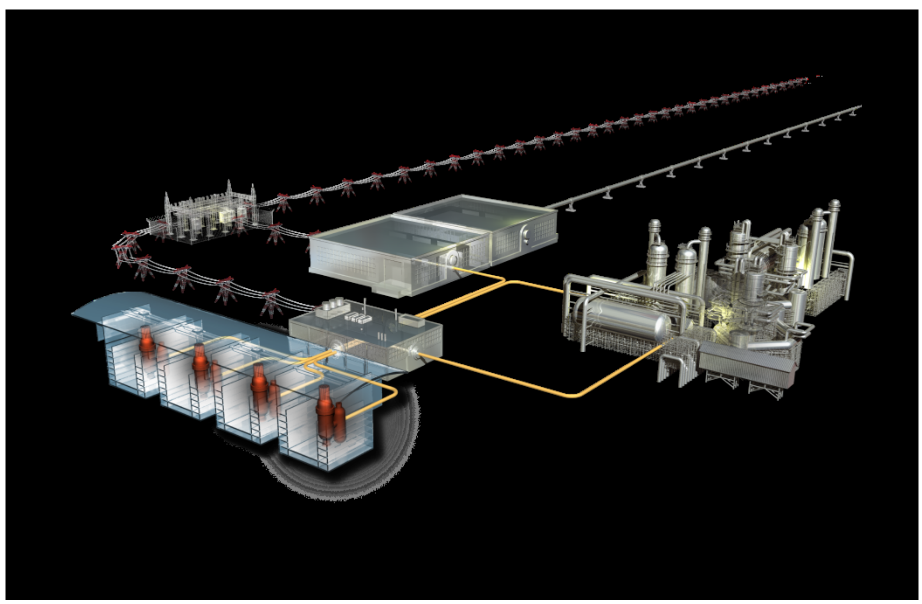
RELAP5-3D Input Model for the High Temperature Test Facility

Paul D. Bayless

June 2018



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ABSTRACT

A RELAP5-3D model of the High Temperature Test Facility at Oregon State University has been developed. The model includes the systems, components, and controls needed to perform code assessment calculations using data from the facility. Details of the model are provided. The input was developed for RELAP5-3D version 4.4.2. An independent quality assurance review of the model was performed.

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ACRONYMS

2-D	two-dimensional
ASTM	American Society for Testing and Materials
CV	control variable
DOE	Department of Energy
HTTF	High Temperature Test Facility
INL	Idaho National Laboratory
PCS	primary coolant system
RCCS	reactor cavity cooling system
RCST	reactor cavity simulation tank
SCS	secondary coolant system

RELAP5-3D Input Model for the High Temperature Test Facility

1. INTRODUCTION

A quality-assured RELAP5-3D input model has been developed for the High Temperature Test Facility (HTTF) at Oregon State University. The model was developed to perform code assessment using experiment data from the HTTF, and is consistent with the input requirements for code Version 4.4.2 (INL 2018).

The model development and quality assurance process is described in Section 2. A brief description of the HTTF is given in Section 3. Section 4 provides an overview of the input model structure. Details on each of the hydrodynamic components are provided in Section 5, followed by the heat structures in Section 6, the radiation and conduction enclosures in Section 7, material properties in Section 8, trips in Section 9, general tables in Section 10, and control variables in Section 11. An alternate nodalization of the outlet plenum and hot duct is described in Section 12. Results of a steam generator nodalization study are presented in Section 13. A list of input files significant to the model development effort is provided in Section 14. References used in developing the input model are listed in Section 15. Appendix A contains a listing of the input model.

2. MODEL DEVELOPMENT

The model was developed and documented in an Excel workbook. The principal advantage of this approach is that changes to reference information are automatically propagated throughout the workbook, altering all subsequent uses of those values, including updating the RELAP5-3D input model; this is particularly useful when the design is evolving as code calculations are being performed. One drawback is that the quality assurance effort to review the input model can become tedious.

There are two principal spreadsheets in the workbook, “geometry” and “RELAP5 input.” The geometry spreadsheet identifies the sources of reference information, and then manipulates the reference data as required to provide the RELAP5-3D input parameters. As its name suggests, the “RELAP5 input” spreadsheet is simply the RELAP5-3D input file. The input parameters are linked to the other spreadsheets in the workbook in which any necessary calculations were performed.

Other spreadsheets provide specialized input or calculations. “Materials” contains the heat structure material property data. “Convars” manipulates the geometric information from the hydrodynamic components and heat structures to generate multipliers for the control variables in the input model. “Power mapping” maps the power from the 10 heater rod banks into the three heater rod heat structures in the model. “Test 140” and “test 150” mimic the inner and outer core rings, but with actual coolant channel sizes; they are used to determine the input model channel hydraulic diameter that preserves the pressure drop through the core. “Benchmarking” contains input parameters that supersede the values originally calculated, based on results from the system characterization and shakedown testing and from the “test 140” and “test 150” calculations.

A large number of control variables are included in the input model. While some of them provide controls for establishing steady-state conditions, most generate parameters to assist in analyzing the code output, such as computing energy balances or peak temperatures. Some of the control variables also calculate parameters that are of interest in scaling analyses.

The principal sources of geometric information were the facility drawings and the facility description report (Woods 2017a). Dimensions of the stainless steel piping were taken from Crane 1988, and of the copper piping from Marks’ handbook (Baumeister, Avallone, and Baumeister 1978). Some specific component geometry was obtained from manufacturers’ product data sheets (Mueller 2011a and 2011b). Initial loss coefficients were calculated from the system geometry using formulas from Crane 1988 or Idelchik 1994. Material properties were obtained from a variety of sources, including testing done specifically for the HTTF.

A detailed, independent quality assurance review of the model was performed at several stages during the model development effort. The review consisted of several steps. First, each reference value identified in the spreadsheets was checked against the reference document. Second, a cell-by-cell check was performed of the calculations manipulating the reference data into code input format. Finally, a cell-by-cell check of the RELAP5-3D input spreadsheet was performed to ensure that each input value was linked to the proper calculated value in the supporting spreadsheets.

3. HTTF DESCRIPTION

The HTTF is a helium-cooled, electrically-heated integral experiment facility. The reference design for the facility is General Atomics' modular high-temperature gas-cooled reactor (DOE 1986), which uses prismatic graphite blocks in the core and reflectors. The HTTF primary pressure vessel and core are one-fourth scale in length and diameter. Most of the coolant channels in the core are full scale, with smaller diameter channels around the core periphery. The facility operates at low pressure, compared to the prototype reactor, and is designed primarily to investigate depressurized conduction cooldown transients.

The facility, described in detail in Woods 2017a, includes a number of systems. The primary coolant system (PCS) has a pressure vessel, a concentric hot and cold duct, a steam generator, a gas circulator, and connecting pipes. Break valves in both the hot and cold legs connect to a large reactor cavity simulation tank (RCST), whose gas composition can be initialized to a range of values to simulate the different conditions that may exist outside the reactor vessel following a loss-of-coolant accident. Figure 1 presents a rendering of the primary pressure vessel, RCST, and hot and cold ducts (Gutowska 2018).

Alumina ceramic blocks are used to simulate the core and top and bottom reflectors. Each block encompasses the radial region occupied by the central reflector, fuel, and side reflector in the reference reactor. Holes in the blocks provide channels for the heater rods, which consist of stacks of graphite rodlets. The rods are grouped into 10 heater banks, each of which contains 21 heater rods. Smaller coolant holes are arranged in a hexagonal pattern around the heater rods. Larger holes cast in the central and side reflector regions represent the core bypass flow in these regions. Permanent or outer reflector blocks, made of a different ceramic material, are located between the core blocks and the core barrel. A graphite plate in the upper plenum covers the gaps on either side of the permanent reflector blocks, so that the only flow through the core is in the holes cast in the core blocks.

The steam generator has 188 U-tubes. Feedwater is pumped from a supply tank into the downcomer on the secondary side, and any steam generated is vented to the atmosphere.

The principal feature of the reactor cavity cooling system (RCCS) is the cooling panels that surround the pressure vessel. Water flowing through the panels provides the heat sink for the PCS during most transients. Water is pumped from the same tank as the steam generator feedwater, but is recirculated back to the tank after exiting the top of the cooling panels. The inlet flow can be controlled to provide a desired panel outlet temperature, and isolation valves on the panels can be closed to simulate a degraded heat sink. There is a cover above the space between the pressure vessel and the RCCS panels, so that there is no direct natural circulation path between the building and the pressure vessel to provide unwanted cooling.

Two additional break lines are available, from the top of the primary pressure vessel to the top of the RCST, and from the bottom of the pressure vessel to the bottom of the RCST.

The facility has over 500 instruments, which are described in Woods 2018. Most of these are thermocouples in the core region to provide a temperature profile of the ceramic. There are also vertical thermocouple rakes in the upper and lower plenums, and in the hot and cold ducts, to try to capture temperature variations associated with recirculating or unmixed flow streams. The core and reflector instrumentation is generally arranged in one-sixth azimuthal sectors. The primary measurement sector is opposite the outlet plenum connection to the hot duct (on the east side of the plenum); the secondary sector is adjacent to the hot duct (west side), and the tertiary sector is next to (south of) the secondary sector.

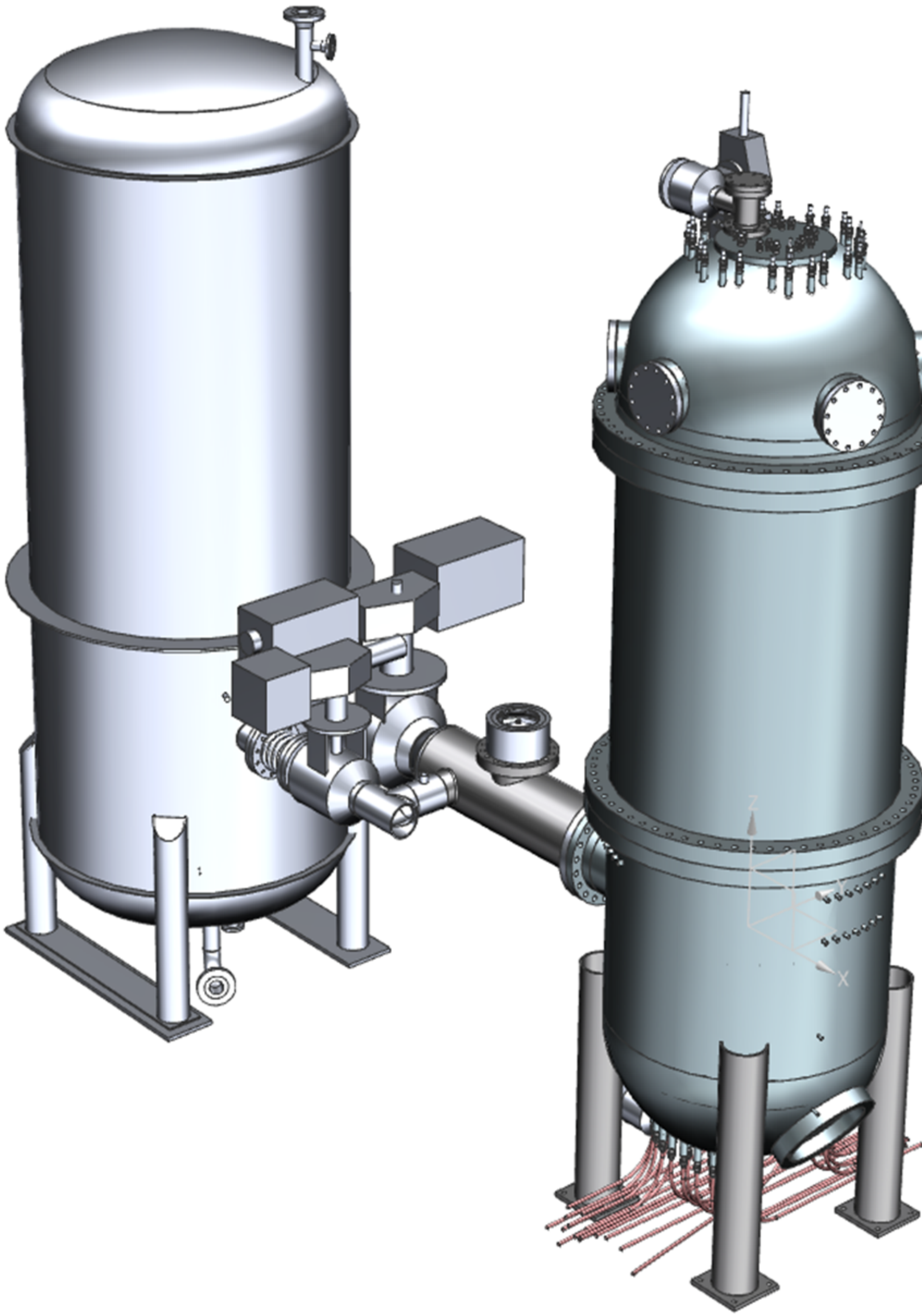

Figure 1. Diagram of the HTTF primary pressure vessel (right), RCST, and hot and cold ducts.

4. INPUT MODEL OVERVIEW

The input model includes hydrodynamic components, heat structures, trips, and control systems. Systems modeled are the PCS, secondary coolant system (SCS), RCCS, potable water system that supplies both the SCS and the RCCS, and reactor cavity. The RCST is considered part of the PCS.

The general hydrodynamic component numbering scheme is:

1-99: alternate break piping

100-199: primary pressure vessel

200-299: PCS piping and components

300-399: secondary coolant system

400-499: potable water system

900-999: reactor cavity and RCCS

More details on all of the components are provided below.

4.1 Primary Pressure Vessel

The hydrodynamic component numbers in the primary pressure vessel are from 100 to 199. Heat structures are generally numbered the same as the fluid volumes connected to them.

The primary pressure vessel nodalization is shown in Figure 2. Flow enters from the cold duct, passes through the core support structure under the outlet plenum bottom plate, then flows up between the primary pressure vessel and core barrel to the inlet plenum. Flow then passes down through various flow channels in the core and reflectors, recombines in the outlet plenum, then flows out into the hot duct.

The heated region of the core is divided into 10 equal-length axial segments, one for each block. The upper and lower reflectors each have two axial regions. This axial nodalization extends through each of the radial components in the vessel and in the RCCS.

The primary pressure vessel is divided into a number of different radial regions, as illustrated in Figure 3. The central reflector is divided into three regions: a central solid cylinder, a middle ring that contains the six 0.75-in.-diameter gap simulation channels and the ceramic that is directly influenced by the holes, and a solid outer ring that is adjacent to the core. The core is also divided into three rings, as it is designed on the hexagonal block pattern of the modular high-temperature gas-cooled reactor, which has three fueled rings. Figure 4 shows which blocks are included in each of the rings in a 60-degree sector; the boundaries of the inner and outer rings were extended beyond the full hexagonal block geometry to include all of the coolant channels. The inner ring includes 23 hexagonal blocks with 56 heater rods and 138 coolant channels, the middle ring models 24 blocks with 72 heater rods and 144 coolant channels, and the outer ring includes 39 blocks with 82 heater rods and 234 coolant channels. The side reflector is divided into three regions: an inner solid ring next to the outer core ring, a middle ring that contains the thirty-six 0.625-in.-diameter gap simulation channels and associated ceramic, and a solid outer ring. The next radial structure is the permanent or outer reflector (permanent side reflector in the reference plant), which has a coolant gap on either side (Components 164 and 166); these gaps do not have axial flow through them, as the top is covered by a plate (the upper plenum floor), leaving them open only to the outlet plenum. Continuing outward, the core barrel is next, followed by the coolant upcomer region between the core barrel and the pressure vessel wall, and finally the primary pressure vessel itself.

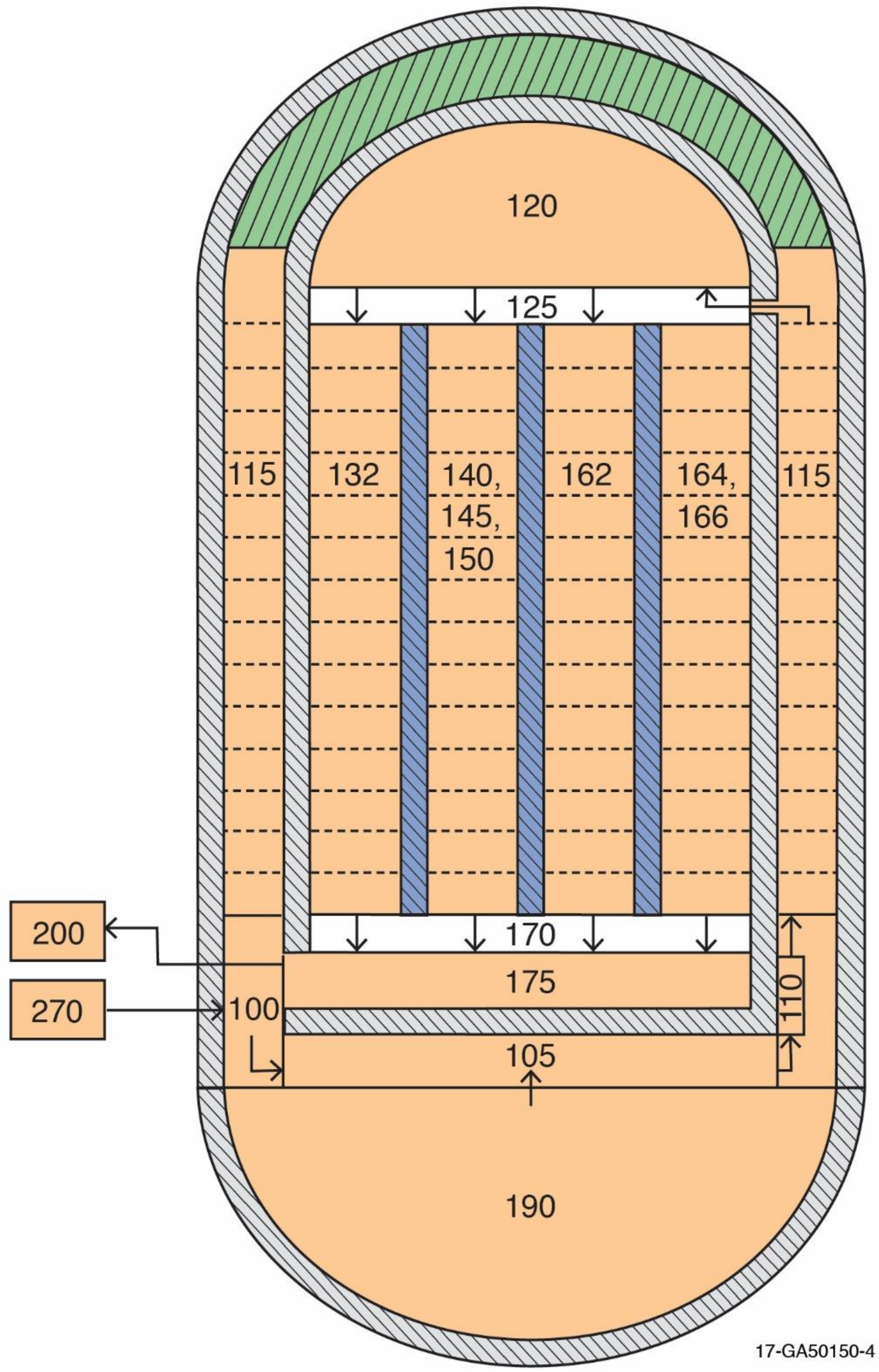

Figure 2. Primary pressure vessel nodalization.

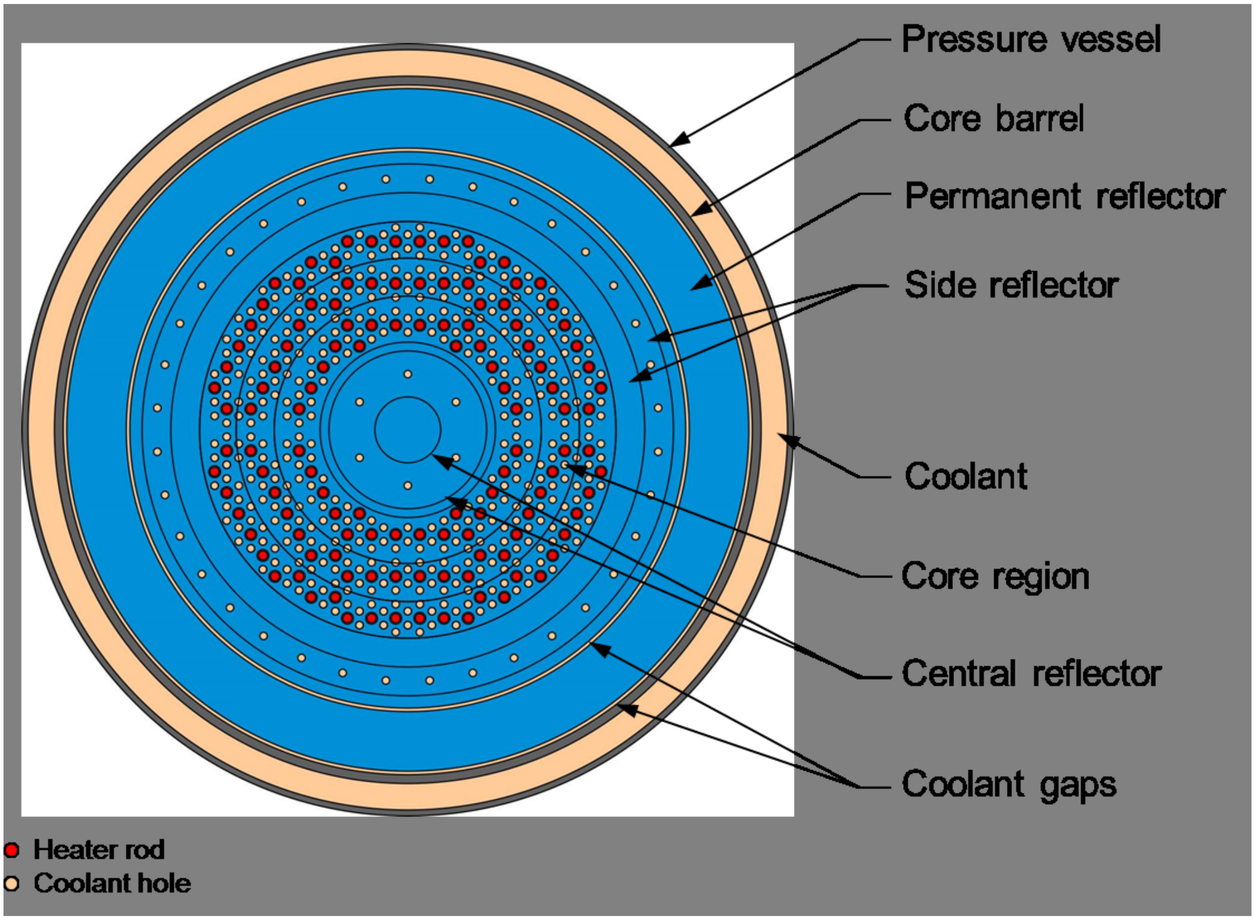

Figure 3. Primary pressure vessel radial nodalization.

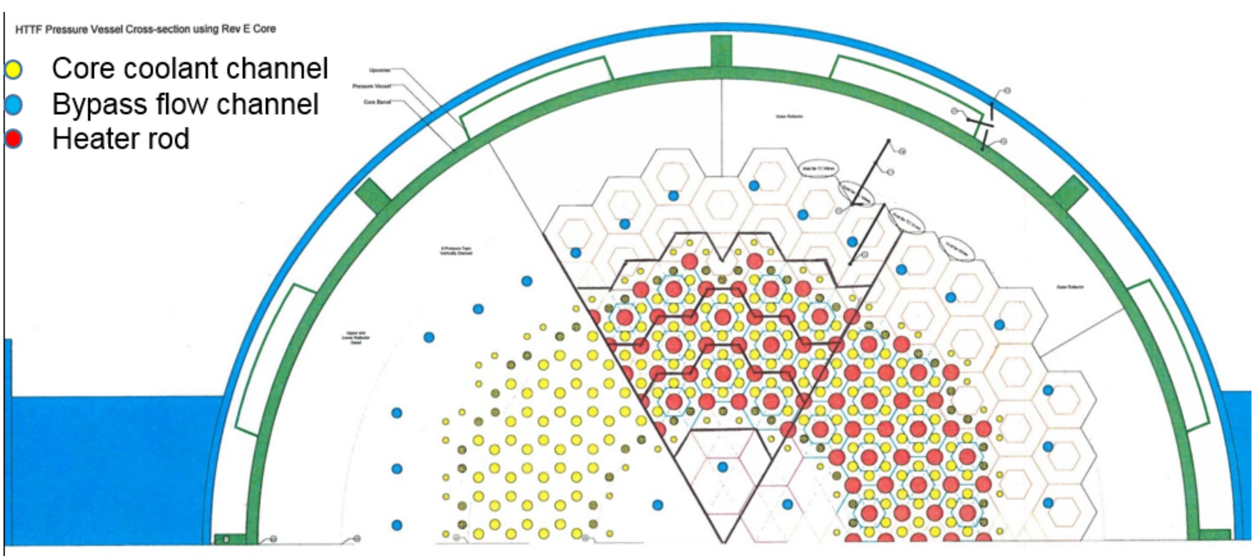

Figure 4. Core ring layout.

4.2 Primary Coolant System

The hydrodynamic component numbers in the PCS are from 200 to 299. Heat structures are generally numbered the same as the fluid volumes connected to them.

The nodalization of the PCS is shown in Figure 5. Hot gas exits the primary pressure vessel into the hot duct, then flows up through a check valve and into the steam generator inlet plenum and tubes. The cooled gas flows out of the steam generator into piping that leads to the gas circulator. From the circulator, flow proceeds through an isolation valve, into a crossover pipe, into an annulus around the hot duct, and then back into the primary pressure vessel.

Break valves are located on the ends of the hot duct and the circulator discharge pipe, connecting them to the RCST. These valves are closed during steady state operation. Safety relief valves and a depressurization line are connected to the cold leg piping between the circulator and the loop isolation valve. These are modeled as a single line in the RELAP5-3D input model.

4.3 Secondary Coolant System

The hydrodynamic component numbers in the SCS are from 300 to 399. Heat structures are generally numbered the same as the fluid volumes connected to them.

The nodalization of the SCS is also provided in Figure 5. The feedwater pump draws suction from a water storage day tank and pumps it into the steam generator downcomer. The downcomer extends to near the top of the tube sheet. The water is then boiled on the outside of the tubes as it flows upward to the steam dome at the top of the steam generator. The steam then turns back downward before exiting out the side of the steam generator. The steam then flows through a pressure control valve in the steam line before flowing through more piping and being vented to the atmosphere. This downstream piping is not included in the RELAP5-3D input model. A safety relief valve is connected to a nozzle on the top of the steam generator. The piping downstream of the relief valve is not included in the input model.

4.4 Potable Water Supply System

Hydrodynamic components in the potable water supply system are numbered from 400 to 499. There are no heat structures associated with this system.

The principal component in the system is the water storage day tank. This tank is the water source for both the SCS and the RCCS. The tank water level is maintained within a specified range. When the level gets too low, a valve opens in the supply line, allowing water from the public water system to flow into the tank. When the level rises to a certain level, the supply line valve is closed. The tank also has an interior drain/vent line that extends from the bottom of the tank to near the top; it is modeled as being open to the atmosphere below the tank. An outlet line is connected to the bottom of the tank; both the feedwater and RCCS pumps take suction from this outlet line.

4.5 Alternate Break Piping

Piping and valves associated with breaks located at the top and bottom of the pressure vessel are numbered from 1 to 99. Heat structures are generally numbered the same as the fluid volumes connected to them.

Figure 6 presents the nodalization for these two break lines. These components are usually inactive in the input model because they would only be active during an appropriate break simulation and would otherwise slow the system calculations down without providing any beneficial information. The component numbering was selected so that the molecular diffusion model could be used for these breaks without including volumes outside the PCS. Because molecular diffusion is expected to be important when these breaks are active, a large number of control volumes are included in the piping, with a target cell length of about 2.0 cm.

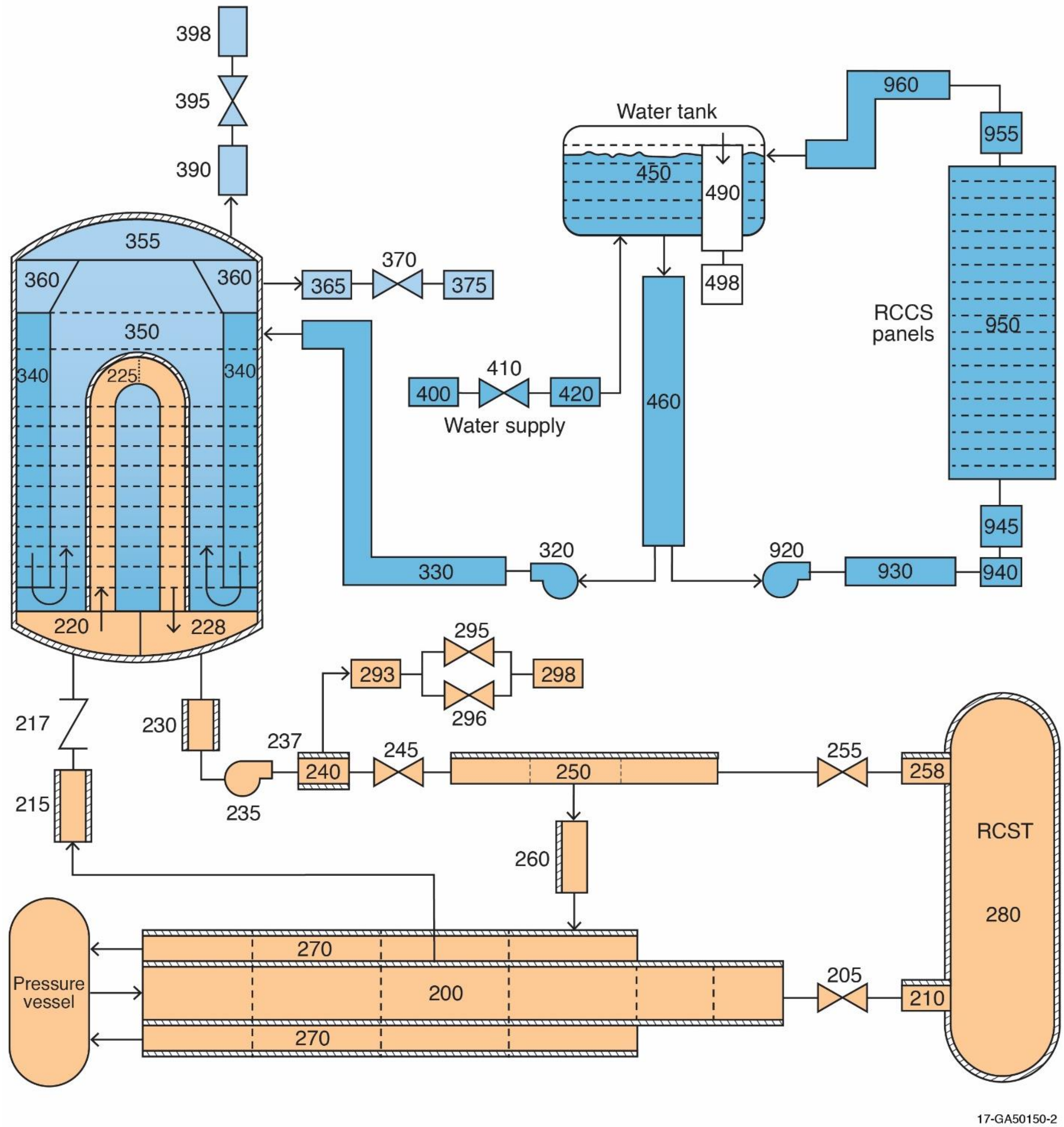

Figure 5. PCS, SCS, and RCCS nodalizations.

4.6 Reactor Cavity and Reactor Cavity Cooling System

Hydrodynamic components in the reactor cavity and RCCS are numbered from 900 to 999. Heat structures are generally numbered the same as the fluid volumes connected to them.

The reactor cavity is modeled as a large air-filled volume at atmospheric pressure, and is located between the primary pressure vessel and the RCCS panels. The roof covering this region is not included in the model. The RCCS draws flow from the water storage tank and pumps it through a series of pipes

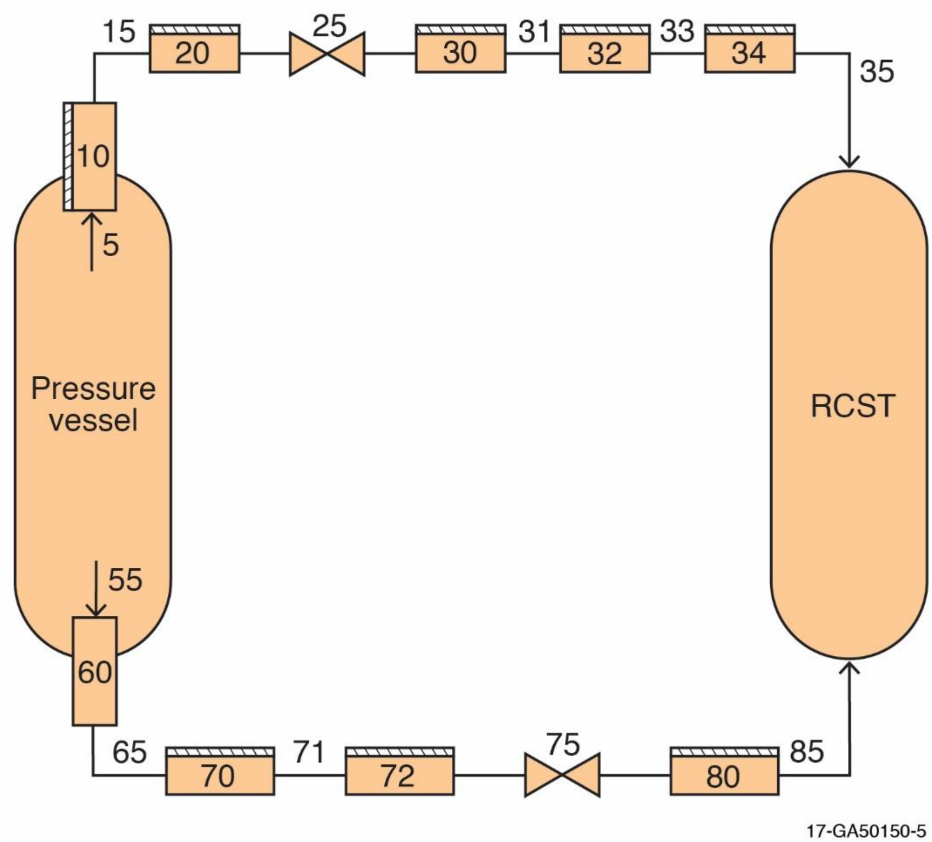

Figure 6. Nodalization of vessel break lines.

into the cooling panels surrounding the primary pressure vessel. Water exiting the top of the panels is collected and returned to the water storage tank.

In some cases, it may make more sense to simplify the RCCS model so that it does not recirculate through the water storage tank; this will likely be true for post-test calculations because the temperature in the water storage tank can only be controlled manually. For this model, a time-dependent volume and junction supply the desired inlet flow rate and temperature, with the panel outlet flow being collected and discharged to a time-dependent volume.

Subsequent sections provide details on each of the components in the input model, grouped by component type. These are followed by a brief description of changes made to the model during initial steady-state testing, and then by references used in developing the input model.

5. HYDRODYNAMIC COMPONENTS

Unless otherwise noted, default values for the volume and junction flags are used.

Approximate initial conditions are entered, as it is expected that a steady-state calculation will be run to establish the desired conditions prior to a transient calculation. The initial values entered are for normal steady-state operation at full power (2200 kW).

5.1 Primary Pressure Vessel

Component 100 is a two-junction branch representing the primary pressure vessel coolant inlet region. It is a vertical volume, with the top at the midpoint of the outlet plenum and the bottom at the midpoint of the coolant region between the lower support plate and the middle distributor plate. It represents the annulus between the pressure vessel and core barrel, from the top of the bottom support plate to the bottom of the liner shell ring. Junction 1 connects the outlet of the cold duct (Component 270) to the inlet of this component, with momentum flux turned off on the vessel side of the junction (flag s = 1); the loss coefficients are approximated based on the area change between the cold duct and the inlet annulus. Junction 2 connects the outlet of this component to the inlet of Component 105, using an abrupt area change (flag a = 1) with code-calculated loss coefficients and with momentum flux from this component turned off (flag s = 2). Three heat structures are attached to this component: Structure 1000 (pressure vessel wall), Structure 1100, (jacket shell), and Structure 1150 (core barrel).

Component 105 is a two-volume pipe representing the coolant region below the core support plate. The first volume includes the volume between the lower support plate and the middle distributor plate; the second volume includes the volume between the middle distributor plate and the upper bulkhead plate. It is assumed that there are thirty 1.75-in.-diameter cylinders extending through both flow regions, providing the power supply to the heater rods. The coolant volume in the gaps around the power supply cylinders where they pass through the middle distributor plate is neglected. The length of each volume is assumed to be equal to the radius of the middle plate, as the flow comes from the periphery to the center, then back out to the periphery. The elevation change between the two volumes is included in the first volume. Z-direction data are also input for the component, with the length equal to the distance between the plates. Since the flow changes direction between the lower and upper volumes, a loss coefficient for a 180-degree change in flow direction is included at the internal junction. Three heat structures are attached to this component: Structure 1050 (middle distributor plate), Structure 1150 (core barrel), and Structure 1750 (outlet plenum bottom plate).

Component 110 is a two-junction branch representing the coolant in the region between the core barrel and the upcomer shell (referred to as the “jacket shell” on Drawing OSU-HTTF-PRIM-DWG-002, sheet 6). Junction 1 connects the outlet of Component 105 to the inlet of this component, and Junction 2 connects the outlet of this component to the inlet of Component 115. Junction 1 is modeled as a smooth area change with no user-input loss coefficients. Junction 2 is modeled as an abrupt area change with code-calculated loss coefficients. Two heat structures are attached to this component: Structure 1100 (jacket shell) and Structure 1150 (core barrel).

Component 115 is a 15-volume pipe representing the gap between the core barrel and the primary pressure vessel. It spans the elevation from the lower core support plate to above the flow slots in the upper plenum. The axial nodalization is the same as that inside the core barrel. The top volume is stagnant, as normal coolant flow exits the fourteenth volume. Three heat structures are attached to this component: Structure 1000 (pressure vessel wall), Structure 1150 (core barrel), and Structure 1200 (upper plenum cylinder).

Component 120 is a branch component representing the inlet (upper) plenum. It has one junction connecting to the coolant gap between the core barrel and the primary pressure vessel (Component 115). This volume extends from the top of the core barrel to the top of the upper plenum shroud. The junction is modeled as a smooth area change with loss coefficients representing the loss through the flow slots. Four heat structures are attached to this component: Structure 1001 (upper plenum shroud), Structure 1200 (upper plenum cylinder), Structure 1201 (upper plenum floor), and Structure 1202 (upper plenum internals).

Component 125 is a multiple junction component that connects the inlet plenum to the inlets of each of the core and reflector cooling channels. It has five junctions. Junction 1 connects to the central reflector, Junction 2 to the inner core ring, Junction 3 to the middle core ring, Junction 4 to the outer core ring, and Junction 5 to the side reflector. All junctions are modeled as abrupt area changes with user-input loss coefficients (flag a = 2) of 0.5 for forward flow and 1.0 for reverse flow, standard for sudden sharp-edged contractions/expansions with a large area change.

Component 132 is a 14-volume pipe component representing the six 0.75-in.-diameter holes in the central reflector. It extends from the bottom of the inlet plenum to the top of the outlet plenum. Heat Structure 1320 (central reflector middle ring) is attached to this component.

Component 140 is a 14-volume pipe component that represents the coolant channels in the inner core ring, extending from the bottom of the inlet plenum to the top of the outlet plenum. This includes the area of eighty-four 0.625-in.-diameter holes, thirty 0.5-in.-diameter holes, and twenty-four 0.375-in.-diameter holes. The hydraulic diameter of the channel was adjusted to provide the same pressure drop as if the holes were modeled individually; this diameter was determined by running a stand-alone model of this core ring with the three different holes sizes modeled individually and iterating on the combined channel hydraulic diameter. Three heat structures are attached to this component: Structure 1400 (inner core ring upper reflector), Structure 1401 (inner core ring ceramic), and Structure 1402 (inner core ring bottom reflector).

Component 141 is a 10-volume pipe component representing the helium gap around the inner core ring heater rods. It extends over the heated length. One heat structure is attached to this component: Structure 1401 (inner core ring ceramic).

Component 142 is a single junction component connecting Component 141 to Component 143.

Component 143 is a time-dependent volume that maintains a constant pressure in the helium gap around the inner core ring heater rods. Its temperature is set to the same value as in the adjacent volume in Component 141.

Component 145 is a 14-volume pipe component that represents the one hundred forty-four 0.625-in.-diameter cooling holes in the middle core ring. It extends from the bottom of the inlet plenum to the top of the outlet plenum. Three heat structures are attached to this component: Structure 1450 (middle core ring upper reflector), Structure 1451 (middle core ring ceramic), and Structure 1452 (middle core ring bottom reflector).

Component 146 is a 10-volume pipe component representing the helium gap around the middle core ring heater rods. It extends over the heated length. One heat structure is attached to this component: Structure 1451 (middle core ring ceramic).

Component 147 is a single junction component connecting Component 146 to Component 148.

Component 148 is a time-dependent volume that maintains a constant pressure in the helium gap around the middle core ring heater rods. Its temperature is set to the same value as in the adjacent volume in Component 146.

Component 150 is a 14-volume pipe component representing the coolant channels in the outer core ring, extending from the bottom of the inlet plenum to the top of the outlet plenum. This includes the area of ninety-six 0.625-in.-diameter holes, sixty-six 0.5-in.-diameter holes, and seventy-two 0.375-in.-diameter holes. As with Component 140, the channel hydraulic diameter was adjusted to provide the appropriate pressure drop. Three heat structures are attached to this component: Structure 1500 (outer core ring upper reflector), Structure 1501 (outer core ring ceramic), and Structure 1502 (outer core ring bottom reflector).

Component 151 is a 10-volume pipe component representing the helium gap around the outer core ring heater rods. It extends over the heated length. One heat structure is attached to this component: Structure 1501 (outer core ring ceramic).

Component 152 is a single junction component connecting Component 151 to Component 153.

Component 153 is a time-dependent volume that maintains a constant pressure in the helium gap around the outer core ring heater rods. Its temperature is set to the same value as in the adjacent volume in Component 151.

Component 162 is a 14-volume pipe component that represents the thirty-six 0.625-in.-diameter holes in the side reflector. It extends from the bottom of the inlet plenum to the top of the outlet plenum. Heat Structure 1620 (side reflector middle ring) is attached to this component.

Component 164 is a 14-volume pipe component that represents the gap between the side reflector and the outer reflector. It extends from the top of the upper reflector to the top of the outlet plenum. It is connected to the outlet plenum, but not to the inlet plenum, as this gap is covered by the upper reflector top plate. Two heat structures are attached to this component: Structure 1640 (side reflector outer ring) and Structure 1660 (outer reflector).

Component 166 is a 15-volume pipe component that represents the gap between the outer reflector and the core barrel. It extends from the top of the upper reflector to the bottom of the outlet plenum. It is connected to the outlet plenum, but not to the inlet plenum, as this gap is also covered by the upper reflector top plate. Two heat structures are attached to this component: Structure 1660 (outer reflector) and Structure 1150 (core barrel).

Component 168 is a single junction component connecting the middle of the last cell in Component 166 to the middle of Component 175, the outlet plenum. The connection is modeled as a crossflow junction with momentum flux turned off on both sides of the junction (flag s = 3). The junction area is modeled as the perimeter of the hot duct flow opening through the side reflector multiplied by the gap width between the outer reflector and the core barrel. Loss coefficients are calculated based on the ratio of the junction flow area to the hot duct flow area.

Component 170 is a multiple junction component connecting the core and reflector coolant channels and gaps to the outlet plenum. It has six junctions. Junction 1 connects to the central reflector, Junction 2 to the inner core ring, Junction 3 to the middle core ring, Junction 4 to the outer core ring, Junction 5 to the side reflector, and Junction 6 to the gap between the side and outer reflectors. These junctions are all modeled as abrupt area changes with user-input loss coefficients (flag a = 2). The three core channels have forward and reverse loss coefficients of 2.5 to account for the channeling of the individual flow paths in the bottom reflector region. The reflector channels have forward loss coefficients of 1.0 and reverse loss coefficients of 0.5, as they are straight flow paths with a sudden expansion into the outlet plenum.

Component 175 is a branch component representing the outlet plenum. It has one junction connecting the middle of this component to the inlet of the hot duct (Component 200); momentum flux is turned off on the plenum side of the junction (flag s = 2). Four heat structures are attached to this component: Structure 1150 (core barrel), Structure 1660 (outer reflector), Structure 1750 (outlet plenum bottom plate), and Structure 1751 (support posts).

Component 190 is a branch component representing the pressure vessel lower head. It has one junction connecting the outlet of this component to the middle of the first volume of Component 105. The junction area is based on flow gaps in the lower support plate. An abrupt area change (flag a = 1) with code-calculated loss coefficients is used, and momentum flux is turned off in the core support region volume (flag s = 1). Structure 1002 (pressure vessel lower head) is connected to this component.

5.2 Primary Coolant System

Component 200 is the hot duct. It is modeled as a six-volume pipe. Cell lengths are selected such that the first instrument rake, the pipe to the steam generator, and the return pipe from the circulator to the cold duct are at cell centers. The segment from the end of the fourth cell to the modeled break valve (Component 205) includes the physical valve in the facility; this segment is divided into two cells to have comparable cell lengths through the hot leg. The loss coefficient for flow through the valve is located at internal Junction 5 in the pipe, rather than in the valve junction. It is assumed that the valve flow area is equal to that of the hot duct. The loss coefficient is based on the nominal hot leg Reynolds number and flow through an open ball valve. Losses associated with the very small area change between the concentric duct and the pipe leading to the RCST are neglected. Two heat structures are attached to this component: Structure 2000 (wall between hot and cold ducts) and Structure 2001 (pipe wall outside the concentric duct region).

Component 205 is a valve representing valve V-313, the hot duct break valve leading to the RCST. It connects the outlet of Component 200 to the inlet of Component 210, and is modeled as a motor valve with a stroke time of 5 seconds (assumed value pending receipt of actual data). The abrupt area change model is used with user-input loss coefficients of 0.0 (flag a = 2), as the losses associated with the valve are included in Component 200. The valve area is modeled as changing linearly with the stem position. Trip 205 opens the valve, and Trip 206 closes it.

Component 210 is the pipe between valve V-313 and the RCST. It is modeled as a branch with one junction, connecting the outlet of this component to the bottom of the second volume in Component 280, the RCST. The junction is modeled as an abrupt area change with user-input loss coefficients; the forward and reverse loss coefficients are for a sudden expansion/contraction with a large area ratio. If a hot duct break is being simulated, with the spool piece installed, the junction connects the outlet of Component 282 to the outlet of this component; in this case, the area change is modeled as abrupt with code-calculated loss coefficients. Heat Structure 2100 (pipe wall) is attached to this component.

Component 215 is the pipe between the hot duct and the steam generator inlet. It consists of the steam generator nozzle and the check valve body shown on Drawing OSU-HTTF-PRIM-DWG-005A. The pipe is modeled as a branch with one junction, connecting the top of the third volume in the hot duct to the inlet of this branch. Heat Structure 2150 (pipe wall) is attached to this component.

Component 217 is the check valve (V-101) in the pipe between the hot duct and the steam generator inlet. It is modeled at the steam generator inlet plenum, connecting the outlet of Component 215 to the inlet of Component 220. The differential pressure required to open the valve is 500 Pa (assumed value pending receipt of actual data). The loss coefficients include the loss from the 45-degree elbow in the steam generator inlet line and the area change between the pipe and inlet plenum; the latter loss is assumed to be an abrupt contraction from the pipe flow area to the average flow area in the plenum. An alternate model for this component is also available, representing a 4-in. (10-cm) diameter orifice that is installed in place of the check valve during system characterization testing.

Component 220 is the steam generator inlet plenum. It includes both the plenum and the 45-degree elbow between the plenum and the flange. It is modeled as a branch with one junction, connecting the outlet of this component to the inlet of the steam generator tubes. This junction is modeled as an abrupt area change with user-input loss coefficients. The loss coefficients are based on a sudden contraction/expansion from the plenum flow area at the tube sheet to the tube flow area. The loss from the elbow and the entrance to the plenum are included in the Component 217 loss coefficient. Two heat structures are attached to this component: Structure 2200 (plenum and inlet pipe walls) and Structure 2201 (plenum pass partition).

Component 225 is the steam generator tubes. The 188 tubes are modeled as a 22-volume pipe. Cells 1–10 carry the gas flow up, Cells 11 and 12 are the U-bend, and Cells 13–22 are the downflow side. The tube bends are assumed to start at the top baffle plate. They are also assumed to be smooth 180-degree bends, so that the radius of the bend is equal to the distance from the center of the bundle (90–270 degree line on Drawing OSU-HTTF-SEC-DWG-003C) to the center of each tube. The loss from the bend is located at the junction at the top of the tubes, Junction 11. The first and last cells include the flow length through the tube sheet. Two heat structures are attached to this component: Structure 2250 (steam generator tubes) and Structure 2251 (tube sheet).

Component 228 is the steam generator outlet plenum. It includes both the plenum and the 45-degree elbow between the plenum and the flange. It is modeled as a branch with two junctions. The inlet junction is modeled as an abrupt area change at the tube sheet with user-input loss coefficients; the loss coefficients are based on a sudden expansion/contraction from the tube flow area to the plenum flow area at the tube sheet. The outlet junction is modeled as a smooth area change with a loss coefficient equal to that of a sudden expansion from the average plenum area to the pipe area plus a 45-degree elbow. Two heat structures are attached to this component: Structure 2280 (plenum and outlet pipe walls) and Structure 2201 (plenum pass partition).

Component 230 is the pipe between the steam generator outlet and the gas circulator inlet. It is modeled using a single volume component. There are two bends in this section of piping. The losses associated with these bends are included in the circulator inlet junction; the estimated friction loss in the bends is subtracted from the published loss coefficient values, as the code will calculate the friction loss. Heat Structure 2300 (pipe wall) is attached to this component.

Component 233 is a single junction connecting the outlet of Component 230 to the inlet of Component 234; it is used only during steady-state calculations and is deleted for transient calculations.

Component 234 is a time-dependent volume that provides pressure control during steady-state calculations; it is deleted for transient calculations. The volume is maintained at a constant temperature equal to the desired primary pressure vessel inlet temperature. The pressure is controlled by control variable (CV) 234 to provide the desired pressure vessel inlet pressure.

Component 235 is the gas circulator volume. It is modeled as a branch with one junction, connecting the outlet of Component 230 to the inlet of this component. Loss coefficients represent the losses associated with the two bends in the inlet piping. Heat Structure 2350 (circulator body) is attached to this component.

Component 237 provides the circulator forced flow, connecting the outlet of Component 235 to the inlet of Component 240. It is modeled as a time-dependent junction, with the flow rate determined by CV 237 during steady state. The time-dependent junction component is expected to provide sufficient modeling of the circulator function, as transients should result in isolation of the portion of the loop piping containing the circulator.

Component 240 is the pipe between the gas circulator outlet and valve V-203 (Component 245). It is modeled as a single volume, and includes the volume of the pipe and half of the valve. The flow area of the valve is assumed to be the same as that of the pipe. Heat Structure 2400 (pipe wall) is attached to this component.

Component 245 is a valve representing valve V-203. It connects the outlet of Component 240 to the inlet of Component 250, and is modeled as a motor valve with a stroke time of 5 seconds (assumed value pending receipt of actual data). The valve area is modeled as changing linearly with the stem position. Trip 245 opens the valve, and Trip 246 closes it. The junction is modeled as an abrupt area change with user-input loss coefficients; the loss coefficients are based on flow through a ball valve and through one 90-degree bend (between the circulator and the valve).

Component 250 is the pipe between valve V-203 and valve V-311 (Component 255). It is modeled as a pipe with three volumes. The first volume extends from the middle of valve V-203 to the tee upstream of the break valve. The second volume is the straight passage of the tee. The third volume is the volume in valve V-313, which is assumed to have the same flow area as the upstream piping. The first junction includes the loss coefficient from the 90-degree elbow in the piping. Heat Structure 2500 (pipe wall) is attached to this component.

Component 255 is valve V-311, which is the cold leg break valve leading to the RCST. It connects the outlet of Component 250 to the inlet of Component 258, and is modeled as a motor valve with a stroke time of 5 seconds (assumed value pending receipt of actual data). The valve area is modeled as changing linearly with the stem position. Trip 255 opens the valve, and Trip 256 closes it. The loss coefficient is based on the nominal cold leg Reynolds number and flow through an open ball valve.

Component 258 is the pipe between valve V-311 and the RCST. It is modeled as a branch with one junction, connecting the outlet of this component to the inlet of the second volume in Component 280, the RCST. The junction is modeled as an abrupt area change with user-input loss coefficients; the forward and reverse loss coefficients are for a sudden expansion/contraction with a large area ratio. If a hot duct break is being simulated, with the spool piece installed, the junction connects the outlet of this component to the inlet of Component 282; in this case, the area change is modeled as smooth with loss coefficients of 0.0. Heat Structure 2580 (pipe wall) is attached to this component.

Component 260 is the crossover pipe from the cold leg tee to the cold duct. It is modeled as a branch with two junctions. The first junction is the tee off of the cold leg pipe upstream of the break valve, connecting the side of the second volume of Component 250 to the inlet of this component. The forward loss coefficient is that of flow for a diverging wye, and the reverse loss coefficient is that for a converging wye; in both cases, all of the flow is through the branch. The second junction connects the outlet of this component to the side of the first volume in the cold duct. The forward loss coefficient at this junction is approximated as that of flow from the side branch of a converging wye. The reverse loss coefficient is for a diverging wye. The geometry of the connection does not match either of the formulas associated with Diagram 7-18 in Idelchik 1994; the second formula is used, and uncertainties in this loss coefficient should not be significant as reverse flow is only expected during some transient tests with natural circulation flow. Heat Structure 2600 (pipe wall) is attached to this component.

Component 270 is the cold duct. It is modeled as a four-volume pipe. The junctions are at the same locations as those in the common portion of the hot duct. Two heat structures are attached to this component: Structure 2000 (wall between hot and cold ducts) and Structure 2700 (outer pipe wall).

Component 280 is the RCST. It is normally modeled as a two-volume vertical pipe. The lower volume represents the region below the break nozzles, which is assumed to not participate in any gas mixing in the tank. The upper volume represents the portion of the tank that will participate in mixing with gas entering from the PCS. With this being modeled as a single cell, all of the fluid will be perfectly mixed. This will overestimate the temperature of gas re-entering the PCS from the tank, as no thermal stratification will occur in the tank; this is a limitation of the one-dimensional modeling of the tank. However, there is no basis for a two- or three-dimensional model, and unphysically large recirculating flows have been observed in the past when such a modeling approach was attempted. The lengths of the two volumes are distorted to maintain the top and bottom of the tank at the appropriate elevations; the total volume is preserved, and the hydraulic diameter used is that of the tank cylinder. A single-volume model is also available; this model is intended to be used when the hot duct break spool piece is installed in the tank (see Component 282). There are normally three heat structures attached to this component: Structure 2100 (hot duct nozzle), Structure 2580 (cold duct nozzle), and Structure 2800 (tank wall). Structure 2820 (spool piece wall) is also attached if the break spool piece (Component 282) is installed.

Component 282 is the spool piece that is installed for hot duct breaks, connecting the hot and cold leg break nozzles inside the RCST. It is modeled as a single volume. Without a full set of dimensional information, the pipe is assumed to be a 180-degree bend with a bend diameter equal to the distance between the hot and cold break nozzle centerlines. From Drawing OSU-HTTF-RCSS-DWG-008C, it appears that the pipe is the same size as the cold leg nozzle piping, and that is therefore assumed to be the case. Heat Structure 2820 (pipe wall) is attached to this component.

Component 293 is the piping leading to the inlet of valves PSV-100 (Component 295) and V-400 (Component 296). It is modeled as a branch with one junction connecting the side of Component 240 to the inlet of this component. The forward loss coefficient at the junction is that of flow into the side branch of a diverging wye. The reverse loss coefficient is for flow from the side branch of a converging wye; this loss coefficient should not matter, as reverse flow through the pressure relief line should not occur.

Component 295 is the pressure relief valve (PSV-100). It connects the outlet of Component 293 to the inlet of Component 298, and is modeled as a trip valve that is open when trip 1295 is true. The flow area of the valve is set to that of the pipe, and will be adjusted when performance data for the valve are available.

Component 296 is the depressurization valve (V-400). It connects the outlet of Component 293 to the inlet of Component 298, and is modeled as a trip valve that is open when trip 1296 is true. The flow area of the valve is assumed to be the same as that of the pipe. The junction is modeled as a smooth area changed with a user-input loss coefficient based on flow through an open ball valve.

Component 298 is the pressure boundary volume downstream of the pressure relief and depressurization valves. It is modeled as a helium-filled volume at atmospheric pressure. Helium is used (rather than air) to avoid some code failures when air flowed back into the PCS through an open valve; since both valves connected to this volume are used to depressurize the PCS, backflow should not occur in the facility.

5.3 Secondary Coolant System

Component 320 is the feedwater pump (P-010). It is modeled as a time-dependent junction. The flow through the pump is determined by CV 320. The pump suction is taken from the water storage tank outlet line, Component 460. The pump discharge is connected to the inlet of Component 330.

Component 330 is the piping between the feedwater pump and the steam generator. The valves in this piping, V-011, V-012, and LCV-013, are not modeled explicitly. The logic controlling LCV-013 will be included in the controls for Component 320. The piping is modeled using a branch component with one junction; the junction connects the outlet of this component to the inlet of Component 340, with momentum flux turned off in the “to” volume (flag s = 1). Details of the pipe configuration are not shown on drawing OSU-HTTF-GEN-DWG-009H, so the length is estimated to be 20% greater than the elevation change between the feedwater pump and the feedwater nozzle on the steam generator to accommodate the horizontal runs. This assumption should have no effect on the calculated plant response, as the feedwater flow rate and steam generator pressure are controlled, so the pressure loss in this piping will be immaterial. The loss coefficients at the junction were calculated assuming the connection is a tee with all of the flow going between the branch and one leg of the tee. The pipe walls are not modeled with heat structures, as heat transfer in the feedwater system is not expected to be important to the steam generator conditions.

Component 340 is the steam generator downcomer. It is modeled as an 11-volume pipe extending from the bottom of the inner shell lap ring to the bottom of the inner shell. The internal junctions are located at the same elevations as those in the boiler region. Two heat structures are attached to this component: Structure 3400 (steam generator outer shell) and Structure 3500 (steam generator inner shell).

Component 345 (not shown in Figure 5) is the junction between the steam generator downcomer and the boiler region. It is modeled using a single junction component connecting the outlet of Component 340 to the outlet of the first cell in Component 350. The junction area and hydraulic diameter are those of the downcomer. The abrupt area change flag is set to 2, and the loss coefficient is based on a sudden expansion (contraction in reverse flow) into the bottom boiler volume.

Component 350 is the steam generator boiler region. It is modeled as a 13-volume pipe extending from the top of the tube sheet to the top of the inner cone. Node boundaries in the boiler region are placed at the centerlines of the baffle plates and halfway in between them, resulting in 10 cells spanning the straight portion of the tubes. The flow area at the baffle plates is modeled as just the flow around the end of the plate; it is assumed that thermal expansion of the tubes and tie rods will result in a negligible flow area between the tubes and the baffle plate. The volume occupied by the baffle plates is also neglected.

Loss coefficients at the baffle plates are estimated as though the area change was through a sharp-edged orifice, and are based on the volume flow area. Cells 11 and 12 are equal-length cells extending from the top baffle plate to the bottom of the inner cone, while cell 13 is the volume inside the inner cone. The U-bends in the steam generator tubes are contained in cell 11. The bundle interphase drag model (flag b = 1) is used in volumes 1–11. Three heat structures are attached to this component: Structure 3400 (steam generator outer shell), Structure 3500 (steam generator inner shell), and Structure 2250 (steam generator tubes).

Component 355 is the steam dome, the region above the top of the inner cone. It is modeled as a branch with two junctions. The dome includes only part of the rounded portion of the end cap; the rest, together with the cylindrical (straight) portion, is included in Component 360. The first junction is the inlet from Component 350 and is modeled as a smooth area change with no loss coefficients: it is assumed that the entering flow occupies the same area as the top of the inner cone, and that the flow going down into the upper annulus occupies the same area as the annulus. The second junction is the connection from the outlet of this component to the inlet of the relief valve inlet piping, Component 390. It is modeled as an abrupt area change with user-input loss coefficients based on the flow area ratios of the pipe and steam dome. Heat Structure 3550 (upper head) is attached to this component.

Component 360 is the steam annulus, the region between the upper cone and the outer shell. It is modeled as a downward-oriented branch with two junctions. The volume includes the region between the inner cone and the upper shell, and a small cylindrical section below between the inner shell and the flange. The first junction is the inlet from Component 355, which is modeled as a smooth area change with no loss coefficients. The second junction is the connection to the steam line, which is modeled as being from the side of this volume to the inlet of Component 365; the steam line area and hydraulic diameter are used for the junction. Momentum flux is turned on, as there should be a radial component to the flow in the facility as it moves around the inner cone to the steam line. The abrupt area change flag is set to 2, with loss coefficients based on an abrupt area change from the crossflow area into the pipe. Heat Structure 3400 (steam generator shell) is attached to this component.

Component 365 is the 4-in. piping in the steam line. It includes valve PCV-602 (Component 370), which is located at the end of the pipe section in the model. It is modeled using a single volume component. The check valve in this line (V-601) is not modeled explicitly. The component length is estimated, and will not have any effect on the calculated behavior in the steam generator as the steam dome pressure is controlled during steady-state operation, and the steam generator is expected to be isolated during most transients.

Component 370 is the pressure control valve (PCV-602). It connects the outlet of Component 365 to the inlet of Component 375, and is modeled as a servo valve controlled by CV 370. The flow area is the same as that of the upstream volume (Component 365). The abrupt area change model is used with code-calculated loss coefficients (flag a = 1). The valve area is modeled as changing linearly with the stem position. The valve is expected to be closed during transient calculations; even if it is not, the steam generator tubes will be isolated on the primary system side, so that any residual heat transfer in the steam generator will not affect the plant response of interest.

Component 375 is the pressure boundary volume downstream of the pressure control valve. It is modeled as a steam-filled volume at atmospheric pressure.

Component 390 is the pipe from the steam generator dome to valve PSV-600 (Component 395). It is modeled as a single volume component.

Component 395 is the pressure relief valve (PSV-600). It is modeled as a trip valve connecting the outlet of Component 390 to the inlet of Component 398. The valve is open when trip 1395 is true. The abrupt area change model is used with code-calculated loss coefficients. The flow area of the valve is set to that of the pipe, and will be adjusted when performance data for the valve are available.

Component 398 is the pressure boundary volume downstream of the pressure relief valve. It is modeled as a steam-filled volume at atmospheric pressure.

5.4 Potable Water Supply System

Choking is turned off (flag c = 1) at all junctions in this system.

Component 400 is the supply pressure boundary volume for the potable water system. It contains 290 K water at a pressure of 400 kPa (assumed values pending receipt of actual data).

Component 410 is level control valve LCV-010. It connects the outlet of Component 400 to the inlet of Component 420, and is modeled as a servo valve controlled by CV 410. The valve area is modeled as changing linearly with the stem position. The abrupt area change model is used with code-calculated loss coefficients, and choking is turned off. A very small flow is maintained through the valve to avoid occasional code thermodynamic property failures in Component 420.

Component 420 is the piping between the level control valve and tank T-010 (Component 450). It is modeled as a branch with one junction, with an assumed length long enough to prevent this volume from controlling the Courant limit. The junction connects the outlet of this component to the inlet of Component 450. User-input loss coefficients are for an abrupt area change (flag a = 2) between the small pipe and the large tank.

Component 450 is the RCCS/coolant day tank, tank T-010. It is modeled as a 6-volume pipe. The mixture level tracking model is turned on where permitted to try to prevent air from entering the feedwater or RCCS lines. The thermal stratification model is turned on where permitted to keep hot water returning from the RCCS panels segregated from the cooler water in the tank, and to segregate the colder supply water being added at the bottom of the tank. There are no heat structures modeling the tank wall, as heat transfer to the wall is not expected to be important to either the steam generator or RCCS behavior.

Component 460 is the tank T-010 outlet line, which provides feedwater to both the steam generator and the RCCS. It is modeled as a branch with one junction. The junction connects the bottom of the tank, the inlet of Component 450, to the inlet of this component. There are no details about the pipe configuration. Since the important part of this section of pipe is the elevation change, which provides the head at the pump suction, the pipe is modeled as a straight vertical run. There is no heat structure modeling the pipe wall, as heat transfer in this piping is not expected to be important to either the steam generator or RCCS behavior.

Component 490 is the vent/overflow line on tank T-010. It is modeled as a branch with two junctions. Its length is sufficient to allow the pipe to exit the bottom of the tank; piping beyond this is neglected. Junction 1 connects the outlet of cell 5 of Component 450 to the inlet of this component. Junction 2 connects the outlet of this component to the inlet of Component 498. Both junctions are modeled as abrupt area changes (flag a = 2) with user-input loss coefficients for a contraction or expansion with a large area change.

Component 498 is the pressure boundary volume at the end of the vent/overflow line on tank T-010, Component 490. It is filled with 295 K air at atmospheric pressure.

5.5 Alternate Break Piping

These components are not active in the base input model, but are activated as needed for the specific transient being modeled.

Component 5 is the junction between the upper plenum and the control rod drive break nozzle. It is modeled as a single junction connecting the outlet of Component 120 to the inlet of Component 10. The abrupt area change model is used with user-defined loss coefficients (flag a = 2). The loss coefficients are based on the area change between the top of the plenum and the nozzle interior.

Component 10 is the control rod drive break nozzle from the inlet to the center of the piping offtake. It is modeled as a pipe with 25 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model.

Heat Structure 0100 (pipe wall) is attached to this component.

Component 15 is the junction between the control rod drive break nozzle and the piping. It is modeled as a single junction connecting the outlet of Component 10 to the inlet of Component 20. It uses the abrupt area change model with user-input loss coefficients (flag a = 2); the loss is approximated as that through the branch of a tee.

Component 20 is the piping between the control rod drive break nozzle and valve V-332 (Component 25). It is modeled as a pipe with 35 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0200 (pipe wall) is attached to this component.

Component 25 is the control rod drive break valve, V-332. It is modeled as a trip valve, using trip 625. It connects the outlet of Component 20 to the inlet of Component 30. The abrupt area change model is used (flag a = 2) with user-input loss coefficients. The loss coefficients are based on a large flow through the valve, but minimal flow is expected during transients when this valve is open.

Component 30 is the first third of the piping between valve V-332 and the RCST. It is modeled as a pipe with 92 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0300 (pipe wall) is attached to this component.

Component 31 is a single junction connecting the outlet of Component 30 to the inlet of Component 32. It uses the smooth area change model with no loss coefficients.

Component 32 is the middle third of the piping between valve V-332 and the RCST. It is modeled as a pipe with 92 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0320 (pipe wall) is attached to this component.

Component 33 is a single junction connecting the outlet of Component 32 to the inlet of Component 34. It uses the smooth area change model with no loss coefficients.

Component 34 is the final third of the piping between valve V-332 and the RCST. It is modeled as a pipe with 92 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0340 (pipe wall) is attached to this component.

Component 35 is a single junction connecting the outlet of Component 34 to the top of the RCST, Component 280. It uses the abrupt area change model (flag a = 2) with user-input loss coefficients representing the large area change between the pipe and the tank.

Component 55 is the junction between the coolant region below the core support plate and the vessel bottom break line nozzle stub. It is modeled as a single junction connecting the bottom of the middle of the first volume in Component 105 to the inlet of Component 60. This connection places the nozzle somewhat higher in the model than in the facility, but the distortion is not expected to be significant for the transients in which the vessel bottom break line is active. The abrupt area change model is used with user-defined loss coefficients (flag a = 2). The loss coefficients are based on the area ratio between the lower support plate and the nozzle stub. Momentum flux is turned off on the vessel side of the junction (flag s = 2).

Component 60 is the vessel bottom break line nozzle stub. It is modeled as a pipe with 43 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model.

Component 65 is the junction between the bottom break line nozzle stub and the bottom break line piping. It is modeled as a single junction connecting the outlet of Component 60 to the inlet of Component 70. It used the abrupt area change model with user-input loss coefficients (flag a = 2).

Component 70 is the first half of the vessel bottom break line piping between the pressure vessel nozzle stub and valve V-331 (Component 75). It is modeled as a pipe with 73 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0700 (pipe wall) is attached to this component.

Component 71 is a single junction connecting the outlet of Component 70 to the inlet of Component 72. It uses the smooth area change model with no loss coefficients.

Component 72 is the second half of the vessel bottom break line piping between the pressure vessel nozzle stub and valve V-331. It is modeled as a pipe with 73 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0720 (pipe wall) is attached to this component.

Component 75 is the pressure vessel bottom break valve, V-331. It is modeled as a trip valve, using trip 675. It connects the outlet of Component 72 to the inlet of Component 80. The abrupt area change model is used (flag a = 2) with user-input loss coefficients. The loss coefficients are based on a large flow through the valve, but minimal flow is expected during transients when this valve is open.

Component 80 is the piping between valve V-331 and the RCST. It is modeled as a pipe with 96 volumes; the large number of volumes reflects the expectation that molecular diffusion will be the principal phenomenon occurring when this break is included in the model. Heat Structure 0800 (pipe wall) is attached to this component.

Component 85 is a single junction connecting the outlet of Component 80 to the bottom of the RCST, Component 280. It uses the abrupt area change model (flag a = 2) with user-input loss coefficients representing the large area change between the pipe and the tank.

5.6 Reactor Cavity and Reactor Cavity Cooling System

Choking is turned off (flag c = 1) at all junctions in the RCCS.

Component 900 is the reactor cavity between the primary pressure vessel and the RCCS panels, extending from the floor to the top of the RCCS panels. It is modeled as a single volume filled with air. An alternate model using a 20-volume pipe filled is included in the input deck for use with code versions in which the heat structure lengths cannot be input on the heat structure 500/600 series cards. The axial nodalization is consistent with the axial nodalization inside the primary pressure vessel. The only connection to the pipe is at the top, so an unphysical temperature profile will occur in the pipe if that nodalization is used. The single volume approach will overestimate the mixing in the cavity by making the air all the same temperature; this is expected to be closer to the actual conditions in the cavity than those that will be calculated using the pipe component. Three heat structures are attached to this component: Structure 1000 (pressure vessel wall), Structure 1001 (pressure vessel upper head), and Structure 9500 (RCCS panels).

Component 903 is a single junction connecting the top of the reactor cavity (outlet of Component 900) to the pressure boundary volume (inlet of Component 905).

Component 905 is the pressure boundary volume for the reactor cavity. It is a time-dependent volume containing 295 K air at a constant pressure of 100 kPa.

Component 915 is the alternate source volume for the RCCS pump. It is a time-dependent volume whose conditions need to be input by the user. The default conditions are 290 K water at a pressure of 100 kPa. This component is not active in the base input model.

Component 920 is the RCCS pump. It is modeled as a time-dependent junction, with the flow determined by CV 920. The suction is taken from the outlet of the water storage tank outlet line, Component 460, and the discharge is to the inlet of Component 930. Suction can also be taken from Component 915.

Component 930 is the piping between the RCCS pump outlet and the RCCS panel inlet headers. It also includes the short section of piping upstream of the pump, as well as the volumes in the pump and valves. The valves in this line (V-805 and PCV-807) are not modeled explicitly. This piping is modeled with a single volume component and no heat structures for the pipe walls, as heat transfer in this piping is not expected to be important to the RCCS behavior.

Component 940 represents the RCCS panel inlet headers. It is modeled as a branch with one junction, connecting the outlet of Component 930 to the inlet of this component. The junction is modeled as an abrupt area change (flag a = 2) with momentum flux turned off on the header side (flag s = 1). The loss coefficients are based on branching at a tee. There is no heat structure modeling the pipe wall, as heat transfer in this piping is not expected to be important to the RCCS behavior.

Component 945 represents the RCCS panel inlet lines. The valves in the lines are not modeled explicitly. The inlet lines are modeled as a branch with two junctions. The first junction connects the outlet of Component 940 to the inlet of this component. The second junction connects the outlet of this component to the inlet of the RCCS panels, Component 950. Since the RCCS flow is being provided by a time-dependent junction, the pressure loss in the piping is not important (the flow rate does not depend on a balance between the pump head and the piping pressure loss), and loss coefficients of 0.0 are entered for the junctions for simplicity. There is no heat structure modeling the pipe wall, as heat transfer in this piping is not expected to be important to the RCCS behavior.

Component 950 represents the RCCS panels. They are modeled with a 19-volume pipe. The axial nodalization is consistent with the axial nodalization inside the primary pressure vessel. Two heat structures are connected to this component: Structure 9500, which represents the surface facing the primary pressure vessel, and Structure 9501, which represents the back side of the panels, are connected to this component. Two heat structures are attached to this component: Structure 9500 (front panels) and Structure 9501 (back panels).

Component 955 represents the RCCS outlet lines leading to the outlet headers. They are modeled with a two-junction branch component. The first junction connects the outlet of the RCCS panels (Component 950) to the inlet of this component, and the second junction connects the outlet of this component to the inlet of Component 960. Since the RCCS flow is being provided by a time-dependent junction, the pressure loss in the piping is not important (the flow rate does not depend on a balance between the pump head and the piping pressure loss), and loss coefficients of 0.0 are entered for the junctions for simplicity. There is no heat structure modeling the pipe wall, as heat transfer in this piping is not expected to be important to the RCCS behavior.

Component 960 represents the RCCS outlet headers. The two 1-in. headers are lumped together with the two 1.5-in. pipes into a single branch component with one junction connecting the outlet of this component to the middle of the fifth cell in Component 450, the RCCS water storage tank. If water is not being recirculated to the storage tank, flow is discharged to Component 965. The hydraulic diameter of the 1-in. pipe is used, as the pressure drop through this piping is not important to the facility response. The junction loss coefficients represent the large area change between the piping and the tank. There is no heat structure modeling the pipe wall, as heat transfer in this piping is not expected to be important to the RCCS behavior.

Component 965 is the alternate sink volume for the RCCS flow, used when flow is not modeled as being recirculated to the water storage tank (Component 450). It is modeled using a time-dependent volume with constant conditions of 290 K water at a pressure of 100 kPa. This component is not active in the base input model.

6. HEAT STRUCTURES

The core region is modeled with two heat structures in each channel. The first structure is centered on a coolant channel, and models the ceramic material. The second structure represents the heater rods, and is modeled as a solid cylinder that radiates heat to the outer surface of the ceramic structure. The "dog bone" shape of the individual heater rodlets is approximated by a cylinder of the same length that preserves the total mass of graphite. This results in about a 10% larger diameter than the actual diameter of the cylindrical portion of the rodlet. This will slightly distort the surface temperature of the rodlet (lower than expected) because of the larger surface area, but this is offset somewhat by modeling only radiation heat transfer, and not convection or conduction, from the heater rods to the ceramic.

The Gnielinski correlation is being used for the core coolant channels. This is implemented by using heat transfer package 160 on the 500/600 series input cards (Word 3). Two-dimensional (2-D) conduction is used in most vertical structures. Dummy values are usually entered for the input on the 800 and 900 series cards related to critical heat flux parameters. With a single-phase vapor coolant, critical heat flux will not be a concern; the exception is the secondary side of the steam generator tubes.

The thickness of the middle rings of the central and side reflectors will likely need to be adjusted based on system characterization data. The amount of material that is influenced by the coolant channels is just estimated in this original model development effort, as appropriate measured data are not yet available.

6.1 Primary Pressure Vessel

Structure 1000 is the cylindrical portion of the primary pressure vessel. It has 17 axial structures (cell 1 is at the bottom), is made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 1, Rev. 0, items 2 and 3], and is connected to Components 100 and 115 on the left side and Component 900 on the right side. Axial conduction is turned on, and the node lengths are input on the 600 series cards. The left side is in a radiation enclosure (Enclosure 19) with the core barrel and the jacket shell, and the right side is in a radiation enclosure (Enclosure 21) with the RCCS.

Structure 1001 includes both the primary pressure vessel upper head and the upper plenum shield, since the volume between these two structures is filled with insulation. The upper head is made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 1, Rev. 1, item 1]. The upper plenum shield is made of Haynes 230 [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, items 90-93]. The insulation is Cerablanket (alumina-silica). The structure is connected to Component 120 on the left side and Component 900 on the right side. The left side is in a radiation enclosure (Enclosure 16) with other structures in the upper plenum, and the right side is in a radiation enclosure (Enclosure 21) with the RCCS.

Structure 1002 is the primary pressure vessel lower head. It is modeled as a hemisphere, is made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 1, Rev. 1, item 1], and is connected to Component 190 on the left side and Component 900 of the right side. The right side is in a radiation enclosure (Enclosure 21) with the RCCS.

Structure 1050 is the middle distributor plate in the coolant inlet region below the outlet plenum. It is a single, horizontal rectangular structure made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, item 103], connected to volume 105-01 on the bottom and volume 105-02 on the top.

Structure 1100 is the jacket shell, the outer plate forming the coolant upcomer between the core barrel and the primary pressure vessel in the lower vessel region. It has one axial structure, is made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, item 85], and is connected to Component 110 on the left side and Component 100 on the right. Both sides of the structure are in a radiation enclosure (Enclosure 19) with the core barrel and primary pressure vessel shell.

Structure 1150 is the core barrel. It has 16 axial structures (cell 1 is at the bottom), is made of 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, item 86], and is connected to Components 105, 166, and 175 on the left side and Components 100, 110, and 115 on the right side. Axial conduction is turned on. The left side of the structure is in a radiation enclosure (Enclosure 15) with the outer reflector, and the right side is in a radiation enclosure (Enclosure 19) with the primary pressure vessel barrel and the jacket shell.

Structure 1200 is the upper plenum cylinder. It has one axial structure, connected to Component 120 on the left side and Component 115, cell 15 on the right side. It is made of Haynes alloy 230 [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, item 90]. The height of the structure extends only to the top of the pressure vessel cylinder, as the remainder of the upper plenum cylinder is included in the upper head/upper plenum shield structure (Structure 1001). The left side of the structure is in a radiation enclosure (Enclosure 16) with other structures in the upper plenum. The right side of the structure is in a radiation enclosure (Enclosure 19) with the primary pressure vessel cylinder.

Structure 1201 is the upper plenum floor. It is made of graphite [Drawing OSU-HTTF-PRIM-DWG-002, Sheet 6, Rev. 1, item 110], and is connected to Component 120 on the right side. The left side is not connected to a fluid volume, but is in a conduction enclosure (Enclosure 2) with the upper reflector portion of each of the core region heat structures; the right side is in a radiation enclosure (Enclosure 16) with other structures in the upper plenum.

Structure 1202 represents the upper plenum internals. It is made of 304 stainless steel, and is connected to Component 120 on the right side; the left side is adiabatic. The right side is in a radiation enclosure (Enclosure 16) with other structures in the upper plenum.

Structure 1300 is the center cylindrical region of the central reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. Neither side of the structure is connected to a fluid volume. Steady-state initialization is turned off to avoid convergence problems during input processing. The right side of the structure is in a conduction enclosure (Enclosure 1) with the other two sections of the central reflector, Structures 1320 and 1340. 2-D conduction is turned on, with heat structure lengths input on the 600 series cards.

Structure 1320 is the middle ring of the central reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. The left side of the structure is connected to Component 132. Steady-state initialization is turned off to avoid convergence problems during input processing. The left side of cell 14 is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum. The right side is in a conduction enclosure (Enclosure 1) with Structures 1300 and 1340. 2-D conduction is turned on.

Structure 1340 is the outer ring of the central reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. Neither side of the structure is connected to a fluid volume. Steady-state initialization is turned off to avoid convergence problems during input processing. The left side of the structure is in a conduction enclosure (Enclosure 1) with Structures 1300 and 1320. The right side is in a conduction enclosure (Enclosure 2) with the three core channels and the inner ring of the outer reflector. 2-D conduction is turned on, with heat structure lengths input on the 500 series cards.

Structure 1400 is the upper reflector above the inner core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 140 and the right side is adiabatic. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate.

Structure 1401 is the ceramic in the heated region of the inner core ring. It is made of Greencast ceramic, and has 10 axial cells (cell 1 is at the top) extending over the heated length of the core. 2-D conduction is turned on. The left side of the structure is connected to Component 140, and the right side is connected to Component 141. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate; the only axial conduction modeled in the enclosure for this structure is from the ends to the top and bottom reflectors. The right side of the structure is in a radiation enclosure (Enclosure 11) with the heater rod, Structure 1403.

Structure 1402 is the bottom reflector below the inner core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 140. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate. The right side of the second cell is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

Structure 1403 represents the heater rods in the inner core ring. It is made of graphite and has 10 axial cells. 2-D conduction is turned on. Both sides of the structure are adiabatic, but the right side is in a radiation enclosure (Enclosure 11) with Structure 1401. The internal heat source is provided by CV 940.

Structure 1450 is the upper reflector above the middle core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 145 and the right side is adiabatic. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate.

Structure 1451 is the ceramic in the heated region of the middle core ring. It is made of Greencast ceramic, and has 10 axial cells (cell 1 is at the top) extending over the heated length of the core. 2-D conduction is turned on. The left side of the structure is connected to Component 145, and the right side is connected to Component 146. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate; the only axial conduction modeled in the enclosure for this structure is from the ends to the top and bottom reflectors. The right side of the structure is in a radiation enclosure (Enclosure 12) with the heater rod, Structure 1453.

Structure 1452 is the bottom reflector below the middle core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 145. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate. The right side of the second cell is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

Structure 1453 represents the heater rods in the middle core ring. It is made of graphite and has 10 axial cells. 2-D conduction is turned on. Both sides of the structure are adiabatic, but the right side is in a radiation enclosure (Enclosure 12) with Structure 1451. The internal heat source is provided by CV 945.

Structure 1500 is the upper reflector above the outer core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 150 and the right side is adiabatic. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate.

Structure 1501 is the ceramic in the heated region of the inner core ring. It is made of Greencast ceramic, and has 10 axial cells (cell 1 is at the top) extending over the heated length of the core. 2-D conduction is turned on. The left side of the structure is connected to Component 150, and the right side is connected to Component 151. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate; the only axial conduction modeled in the enclosure for this structure is from the ends to the top and bottom reflectors. The right side of the structure is in a radiation enclosure (Enclosure 13) with the heater rod, Structure 1503.

Structure 1502 is the bottom reflector below the outer core ring. It is made of Greencast ceramic, and has two axial cells. 2-D conduction is turned on. The left side of the structure is connected to Component 150. The left side is in a conduction enclosure (Enclosure 2) with the other core channels, the outer ring of the inner reflector, the inner ring of the outer reflector, and the upper plenum plate. The right side of the second cell is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

Structure 1503 represents the heater rods in the outer core ring. It is made of graphite and has 10 axial cells. 2-D conduction is turned on. Both sides of the structure are adiabatic, but the right side is in a radiation enclosure (Enclosure 13) with Structure 1501. The internal heat source is provided by CV 950.

Structure 1600 is the inner ring of the side reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. Neither side of the structure is connected to a fluid volume. Steady-state initialization is turned off to avoid convergence problems during input processing. The left side of the structure is in a conduction enclosure (Enclosure 2) with the three core channels and the outer ring of the central reflector. The right side of the structure is in a conduction enclosure (Enclosure 3) with the other two sections of the side reflector, Structures 1620 and 1640. 2-D conduction is turned on, with heat structure lengths input on the 500 series cards.

Structure 1620 is the middle ring of the side reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. The left side of the structure is connected to Component 132. Steady-state initialization is turned off to avoid convergence problems during input processing. The left side of cell 14 is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum. The right side is in a conduction enclosure (Enclosure 3) with structures 1300 and 1340. 2-D conduction is turned on.

Structure 1640 is the outer ring of the side reflector, which is made of Greencast ceramic. Its 14 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the lower reflector. The right side of the structure is connected to Component 164. Steady-state initialization is turned off to avoid convergence problems during input processing. 2-D conduction is turned on. The left side of the structure is in a conduction enclosure (Enclosure 3) with Structures 1600 and 1620. The right side is in a radiation enclosure (Enclosure 14) with the outer reflector, Structure 1660.

Structure 1660 is the outer reflector, which is made of Shot-Tech SiC 80 ceramic. Its 15 axial cells (cell 1 is at the top) extend from the top of the upper reflector to the bottom of the outlet plenum. 2-D conduction is turned on. The left side of the structure is connected to Components 164 and 175, and the right side is connected to Component 166. Most of the left side is in a radiation enclosure (Enclosure 14) with the outer surface of the side reflector, Structure 1640, and the right side is in a radiation enclosure (Enclosure 15) with the core barrel, Structure 110; the left side of cell 15 is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

Structure 1750 represents the outlet plenum bottom plate, which is a composite horizontal structure that includes the outlet plenum bottom plate on the top, the upper bulkhead plate on the bottom, and insulation in between. The top of the structure is connected to Component 175, and the bottom is connected to Component 105. The top surface is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

Structure 1751 represents the support posts in the outlet plenum, which are made of Greencast ceramic. The right side of this solid cylinder is connected to Component 175 and is in a radiation enclosure (Enclosure 18) with other structures in the outlet plenum.

6.2 Primary Coolant System

Structure 2000 is the structure separating the hot and cold ducts. It is connected to Component 200 on the left side and to Component 270 on the right side. It consists of two cylinders of 304 stainless steel with a 3/8 in. layer of alumina silica insulation between them [Drawing OSU-HTTF-PRIM-DWG-005A, Rev. 0, items 8-13].

Structure 2001 is the section of the hot duct from the end of the cold duct to the outlet of the isolation/break valve. It is a cylindrical structure with 304 stainless steel on the inside and insulation on the outside. It is connected to cells 5 and 6 of Component 200 on the left side, with a natural convection heat transfer coefficient from Table 951 on the right side and a heat sink temperature provided by Table 950.

Structure 2100 is the section of hot duct between the isolation/break valve and the RCST. It is a cylindrical structure made of 304 stainless steel. Since most of this pipe is on the inside of the RCST, it is modeled without insulation on the outside. It is connected to Component 210 on the left side and Component 280 on the right side.

Structure 2150 is the pipe between the hot duct and the steam generator inlet plenum. The geometry of the structure in this region is complicated, including the check valve body and a gap between the liner and the nozzle. This will be approximated by a single 304 stainless steel [Drawing OSU-HTTF-PRIM-DWG-005A, Rev. 0, items 5 and 6] cylindrical structure with an inner radius of that of the inner sleeve and an outer steel radius of the steam generator nozzle; a layer of insulation completes the structure. It is connected to Component 215 on the left side, with a natural convection heat transfer coefficient from Table 951 on the right side and a heat sink temperature provided by Table 950.

Structure 2200 is the inlet plenum portion of the steam generator shell. It is modeled as a 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, items 8, 36, and 37] cylinder whose inner surface area and total volume are equal to those that of the inlet plenum, inlet nozzle stub, and inlet elbow. The left side is connected to Component 220, and the right side has a heat transfer coefficient boundary condition applied to the outside of the insulation (from Table 951) with a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

Structure 2201 is the dividing plate ("pass partition") between the inlet and outlet plena of the steam generator. It is made of 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, item 10]. It is modeled as a rectangular structure, connected to Component 220 on the left side and to Component 228 on the right side.

Structure 2250 represents the 188 steam generator tubes. The tubes are made of 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, item 2]. The left side is connected to Component 225, and the right side is connected to Component 350. The right side uses the rod bundle with crossflow heat transfer package, as the baffle plates should force some flow across the tubes. Axial conduction is turned on in the tubes because large temperature gradients are expected along the tubes.

Structure 2251 represents the tube sheet. It is modeled as a 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, item 1] cylindrical structure with two axial nodes: the first models the half of the tube sheet connected to the inlet end of the steam generator tubes, and the second models the half connected to the outlet end of the tubes. The structure is built around a unit cell, the inner radius being the inner radius of the tubes and the outer radius determined by conservation of mass (area). There are 188 of these unit cells in each half of the tube sheet. Heat transfer from the faces of the tube sheet to the boiler region and to the plena is not modeled as it is expected to be much smaller than the heat transfer in the flow passages.

Structure 2280 is the outlet plenum portion of the steam generator shell. It is modeled as a 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, items 8, 38, and 39] cylinder whose inner surface area and total volume are equal to those that of the outlet plenum, outlet nozzle stub, and outlet elbow. The left side is connected to Component 228, and the right side has a natural convection heat transfer coefficient boundary condition applied to the outside of the insulation (from Table 951) with a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

Structure 2300 is the pipe between the steam generator outlet plenum and the circulator. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and one axial structure. The left side is connected to Component 230, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2350 is the circulator body. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and one axial structure. The left side is connected to Component 235, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2400 is the pipe between the circulator outlet and valve V-203. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and one axial structure. The left side is connected to Component 240, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2500 is the pipe between valve V-203 and the cold leg break valve. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and three axial structures. The left side is connected to Component 250, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2580 is the section of cold leg between the break valve and the RCST. It is a cylindrical structure made of 304 stainless steel. Since most of this pipe is on the inside of the RCST, it is modeled without insulation on the outside. It is connected to Component 258 on the left side and Component 280 on the right side.

Structure 2600 is the crossover line between the cold leg and the cold duct. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and one axial structure. The left side is connected to Component 260, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2700 is the outer wall of the cold duct. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and four axial structures. The left side is connected to Component 270, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 2800 is the RCST wall. It is a cylindrical structure with 304 stainless steel on the inside [Drawing OSU-HTTF-RCSS-DWG-008A, Sheet 1, Rev. 0, items 1 and 2], insulation on the outside, and either one or two axial structures. The mass of the heads is not completely accounted for with this modeling approach. The left side of the structure is connected to Component 280. The right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

Structure 2820 is the hot duct break spool piece. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and one axial structure. The left side of the structure is connected to Component 282, and the right side is connected to Component 280.

6.3 Secondary Coolant System

Structure 3400 is the steam generator outer cylindrical shell, modeled with 13 axial structures. It is made of 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, items 4 and 5]. The thicker wall just above the tube sheet is ignored. Most of the left side is connected to Component 340, with the bottom node being connected to the first volume in Component 350 and the top node being connected to Component 360. The right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

Structure 3500 is the steam generator inner cylindrical shell separating the downcomer from the boiler. The shell is made of 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, item 11]. It has 11 axial nodes, and is connected to the boiler (Component 350) on the left side and the downcomer (Component 340) on the right side. The portion of the cylinder above the top of the downcomer is neglected, as there is expected to be little temperature difference between the top of the boiler and the steam annulus region, and stored energy in the steam generator structures is not expected to be important in the transients to be simulated.

Structure 3550 is the steam generator upper head. The head is made of 304 stainless steel [Drawing OSU-HTTF-SEC-DWG-003A, Rev. 0, item 7]. The left side is connected to Component 355, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

6.4 Alternate Break Piping

Structure 0100 is the pressure vessel control rod drive break nozzle. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (25). The left side is connected to Component 10, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0200 is the section of piping between the pressure vessel control rod drive break nozzle and valve V-332. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (35). The left side is connected to Component 20, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0300 is the first third of the piping between valve V-332 and the RCST. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (92). The left side is connected to Component 30, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0320 is the middle third of the piping between valve V-332 and the RCST. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (92). The left side is connected to Component 32, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0340 is the final third of the piping between valve V-332 and the RCST. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (92). The left side is connected to Component 34, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0700 is the first half of the piping between the pressure vessel bottom break nozzle stub and valve V-331. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (73). The left side is connected to Component 70, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0720 is the second half of the piping between the pressure vessel bottom break nozzle stub and valve V-331. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (73). The left side is connected to Component 72, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

Structure 0800 is the section of piping between valve V-331 and the RCST. It is a cylindrical structure with 304 stainless steel on the inside, insulation on the outside, and the same number of axial structures as the attached pipe has volumes (96). The left side is connected to Component 80, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950.

6.5 Reactor Cavity Cooling System

Structure 9500 is the front wall of the RCCS panels. The left side is connected to Component 900, and is in a radiation enclosure (Enclosure 21) with the primary pressure vessel. The right side is connected to Component 950.

Structure 9501 is the back wall of the RCCS panels. The left side is connected to Component 950, and the right side has a natural convection heat transfer coefficient from Table 951 and a heat sink temperature provided by Table 950. The thin (0.024 in.) aluminum jacket on the outside of the insulation is not modeled, as it will provide a negligible resistance to heat transfer compared to the low thermal conductivity of the insulating material.

7. ENCLOSURES

Both radiation and conduction enclosures are used in the model. The view factors in the radiation enclosures with concentric vertical structures are strictly radial, assuming that the cross-product terms between different axial levels will balance out enough to make them a second-order effect.

Enclosure 1 (601xxxxx cards) models the radial conduction between the three structures in the central reflector (Structures 1300, 1320, and 1340). It uses a temperature-dependent conductance from Table 601.

Enclosure 2 (602xxxxx cards) models the conduction in the core (heater rod) region. It includes radial conduction between the ceramic structures in the three core channels (Structures 1401, 1451, and 1501), as well from the core to the adjacent central and side reflector structures (Structures 1340 and 1600, respectively). It models axial conduction from the core ceramic structures to the top and bottom reflector structures (Structures 1400, 1402, 1450, 1452, 1500, and 1502). It also models conduction from the upper reflector structures to the upper plenum plate (Structure 1201). It uses a temperature-dependent conductance from Table 601.

Enclosure 3 (603xxxxx cards) models the radial conduction between the three structures in the side reflector (Structures 1600, 1620, and 1640). It uses a temperature-dependent conductance from Table 601.

Enclosure 11 (611xxxxx cards) models the radiation from the heater rods (Structure 1403) to the ceramic (Structure 1401) in the inner core ring.

Enclosure 12 (612xxxxx cards) models the radiation from the heater rods (Structure 1453) to the ceramic (Structure 1451) in the middle core ring.

Enclosure 13 (613xxxxx cards) models the radiation from the heater rods (Structure 1503) to the ceramic (Structure 1501) in the outer core ring.

Enclosure 14 (614xxxxx cards) models the radiation from the side reflector (Structure 1640) to the outer reflector (Structure 1660).

Enclosure 15 (615xxxxx cards) models the radiation from the outer reflector (Structure 1660) to the core barrel (Structure 1150).

Enclosure 16 (616xxxxx cards) models the radiation between the upper plenum plate (Structure 1201), upper plenum internals (Structure 1202), upper plenum shield (Structure 1001), and upper plenum cylinder (Structure 1200).

Enclosure 18 (618xxxxx cards) models the radiation between the core bottom reflector (Structures 1320, 1402, 1452, 1502, 1620), outlet plenum side reflector (Structure 1660), lower plenum bottom plate (Structure 1750), and lower plenum posts (Structure 1751).

Enclosure 19 (619xxxxx cards) models the radiation from the core barrel (Structure 1150) and upper plenum cylinder (Structure 1200) to the primary pressure vessel wall (Structure 1000). In the outlet plenum region, the core barrel radiates to the inner surface of the jacket shell (Structure 1100), and the outer surface of the jacket shell then radiates to the primary pressure vessel wall. Although the jacket shell extends below the outlet plenum, its total length is included in the radiation at the outlet plenum level.

Enclosure 21 (621xxxxx cards) models the radiation from the primary pressure vessel (Structures 1000, 1001, and 1002) to the RCCS panels (Structure 9500).

8. MATERIALS

Material 1 is Greencast-94F Plus ceramic. It is used in the core, central and side reflectors, top and bottom reflectors, and the posts in the outlet plenum. The product data sheet[a] had thermal conductivity values for five temperatures, but temperatures both above and below the range of these data are expected. A third-order curve fit was used (R^2 value of 0.9994) to extrapolate the measured data. Data for specific heat capacity and emissivity were contracted by Oregon State University (Larsen 2012) and are used in the input model. Only four emissivity data points are available, with a maximum temperature of 150°C, which is well below the normal operating temperature of the facility. Extrapolating these data using a quadratic or cubic fit resulted in negative emissivities near the nominal steady state operating temperatures. A linear fit was therefore used to extrapolate the data to higher temperatures; although the curve fit statistics were not particularly good (R^2 value of 0.977), the values were positive over the entire expected temperature range.

Material 2 is G320 graphite. It is used in the heater rods and the upper plenum floor. Density and thermal conductivity values were taken from the data provided in Figures 10-3 and 10-4 of Cadell 2011. Specific heat capacity values were obtained from Table A6.1 of ASTM International 2014. The emissivity used is the value for unoxidized carbon from Engineering Toolbox 2017.

Material 3 is Type 304 stainless steel. It is used in the pressure vessel, piping, and steam generator. Thermodynamic properties were obtained from Siefken et al. 2001. The emissivity used is the value for polished stainless steel from Engineering ToolBox 2017.

Material 4 is Haynes 230 alloy. It is used in the upper plenum cylinder. The emissivity used is the value for polished nickel from Engineering ToolBox 2017.

Material 5 is Shot-Tech SiC 80 ceramic. It is used in the outer reflector. The only needed property information on the ceramic product data sheet[a] was the density. The value of 2.37 g/cm^3 is used for the constant density. Thermal conductivity and specific heat capacity values are not available. With no other information, these data are taken from measurements of Thor 80 ceramic, which has a similar chemical composition, with somewhat more alumina and less silica than the Shot-Tech. No measurements of the emissivity of Shot-Tech were made; therefore data for Thor 80 will be used. Only four emissivity data points are available, with a maximum temperature of 150°C, which is well below the normal operating temperature of the facility. As for the Greencast ceramic, a linear fit of the four data points (R^2 value of 0.979) was used to extrapolate to higher temperatures.

Material 6 is Enerwrap MA 960 insulation (Roxul 2014). It is used for the permanent insulation on the outside of the large tanks and on the back side of the RCCS panels. Heat capacity information was not provided by the manufacturer, so it is assumed to be the same as that of mineral wool (Engineering Toolbox 2014).

Material 7 is structural insulation. It is used in the metallic core support structure.

Material 8 is alumina silica insulation. It is used in the upper plenum between the upper plenum shroud and the pressure vessel upper head and between the hot and cold ducts. The upper plenum insulation is McMaster-Carr Ultra-High Temperature Ceramic Insulation Roll; the associated safety data sheet identifies the product as Cerablanket from Morgan Advanced Materials. McMaster-Carr states the density is 4 lb/ft^3, which corresponds to 64 kg/m^3.

Material 9 is Lewco Needled E Glass Blanket fiberglass insulation (Lewco undated). It is the removable insulation used on the outside of the piping. Heat capacity information was not provided by the manufacturer, so it is assumed to be the same as that of glass wool.

Additional information on insulation was provided in Hertel 2014, Hertel 2015, and Woods 2017b.

[a] Data sheets for the ceramics were provided to Idaho National Laboratory by HTTF personnel.

9. TRIPS

Trip 25 manually opens the control rod drive break valve, V-332, Component 25. It is set to be always false, and must be changed to open the valve.

Trip 75 manually opens the vessel bottom break valve, V-331, Component 75. It is set to be always false, and must be changed to open the valve.

Trip 100 is the scram trip. It is set to be always false, and must be changed to initiate a power decrease.

Trip 205 opens the hot duct break valve, V-313, Component 205. It is set to be always false, and must be changed to initiate a break.

Trip 206 closes the hot duct break valve, V-313, Component 205. It is set to be always false, and must be changed to reclose a break.

Trip 245 opens the loop isolation valve, V-203, Component 245. It is set to be always false, and the valve is initialized to be fully open.

Trip 246 closes the loop isolation valve, V-203, Component 245. It is set to be always false, and must be changed to close the valve.

Trip 255 opens the cold leg break valve, V-311, Component 255. It is set to be always false, and must be changed to initiate a break.

Trip 256 closes the cold leg break valve, V-311, Component 255. It is set to be always false, and must be changed to reclose a break.

Trip 294 is the opening (setpoint) pressure for the PCS relief valve, PSV-100, Component 295.

Trip 295 is the closing (reseat) pressure for the PCS relief valve, PSV-100, Component 295.

Trip 296 manually opens the depressurization valve, PCV-400, Component 296. It is set to be always false, and must be changed to open the valve.

Trip 297 manually closes the depressurization valve, PCV-400, Component 296. It is set to be always false, and must be changed to close the valve.

Trip 394 is the opening (setpoint) pressure for the steam generator relief valve, PSV-600, Component 395.

Trip 395 is the closing (reseat) pressure for the steam generator relief valve, PSV-600, Component 395.

Trip 410 is the low liquid level setpoint on tank T-010 for the water supply control logic.

Trip 411 is the high liquid level setpoint on tank T-010 for the water supply control logic.

Trip 412 is true if the liquid level in tank T-010 is above mid-range (halfway between open and close setpoints)

Trip 1294 is true if valve Component 295 either should open or is already open.

Trip 1295 opens the PCS relief valve, PSV-100, Component 295.

Trip 1296 opens the depressurization valve, Component 296.

Trip 1394 is true if valve Component 395 either should open or is already open.

Trip 1395 opens the steam generator relief valve, PSV-600, Component 395.

Trip 1409 is true if the tank T-010 water supply valve, Component 410, either should open or is already open.

Trip 1410 opens the tank T-010 water supply valve, Component 410, or maintains a higher flow until the liquid level is above mid-range.

Trip 1411 is true if the tank T-010 water supply valve, Component 410, either should close or is already closed.

Trip 1412 closes the tank T-010 water supply valve, Component 410, or maintains a lower flow until the liquid level is below mid-range.

10. GENERAL TABLES

Table 1 reproduces the volumetric heat capacity for Material 1. It is used in the calculation of the stored energy in the system.

Table 2 reproduces the volumetric heat capacity for Material 2. It is used in the calculation of the stored energy in the system.

Table 3 reproduces the volumetric heat capacity for Material 3. It is used in the calculation of the stored energy in the system.

Table 4 reproduces the volumetric heat capacity for Material 4. It is used in the calculation of the stored energy in the system.

Table 5 reproduces the volumetric heat capacity for Material 5. It is used in the calculation of the stored energy in the system.

Table 601 is the temperature-dependent conductance used in the core conduction enclosures.

Table 901 is the power in heater bank 101. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 902 is the power in heater bank 102. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 903 is the power in heater bank 103. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 904 is the power in heater bank 104. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 905 is the power in heater bank 105. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 906 is the power in heater bank 106. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 907 is the power in heater bank 107. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 908 is the power in heater bank 108. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 909 is the power in heater bank 109. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 910 is the power in heater bank 110. It includes a normalized power decay curve that can be adjusted depending on the scaling factors on time and power that are appropriate for the transient being simulated. Alternatively, the measured power from an experiment could be input directly into this table.

Table 950 is the building temperature, used as a boundary temperature for the back side of the RCCS panels and for the outside of insulated structures. It is set to 300 K.

Table 951 is the convective heat transfer coefficient boundary condition for the back side of the RCCS panels and for the outside of insulated structures. It is set to a value of 15 W/m^2-K, which is a representative natural convection value.

11. CONTROL VARIABLES

CV 1 calculates the heat input (W) to the coolant in Component 140, the flow path through the core region inner ring.

CV 2 calculates the heat input (W) to the coolant in Component 145, the flow path through the core region middle ring.

CV 3 calculates the heat input (W) to the coolant in Component 150, the flow path through the core region outer ring.

CV 4 calculates the heat input (W) to the coolant in Component 132, the flow path through the central reflector cooling channels.

CV 5 calculates the heat input (W) to the coolant in Component 162, the flow path through the side reflector cooling channels.

CV 6 calculates the heat input (W) to the coolant in Component 164, the gas gap between the side and outer reflectors.

CV 7 calculates the heat input (W) to the coolant in Component 166, the gas gap between the outer reflector and the core barrel.

CV 8 calculates the heat input (W) to the coolant in Component 141, the gas gap around the heater rod in the core region inner ring.

CV 9 calculates the heat input (W) to the coolant in Component 146, the gas gap around the heater rod in the core region middle ring.

CV 10 calculates the heat input (W) to the coolant in Component 151, the gas gap around the heater rod in the core region outer ring.

CV 11 calculates the total heat input (W) to the gas in the core region by adding CVs 1–10.

CV 12 integrates the total heat input (J) to the gas in the core region, CV 11.

CV 13 calculates the total heat input (W) to the gas in the primary pressure vessel by taking the difference between the flow enthalpy leaving the vessel (Junction 175-01) and that entering (Junction 100-01). This will generally only be a valid calculation under steady forced convection flow conditions.

CV 14 calculates the total heat input (J) to the gas in the primary pressure vessel by integrating CV 13.

CV 16 calculates the heat input (W) to the coolant in Component 115, the gap between the core barrel and the primary pressure vessel.

CV 20 mimics the total flow (kg/s) through the core by taking the mass flow through Junction 175-01. A minimum value of 0.001 is applied to prevent division by zero during subsequent use of this flow rate.

CV 21 calculates the flow fraction through the central reflector cooling channel by dividing the flow through the channel outlet, Junction 1700101, by the total flow, CV 20.

CV 22 calculates the flow fraction through the core inner ring by dividing the flow through the channel outlet, Junction 1700102, by the total flow, CV 20.

CV 23 calculates the flow fraction through the core middle ring by dividing the flow through the channel outlet, Junction 1700103, by the total flow, CV 20.

CV 24 calculates the flow fraction through the core outer ring by dividing the flow through the channel outlet, Junction 1700104, by the total flow, CV 20.

CV 25 calculates the flow fraction through the side reflector cooling channel by dividing the flow through the channel outlet, Junction 1700105, by the total flow, CV 20.

CV 26 calculates the flow fraction through the gap between the side reflector and the outer reflector by dividing the flow through the channel outlet, Junction 1700106, by the total flow, CV 20.

CV 27 calculates the flow fraction through the gap between the outer reflector and the core barrel by dividing the flow through the channel outlet, Junction 1680000, by the total flow, CV 20.

CV 28 calculates the total core bypass flow fraction through the channels connected to the central and side reflectors.

CV 29 calculates the total core bypass flow fraction.

CV 31 calculates the total primary-to-secondary heat transfer rate (W) by summing the heat removal from the coolant in the steam generator tubes.

CV 32 calculates the total primary-to-secondary heat transfer rate (W) by summing the heat transfer out of the steam generator tube heat structures.

CV 33 calculates the total primary-to-secondary heat transfer rate (W) by summing the heat addition to the coolant in the steam generator boiler region.

CV 35 calculates the total energy transferred to the steam generator (W) by taking the difference between the flow enthalpy leaving the steam generator (Junction 360-02) and that entering (Junction 330-01). This will generally only be a valid calculation under steady forced convection flow conditions.

CV 36 integrates CV 35 to calculate the total net energy transferred to the steam generator secondary coolant (J).

CV 45 calculates the heat added by the circulator (W) by taking the difference between the flow enthalpy downstream (Junction 245) and upstream (Junction 235-01) of the circulator. This will generally only be a valid calculation under steady forced convection flow conditions.

CV 46 integrates CV 45 to calculate the total energy (J) added to the coolant by the circulator.

CV 95 calculates the heat input (W) to the coolant in Component 950, the RCCS panels.

CV 96 integrates CV 95 to calculate the total net heat input (J) to the coolant in the RCCS panels.

CV 98 calculates the net heat transfer to the RCCS coolant in the RCCS panels (W) by taking the difference between the flow enthalpy downstream (Junction 955-01) and upstream (Junction 945-02) of the panels. This will generally only be a valid calculation under steady forced convection flow conditions.

CV 99 integrates CV 98 to calculate the total net energy deposition in the RCCS coolant (J).

CV 100 calculates the maximum volume-average structure temperature (K) for the primary pressure vessel cylinder.

CV 101 calculates the peak volume-average structure temperature (K) for the primary pressure vessel cylinder.

CV 103 calculates the maximum volume-average structure temperature (K) for the core barrel.

CV 104 calculates the peak volume-average structure temperature (K) for the core barrel.

CV 120 calculates the maximum volume-average structure temperature (K) for the central reflector inner cylinder over the heated length of the core.

CV 121 calculates the maximum volume-average structure temperature (K) for the central reflector middle ring over the heated length of the core.

CV 122 calculates the maximum volume-average structure temperature (K) for the central reflector outer ring over the heated length of the core.

CV 123 calculates the maximum volume-average structure temperature (K) for the core inner ring ceramic over the heated length of the core.

CV 124 calculates the maximum volume-average structure temperature (K) for the core middle ring ceramic over the heated length of the core.

CV 125 calculates the maximum volume-average structure temperature (K) for the core outer ring ceramic over the heated length of the core.

CV 126 calculates the maximum volume-average structure temperature (K) for the side reflector inner ring over the heated length of the core.

CV 127 calculates the maximum volume-average structure temperature (K) for the side reflector middle ring over the heated length of the core.

CV 128 calculates the maximum volume-average structure temperature (K) for the side reflector outer ring over the heated length of the core.

CV 129 calculates the maximum volume-average structure temperature (K) for the outer reflector over the heated length of the core.

CV 130 calculates the peak volume-average structure temperature (K) achieved during the simulation for the central reflector center cylinder over the heated length of the core.

CV 131 calculates the peak volume-average structure temperature (K) achieved during the simulation for the central reflector middle ring over the heated length of the core.

CV 132 calculates the peak volume-average structure temperature (K) achieved during the simulation for the central reflector outer ring over the heated length of the core.

CV 133 calculates the peak volume-average structure temperature (K) achieved during the simulation for the core inner ring ceramic over the heated length of the core.

CV 134 calculates the peak volume-average structure temperature (K) achieved during the simulation for the core middle ring ceramic over the heated length of the core.

CV 135 calculates the peak volume-average structure temperature (K) achieved during the simulation for the core outer ring ceramic over the heated length of the core.

CV 136 calculates the peak volume-average structure temperature (K) achieved during the simulation for the side reflector inner ring over the heated length of the core.

CV 137 calculates the peak volume-average structure temperature (K) achieved during the simulation for the side reflector middle ring over the heated length of the core.

CV 138 calculates the peak volume-average structure temperature (K) achieved during the simulation for the side reflector outer ring over the heated length of the core.

CV 139 calculates the peak volume-average structure temperature (K) achieved during the simulation for the outer reflector over the heated length of the core.

CV 140 calculates the maximum volume-average structure temperature (K) for the heater rod in the core inner ring.

CV 145 calculates the maximum volume-average structure temperature (K) for the heater rod in the core middle ring.

CV 150 calculates the maximum volume-average structure temperature (K) for the heater rod in the core outer ring.

CV 156 calculates the maximum volume-average structure temperature (K) for the heater rods.

CV 157 calculates the peak volume-average structure temperature (K) for the heater rods during the simulation.

CV 161 calculates the axial average structure temperature (K) for the primary pressure vessel cylinder over the core heated length.

CV 162 calculates the axial average structure temperature (K) for the core barrel over the core heated length.

CV 166 calculates the axial average structure temperature (K) for the central reflector center cylinder over the core heated length.

CV 167 calculates the axial average structure temperature (K) for the central reflector middle ring over the core heated length.

CV 168 calculates the axial average structure temperature (K) for the central reflector outer ring over the core heated length.

CV 169 calculates the axial average structure temperature (K) for the core inner ring ceramic over the core heated length.

CV 170 calculates the axial average structure temperature (K) for the core inner ring heater rod over the core heated length.

CV 171 calculates the axial average structure temperature (K) for the core middle ring ceramic over the core heated length.

CV 172 calculates the axial average structure temperature (K) for the core middle ring heater rod over the core heated length.

CV 173 calculates the axial average structure temperature (K) for the core outer ring ceramic over the core heated length.

CV 174 calculates the axial average structure temperature (K) for the core outer ring heater rod over the core heated length.

CV 175 calculates the axial average structure temperature (K) for the side reflector inner ring over the core heated length.

CV 176 calculates the axial average structure temperature (K) for the side reflector outer ring over the core heated length.

CV 177 calculates the axial average structure temperature (K) for the side reflector outer ring over the core heated length.

CV 178 calculates the axial average structure temperature (K) for the outer reflector over the core heated length.

CV 183 calculates the axial average structure temperature (K) for the front (primary pressure vessel) side of the RCCS cooling panels.

CV 184 calculates the axial average structure temperature (K) for the back side of the RCCS cooling panels.

CV 233 calculates the primary pressure vessel inlet pressure error (Pa), which is the difference between the calculated and desired steady-state pressure at the vessel inlet, Component 100.

CV 234 integrates CV 233, processing the pressure error signal. This processed signal is used to change the PCS pressure (Component 234) to achieve the desired steady-state conditions.

CV 236 calculates the primary pressure vessel outlet temperature error (K), which is the difference between the calculated and desired steady-state gas temperature in the outlet plenum, Component 175.

CV 237 integrates CV 236, processing the temperature error signal. This processed signal is used to change the PCS flow rate (Component 237) to achieve the desired steady-state conditions.

CV 275 calculates the pressure difference (Pa) between the core inlet and outlet plenums.

CV 276 calculates the pressure drop (Pa) across the primary pressure vessel.

CV 319 calculates the steam generator outlet temperature error (K), which is the difference between the calculated and desired steady-state gas temperature in the cold duct near the primary pressure vessel, volume 4 of Component 270.

CV 320 integrates CV 319, processing the temperature error signal. This processed signal is used to change the steam generator feedwater flow rate (Component 320) to achieve the desired steady-state conditions.

CV 321 integrates the feedwater flow rate, the mass flow in Component 320, to calculate the total amount of water flowing into the steam generator secondary side (kg).

CV 350 calculates the collapsed liquid level (m) in the steam generator boiler region.

CV 355 converts the collapsed liquid level from CV 350 to a level span (%) corresponding to HTTF measurement LDP-601.

CV 369 calculates the steam generator secondary pressure error (Pa), which is the difference between the calculated and desired steady-state pressure in the steam dome, Component 355.

CV 370 integrates CV 369, processing the pressure error signal. This processed signal is used to change the SCS pressure by modulating valve Component 370 to achieve the desired steady-state conditions.

CV 403 calculates the flow demand for the feedwater and RCCS systems.

CV 404 is a tripunit that has a value of 1.0 if the liquid level in the water storage tank is below the low setpoint.

CV 405 is a tripunit that has a value of -1.0 if the liquid level in the water storage tank is above the high setpoint.

CV 406 adds CV 404 and CV 405, which will provide a non-zero value if the tank liquid level is out-of-range.

CV 407 calculates a liquid level out-of-range contribution to the water storage tank flow demand signal. The amount is assumed to be 25% of the value of CV 403.

CV 408 calculates the flow demand signal for the water storage tank makeup by adding CV 403 and CV 407.

CV 409 calculates the flow error for the water storage tank makeup by subtracting the flow in Component 410 from the demand value in CV 408.

CV 410 integrates the error signal in CV 409. CV 410 is then used to modulate the valve area in Component 410, a servo valve. Minimum and maximum values of 1.0E-5 and 1.0 are specified, respectively.

CV 450 calculates the collapsed liquid level (m) in the water storage day tank (T-010).

CV 451 is a constant that provides the water storage tank low level setpoint (m).

CV 452 is a constant that provides the water storage tank high level setpoint (m).

CV 453 calculates the mid-range of the tank level setpoints by averaging CV 451 and CV 452.

CV 501 is the core differential pressure (kPa). It corresponds to HTTF measurement DP-1001.

CV 502 is the pressure difference (kPa) between the pressure vessel inlet and the hot duct. It corresponds to HTTF measurement DP-4001.

CV 503 is the pressure difference (kPa) between the pressure vessel inlet and the upper plenum. It corresponds to HTTF measurement DP-7001.

CV 504 is the pressure difference (kPa) between the pressure vessel inlet and the lower plenum. It corresponds to HTTF measurement DP-8001.

CV 505 is the pressure difference (kPa) between the pressure vessel inlet and the metallic core support structure. It corresponds to HTTF measurement DP-8002.

CV 506 is the pressure difference (kPa) between the pressure vessel inlet and the top of the upcomer. It corresponds to HTTF measurement DP-9001.

CV 507 is the pressure difference (kPa) between the RCCS panel inlet lines and the outlet lines. It corresponds to HTTF measurement DP-801.

CV 901 obtains the power (W) for heater bank 101 from Table 901.

CV 902 obtains the power (W) for heater bank 102 from Table 902.

CV 903 obtains the power (W) for heater bank 103 from Table 903.

CV 904 obtains the power (W) for heater bank 104 from Table 904.

CV 905 obtains the power (W) for heater bank 105 from Table 905.

CV 906 obtains the power (W) for heater bank 106 from Table 906.

CV 907 obtains the power (W) for heater bank 107 from Table 907.

CV 908 obtains the power (W) for heater bank 108 from Table 908.

CV 909 obtains the power (W) for heater bank 109 from Table 909.

CV 910 obtains the power (W) for heater bank 110 from Table 910.

CV 911 calculates the total core power (W) by adding CVs 901–910.

CV 912 converts the core power from CV 911 into MW.

CV 913 calculates the total energy input (MJ) during the simulation by integrating CV 912.

CV 918 is a constant that provides the desired outlet temperature (K) for the RCCS panels.

CV 919 calculates the RCCS panel coolant outlet temperature error (K).

CV 920 is a proportional-integral controller that processes the error in CV 919 to control the flow rate in the RCCS pump (Component 920).

CV 940 calculates the power input (W) to heat Structure 1403 by taking appropriate fractions of the power from the 10 heaters.

CV 945 calculates the power input (W) to heat Structure 1453 by taking appropriate fractions of the power from the 10 heaters.

CV 950 calculates the power input (W) to heat Structure 1503 by taking appropriate fractions of the power from the 10 heaters.

CV 1000 calculates the convective heat transfer (W) to the left side of the primary pressure vessel cylinder heat structure.

CV 1001 calculates the radiation heat transfer (W) to the left side of the primary pressure vessel cylinder heat structure.

CV 1002 calculates the total heat transfer (W) to the left side of the primary pressure vessel cylinder heat structure.

CV 1003 calculates the integral energy transfer (J) to the left side of the primary pressure vessel cylinder heat structure.

CV 1004 calculates the convective heat transfer (W) to the right side of the primary pressure vessel cylinder heat structure.

CV 1005 calculates the radiation heat transfer (W) to the right side of the primary pressure vessel cylinder heat structure.

CV 1006 calculates the total heat transfer (W) to the right side of the primary pressure vessel cylinder heat structure.

CV 1007 calculates the integral energy transfer (J) to the right side of the primary pressure vessel cylinder heat structure.

CV 1008 calculates the net heat transfer (W) to the primary pressure vessel cylinder heat structure.

CV 1009 calculates the integral net heat transfer (J) to the primary pressure vessel cylinder heat structure.

CV 1010 calculates the convective heat transfer (W) to the left side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1011 calculates the radiation heat transfer (W) to the left side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1012 calculates the total heat transfer (W) to the left side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1013 calculates the integral energy transfer (J) to the left side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1014 calculates the convective heat transfer (W) to the right side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1015 calculates the radiation heat transfer (W) to the right side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1016 calculates the total heat transfer (W) to the right side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1017 calculates the integral energy transfer (J) to the right side of the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1018 calculates the net heat transfer (W) to the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1019 calculates the integral net heat transfer (J) to the primary pressure vessel upper head/upper plenum shield heat structure.

CV 1020 calculates the convective heat transfer (W) to the left side of the core barrel heat structure.

CV 1021 calculates the radiation heat transfer (W) to the left side of the core barrel heat structure.

CV 1022 calculates the total heat transfer (W) to the left side of the core barrel heat structure.

CV 1023 calculates the integral energy transfer (J) to the left side of the core barrel heat structure.

CV 1024 calculates the convective heat transfer (W) to the right side of the core barrel heat structure.

CV 1025 calculates the radiation heat transfer (W) to the right side of the core barrel heat structure.

CV 1026 calculates the total heat transfer (W) to the right side of the core barrel heat structure.

CV 1027 calculates the integral energy transfer (J) to the right side of the core barrel heat structure.

CV 1028 calculates the net heat transfer (W) to the core barrel heat structure.

CV 1029 calculates the integral net heat transfer (J) to the core barrel heat structure.

CV 1030 calculates the convective heat transfer (W) to the left side of the upper plenum cylinder heat structure.

CV 1031 calculates the radiation heat transfer (W) to the left side of the upper plenum cylinder heat structure.

CV 1032 calculates the total heat transfer (W) to the left side of the upper plenum cylinder heat structure.

CV 1033 calculates the integral energy transfer (J) to the left side of the upper plenum cylinder heat structure.

CV 1034 calculates the convective heat transfer (W) to the right side of the upper plenum cylinder heat structure.

CV 1035 calculates the radiation heat transfer (W) to the right side of the upper plenum cylinder heat structure.

CV 1036 calculates the total heat transfer (W) to the right side of the upper plenum cylinder heat structure.

CV 1037 calculates the integral energy transfer (J) to the right side of the upper plenum cylinder heat structure.

CV 1038 calculates the net heat transfer (W) to the upper plenum cylinder heat structure.

CV 1039 calculates the integral net heat transfer (J) to the upper plenum cylinder heat structure.

CV 1041 calculates the conduction heat transfer (W) to the left side of the upper plenum floor heat structure.

CV 1042 calculates the total heat transfer (W) to the left side of the upper plenum floor heat structure.

CV 1043 calculates the integral energy transfer (J) to the left side of the upper plenum floor heat structure.

CV 1044 calculates the convective heat transfer (W) to the right side of the upper plenum floor heat structure.

CV 1045 calculates the radiation heat transfer (W) to the right side of the upper plenum floor heat structure.

CV 1046 calculates the total heat transfer (W) to the right side of the upper plenum floor heat structure.

CV 1047 calculates the integral energy transfer (J) to the right side of the upper plenum floor heat structure.

CV 1048 calculates the net heat transfer (W) to the upper plenum floor heat structure.

CV 1049 calculates the integral net heat transfer (J) to the upper plenum floor heat structure.

CV 1054 calculates the convective heat transfer (W) to the right side of the upper plenum internals heat structure.

CV 1055 calculates the radiation heat transfer (W) to the right side of the upper plenum internals heat structure.

CV 1056 calculates the total heat transfer (W) to the right side of the upper plenum internals heat structure.

CV 1057 calculates the integral energy transfer (J) to the right side of the upper plenum internals heat structure.

CV 1058 calculates the net heat transfer (W) to the upper plenum internals heat structure.

CV 1059 calculates the integral net heat transfer (J) to the upper plenum internals heat structure.

CV 1065 calculates the conduction heat transfer (W) to the right side of the central reflector center cylinder heat structure.

CV 1066 calculates the total heat transfer (W) to the right side of the central reflector center cylinder heat structure.

CV 1067 calculates the integral energy transfer (J) to the right side of the central reflector center cylinder heat structure.

CV 1068 calculates the net heat transfer (W) to the central reflector center cylinder heat structure.

CV 1069 calculates the integral net heat transfer (J) to the central reflector center cylinder heat structure.

CV 1070 calculates the convective heat transfer (W) to the left side of the central reflector middle ring heat structure.

CV 1071 calculates the radiation heat transfer (W) to the left side of the central reflector middle ring heat structure.

CV 1072 calculates the total heat transfer (W) to the left side of the central reflector middle ring heat structure.

CV 1073 calculates the integral energy transfer (J) to the left side of the central reflector middle ring heat structure.

CV 1075 calculates the conduction heat transfer (W) to the right side of the central reflector middle ring heat structure.

CV 1076 calculates the total heat transfer (W) to the right side of the central reflector middle ring heat structure.

CV 1077 calculates the integral energy transfer (J) to the right side of the central reflector middle ring heat structure.

CV 1078 calculates the net heat transfer (W) to the central reflector middle ring heat structure.

CV 1079 calculates the integral net heat transfer (J) to the central reflector middle ring heat structure.

CV 1081 calculates the conduction heat transfer (W) to the left side of the central reflector outer ring heat structure.

CV 1082 calculates the total heat transfer (W) to the left side of the central reflector outer ring heat structure.

CV 1083 calculates the integral energy transfer (J) to the left side of the central reflector outer ring heat structure.

CV 1085 calculates the conduction heat transfer (W) to the right side of the central reflector outer ring heat structure.

CV 1086 calculates the total heat transfer (W) to the right side of the central reflector outer ring heat structure.

CV 1087 calculates the integral energy transfer (J) to the right side of the central reflector outer ring heat structure.

CV 1088 calculates the net heat transfer (W) to the central reflector outer ring heat structure.

CV 1089 calculates the integral net heat transfer (J) to the central reflector outer ring heat structure.

CV 1090 calculates the convective heat transfer (W) to the left side of the inner core ring ceramic heat structure.

CV 1091 calculates the conduction heat transfer (W) to the left side of the inner core ring ceramic heat structure.

CV 1092 calculates the total heat transfer (W) to the left side of the inner core ring ceramic heat structure.

CV 1093 calculates the integral energy transfer (J) to the left side of the inner core ring ceramic heat structure.

CV 1094 calculates the convective heat transfer (W) to the right side of the inner core ring ceramic heat structure.

CV 1095 calculates the radiation heat transfer (W) to the right side of the inner core ring ceramic heat structure.

CV 1096 calculates the total heat transfer (W) to the right side of the inner core ring ceramic heat structure.

CV 1097 calculates the integral energy transfer (J) to the right side of the inner core ring ceramic heat structure.

CV 1098 calculates the net heat transfer (W) to the inner core ring ceramic heat structure.

CV 1099 calculates the integral net heat transfer (J) to the inner core ring ceramic heat structure.

CV 1100 calculates the convective heat transfer (W) to the left side of the middle core ring ceramic heat structure.

CV 1101 calculates the conduction heat transfer (W) to the left side of the middle core ring ceramic heat structure.

CV 1102 calculates the total heat transfer (W) to the left side of the middle core ring ceramic heat structure.

CV 1103 calculates the integral energy transfer (J) to the left side of the middle core ring ceramic heat structure.

CV 1104 calculates the convective heat transfer (W) to the right side of the middle core ring ceramic heat structure.

CV 1105 calculates the radiation heat transfer (W) to the right side of the middle core ring ceramic heat structure.

CV 1106 calculates the total heat transfer (W) to the right side of the middle core ring ceramic heat structure.

CV 1107 calculates the integral energy transfer (J) to the right side of the middle core ring ceramic heat structure.

CV 1108 calculates the net heat transfer (W) to the middle core ring ceramic heat structure.

CV 1109 calculates the integral net heat transfer (J) to the middle core ring ceramic heat structure.

CV 1110 calculates the convective heat transfer (W) to the left side of the outer core ring ceramic heat structure.

CV 1111 calculates the conduction heat transfer (W) to the left side of the outer core ring ceramic heat structure.

CV 1112 calculates the total heat transfer (W) to the left side of the outer core ring ceramic heat structure.

CV 1113 calculates the integral energy transfer (J) to the left side of the outer core ring ceramic heat structure.

CV 1114 calculates the convective heat transfer (W) to the right side of the outer core ring ceramic heat structure.

CV 1115 calculates the radiation heat transfer (W) to the right side of the outer core ring ceramic heat structure.

CV 1116 calculates the total heat transfer (W) to the right side of the outer core ring ceramic heat structure.

CV 1117 calculates the integral energy transfer (J) to the right side of the outer core ring ceramic heat structure.

CV 1118 calculates the net heat transfer (W) to the outer core ring ceramic heat structure.

CV 1119 calculates the integral net heat transfer (J) to the outer core ring ceramic heat structure.

CV 1121 calculates the conduction heat transfer (W) to the left side of the side reflector inner ring heat structure.

CV 1122 calculates the total heat transfer (W) to the left side of the side reflector inner ring heat structure.

CV 1123 calculates the integral energy transfer (J) to the left side of the side reflector inner ring heat structure.

CV 1125 calculates the conduction heat transfer (W) to the right side of the side reflector inner ring heat structure.

CV 1126 calculates the total heat transfer (W) to the right side of the side reflector inner ring heat structure.

CV 1127 calculates the integral energy transfer (J) to the right side of the side reflector inner ring heat structure.

CV 1128 calculates the net heat transfer (W) to the side reflector inner ring heat structure.

CV 1129 calculates the integral net heat transfer (J) to the side reflector inner ring heat structure.

CV 1130 calculates the convective heat transfer (W) to the left side of the side reflector middle ring heat structure.

CV 1131 calculates the conduction heat transfer (W) to the left side of the side reflector middle ring heat structure.

CV 1132 calculates the total heat transfer (W) to the left side of the side reflector middle ring heat structure.

CV 1133 calculates the integral energy transfer (J) to the left side of the side reflector middle ring heat structure.

CV 1135 calculates the conduction heat transfer (W) to the right side of the side reflector middle ring heat structure.

CV 1136 calculates the total heat transfer (W) to the right side of the side reflector middle ring heat structure.

CV 1137 calculates the integral energy transfer (J) to the right side of the side reflector middle ring heat structure.

CV 1138 calculates the net heat transfer (W) to the side reflector middle ring heat structure.

CV 1139 calculates the integral net heat transfer (J) to the side reflector middle ring heat structure.

CV 1141 calculates the conduction heat transfer (W) to the left side of the side reflector outer ring heat structure.

CV 1142 calculates the total heat transfer (W) to the left side of the side reflector outer ring heat structure.

CV 1143 calculates the integral energy transfer (J) to the left side of the side reflector outer ring heat structure.

CV 1144 calculates the convective heat transfer (W) to the right side of the side reflector outer ring heat structure.

CV 1145 calculates the radiation heat transfer (W) to the right side of the side reflector outer ring heat structure.

CV 1146 calculates the total heat transfer (W) to the right side of the side reflector outer ring heat structure.

CV 1147 calculates the integral energy transfer (J) to the right side of the side reflector outer ring heat structure.

CV 1148 calculates the net heat transfer (W) to the side reflector outer ring heat structure.

CV 1149 calculates the integral net heat transfer (J) to the side reflector outer ring heat structure.

CV 1150 calculates the convective heat transfer (W) to the left side of the outer reflector heat structure.

CV 1151 calculates the radiation heat transfer (W) to the left side of the outer reflector heat structure.

CV 1152 calculates the total heat transfer (W) to the left side of the outer reflector heat structure.

CV 1153 calculates the integral energy transfer (J) to the left side of the outer reflector heat structure.

CV 1154 calculates the convective heat transfer (W) to the right side of the outer reflector heat structure.

CV 1155 calculates the radiation heat transfer (W) to the right side of the outer reflector heat structure.

CV 1156 calculates the total heat transfer (W) to the right side of the outer reflector heat structure.

CV 1157 calculates the integral energy transfer (J) to the right side of the outer reflector heat structure.

CV 1158 calculates the net heat transfer (W) to the outer reflector heat structure.

CV 1159 calculates the integral net heat transfer (J) to the outer reflector heat structure.

CV 1160 calculates the convective heat transfer (W) to the left side of the outlet plenum bottom plate heat structure.

CV 1161 calculates the radiation heat transfer (W) to the left side of the outlet plenum bottom plate heat structure.

CV 1162 calculates the total heat transfer (W) to the left side of the outlet plenum bottom plate heat structure.

CV 1163 calculates the integral energy transfer (J) to the left side of the outlet plenum bottom plate heat structure.

CV 1164 calculates the convective heat transfer (W) to the right side of the outlet plenum bottom plate heat structure.

CV 1166 calculates the total heat transfer (W) to the right side of the outlet plenum bottom plate heat structure.

CV 1167 calculates the integral energy transfer (J) to the right side of the outlet plenum bottom plate heat structure.

CV 1168 calculates the net heat transfer (W) to the outlet plenum bottom plate heat structure.

CV 1169 calculates the integral net heat transfer (J) to the outlet plenum bottom plate heat structure.

CV 1174 calculates the convective heat transfer (W) to the right side of the outlet plenum support columns heat structure.

CV 1175 calculates the radiation heat transfer (W) to the right side of the outlet plenum support columns heat structure.

CV 1176 calculates the total heat transfer (W) to the right side of the outlet plenum support columns heat structure.

CV 1177 calculates the integral energy transfer (J) to the right side of the outlet plenum support columns heat structure.

CV 1178 calculates the net heat transfer (W) to the outlet plenum support columns heat structure.

CV 1179 calculates the integral net heat transfer (J) to the outlet plenum support columns heat structure.

CV 1180 calculates the convective heat transfer (W) to the left side of the RCCS panels front (vessel) side heat structure.

CV 1181 calculates the radiation heat transfer (W) to the left side of the RCCS panels front (vessel) side heat structure.

CV 1182 calculates the total heat transfer (W) to the left side of the RCCS panels front (vessel) side heat structure.

CV 1183 calculates the integral energy transfer (J) to the left side of the RCCS panels front (vessel) side heat structure.

CV 1184 calculates the convective heat transfer (W) to the right side of the RCCS panels front (vessel) side heat structure.

CV 1186 calculates the total heat transfer (W) to the right side of the RCCS panels front (vessel) side heat structure.

CV 1187 calculates the integral energy transfer (J) to the right side of the RCCS panels front (vessel) side heat structure.

CV 1188 calculates the net heat transfer (W) to the RCCS panels front (vessel) side heat structure.

CV 1189 calculates the integral net heat transfer (J) to the RCCS panels front (vessel) side heat structure.

CV 1190 calculates the convective heat transfer (W) to the left side of the RCCS panels back side heat structure.

CV 1192 calculates the total heat transfer (W) to the left side of the RCCS panels back side heat structure.

CV 1193 calculates the integral energy transfer (J) to the left side of the RCCS panels back side heat structure.

CV 1194 calculates the convective heat transfer (W) to the right side of the RCCS panels back side heat structure.

CV 1196 calculates the total heat transfer (W) to the right side of the RCCS panels back side heat structure.

CV 1197 calculates the integral energy transfer (J) to the right side of the RCCS panels back side heat structure.

CV 1198 calculates the net heat transfer (W) to the RCCS panels back side heat structure.

CV 1199 calculates the integral net heat transfer (J) to the RCCS panels back side heat structure.

CV 1200 calculates the convective heat transfer (W) to the left side of the primary pressure vessel lower head heat structure.

CV 1202 calculates the total heat transfer (W) to the left side of the primary pressure vessel lower head heat structure.

CV 1203 calculates the integral energy transfer (J) to the left side of the primary pressure vessel lower head heat structure.

CV 1204 calculates the convective heat transfer (W) to the right side of the primary pressure vessel lower head heat structure.

CV 1205 calculates the radiation heat transfer (W) to the right side of the primary pressure vessel lower head heat structure.

CV 1206 calculates the total heat transfer (W) to the right side of the primary pressure vessel lower head heat structure.

CV 1207 calculates the integral energy transfer (J) to the right side of the primary pressure vessel lower head heat structure.

CV 1208 calculates the net heat transfer (W) to the primary pressure vessel lower head heat structure.

CV 1209 calculates the integral net heat transfer (J) to the primary pressure vessel lower head heat structure.

CV 1215 calculates the radiation heat transfer (W) to the right side of the inner core ring heater rod heat structure.

CV 1216 calculates the total heat transfer (W) to the right side of the inner core ring heater rod heat structure.

CV 1217 calculates the integral energy transfer (J) to the right side of the inner core ring heater rod heat structure.

CV 1225 calculates the radiation heat transfer (W) to the right side of the middle core ring heater rod heat structure.

CV 1226 calculates the total heat transfer (W) to the right side of the middle core ring heater rod heat structure.

CV 1227 calculates the integral energy transfer (J) to the right side of the middle core ring heater rod heat structure.

CV 1235 calculates the radiation heat transfer (W) to the right side of the outer core ring heater rod heat structure.

CV 1236 calculates the total heat transfer (W) to the right side of the outer core ring heater rod heat structure.

CV 1237 calculates the integral energy transfer (J) to the right side of the outer core ring heater rod heat structure.

CV 1301 calculates the net heat removal (W) from the heater rods.

CV 1302 calculates the net heat removal (W) from the ceramic around the heater rods.

CV 1303 calculates the net heat removal (W) from the core ceramic blocks.

CV 1304 calculates the net heat removal (W) from the core and reflectors.

CV 1305 calculates the net heat removal (W) from the core, reflectors, and core barrel.

CV 1306 calculates the net heat removal (W) from the primary pressure vessel and its internals.

CV 1401 calculates the environmental heat loss (W) from Structure 2001.

CV 1403 calculates the environmental heat loss (W) from Structure 2150.

CV 1404 calculates the environmental heat loss (W) from Structure 2200.

CV 1405 calculates the environmental heat loss (W) from Structure 2280.

CV 1406 calculates the environmental heat loss (W) from Structure 2300.

CV 1407 calculates the environmental heat loss (W) from Structure 2350.

CV 1408 calculates the environmental heat loss (W) from Structure 2400.

CV 1409 calculates the environmental heat loss (W) from Structure 2500.

CV 1411 calculates the environmental heat loss (W) from Structure 2600.

CV 1412 calculates the environmental heat loss (W) from Structure 2700.

CV 1413 calculates the environmental heat loss (W) from Structure 2800.

CV 1414 calculates the environmental heat loss (W) from Structure 3400.

CV 1415 calculates the environmental heat loss (W) from Structure 3550.

CV 1416 calculates the environmental heat loss (W) from Structure 0100. (Only used if the control rod drive break line is active in the input model.)

CV 1417 calculates the environmental heat loss (W) from Structure 0200. (Only used if the control rod drive break line is active in the input model.)

CV 1418 calculates the environmental heat loss (W) from cells 1-40 in Structure 0300. (Only used if the control rod drive break line is active in the input model.)

CV 1419 calculates the environmental heat loss (W) from cells 41-80 in Structure 0300. (Only used if the control rod drive break line is active in the input model.)

CV 1420 calculates the environmental heat loss (W) from cells 81-92 in Structure 0300. (Only used if the control rod drive break line is active in the input model.)

CV 1421 calculates the total environmental heat loss (W) from Structure 0300. (Only used if the control rod drive break line is active in the input model.)

CV 1422 calculates the environmental heat loss (W) from cells 1-40 in Structure 0320. (Only used if the control rod drive break line is active in the input model.)

CV 1423 calculates the environmental heat loss (W) from cells 41-80 in Structure 0320. (Only used if the control rod drive break line is active in the input model.)

CV 1424 calculates the environmental heat loss (W) from cells 81-92 in Structure 0320. (Only used if the control rod drive break line is active in the input model.)

CV 1425 calculates the total environmental heat loss (W) from Structure 0320. (Only used if the control rod drive break line is active in the input model.)

CV 1426 calculates the environmental heat loss (W) from cells 1-40 in Structure 0340. (Only used if the control rod drive break line is active in the input model.)

CV 1427 calculates the environmental heat loss (W) from cells 41-80 in Structure 0340. (Only used if the control rod drive break line is active in the input model.)

CV 1428 calculates the environmental heat loss (W) from cells 81-92 in Structure 0340. (Only used if the control rod drive break line is active in the input model.)

CV 1429 calculates the total environmental heat loss (W) from Structure 0340. (Only used if the control rod drive break line is active in the input model.)

CV 1430 calculates the total environmental heat loss (W) from the control rod drive break piping. (Only used if the control rod drive break line is active in the input model.)

CV 1431 calculates the environmental heat loss (W) from cells 1-40 in Structure 0700. (Only used if the vessel bottom break line is active in the input model.)

CV 1432 calculates the environmental heat loss (W) from cells 41-73 in Structure 0700. (Only used if the vessel bottom break line is active in the input model.)

CV 1433 calculates the total environmental heat loss (W) from Structure 0700. (Only used if the vessel bottom break line is active in the input model.)

CV 1434 calculates the environmental heat loss (W) from cells 1-40 in Structure 0720. (Only used if the vessel bottom break line is active in the input model.)

CV 1435 calculates the environmental heat loss (W) from cells 41-73 in Structure 0720. (Only used if the vessel bottom break line is active in the input model.)

CV 1436 calculates the total environmental heat loss (W) from Structure 0720. (Only used if the vessel bottom break line is active in the input model.)

CV 1437 calculates the environmental heat loss (W) from cells 1-40 in Structure 0800. (Only used if the vessel bottom break line is active in the input model.)

CV 1438 calculates the environmental heat loss (W) from cells 41-80 in Structure 0800. (Only used if the vessel bottom break line is active in the input model.)

CV 1439 calculates the environmental heat loss (W) from cells 81-96 in Structure 0800. (Only used if the vessel bottom break line is active in the input model.)

CV 1440 calculates the total environmental heat loss (W) from Structure 0800. (Only used if the vessel bottom break line is active in the input model.)

CV 1441 calculates the total environmental heat loss (W) from the vessel bottom break piping. (Only used if the vessel bottom break line is active in the input model.)

CV 1444 calculates the total environmental heat loss (W) from the loop piping.

CV 1445 calculates the total environmental heat loss (W) from the steam generator body.

CV 1446 calculates the total environmental heat loss (W) from the PCS.

CV 1447 calculates the total environmental heat loss (W) from the SCS.

CV 1449 calculates the total environmental heat loss (W).

CV 1450 integrates the total environmental heat loss (J).

CV 1601 calculates the total fluid mass (kg) in Component 140.

CV 1602 calculates the total fluid mass (kg) in Component 145.

CV 1603 calculates the total fluid mass (kg) in Component 150.

CV 1604 calculates the total fluid mass (kg) in Component 132.

CV 1605 calculates the total fluid mass (kg) in Component 162.

CV 1606 calculates the total fluid mass (kg) in Component 164.

CV 1607 calculates the total fluid mass (kg) in Component 166.

CV 1608 calculates the total fluid mass (kg) in the core region.

CV 1609 calculates the total fluid mass (kg) in Component 115.

CV 1610 calculates the total fluid mass (kg) in the remaining components in the primary pressure vessel (100, 105, 110, 120, 175).

CV 1611 calculates the total fluid mass (kg) in the primary pressure vessel.

CV 1615 calculates the total fluid mass (kg) in the hot leg, Components 200 and 215.

CV 1616 calculates the total fluid mass (kg) on the primary side of the steam generator, Components 220, 225, and 228.

CV 1617 calculates the total fluid mass (kg) in the cold leg, Components 230, 235, 240, 250, 260, 270, and 293.

CV 1618 calculates the total fluid mass (kg) in the PCS piping.

CV 1619 calculates the total fluid mass (kg) in the PCS inside of the break valves (does not include the piping between the valves and the RCST or the RCST itself).

CV 1621 calculates the total fluid mass (kg) in the RCST, Components 210, 258, and 280.

CV 1626 calculates the total fluid mass (kg) in the secondary side of the steam generator, Components 340, 350, 355, and 360.

CV 1627 calculates the total fluid mass (kg) in the SCS.

CV 1631 calculates the total fluid mass (kg) in the RCCS cooling panels, Component 950.

CV 1632 calculates the total fluid mass (kg) in the RCCS.

CV 1636 calculates the total fluid mass (kg) in the water storage tank, Component 450.

CV 1637 calculates the total fluid mass (kg) in the potable water system.

CV 1640 calculates the total fluid mass (kg) in the water systems.

The CVs in the 2000s calculate various scaling parameters that can be used for comparison with the reference plant or other experiment facilities. The parameters below are taken from McEligot and McCreery 2004.

Non-dimensional heat flux: $q^+ = \beta q''_{wall} / (G c_p)$

Acceleration parameter: $K_v = 4 q^+ / Re_D$

Buoyancy parameter: $Bo^* = Gr^* / (Re_{Dh}^{3.425} Pr^{0.8})$

Some of these require average values over the heated length. These averages are calculated as the simple average of the values of those parameters in the first and last cells over the heated length.

CV 2001 calculates the pressure difference (Pa) across the heated length of Component 115.

CV 2002 calculates the average pressure (Pa) along the heated length of Component 115.

CV 2003 calculates the gas temperature difference (K) across the heated length of Component 115.

CV 2004 calculates the average gas temperature (K) along the heated length of Component 115.

CV 2005 calculates the average gas density (kg/m^3) along the heated length of Component 115.

CV 2006 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 115.

CV 2007 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 115.

CV 2008 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 115.

CV 2009 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 115.

CV 2010 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 115.

CV 2011 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 115.

CV 2012 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 115.

CV 2013 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 115.

CV 2014 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 115.

CV 2015 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 115.

CV 2016 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 115.

CV 2017 calculates the gas Reynolds number near the middle of the heated length of Component 115.

CV 2018 calculates the gas Nusselt number near the middle of the heated length of Component 115.

CV 2019 calculates the gas Prandtl number near the middle of the heated length of Component 115.

CV 2020 calculates the gas Grashof number near the middle of the heated length of Component 115.

CV 2021 calculates the gas Froude number near the middle of the heated length of Component 115.

CV 2022 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2023 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2024 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 115.

CV 2025 calculates the acceleration parameter K_v near the middle of the heated length of Component 115.

CV 2026 calculates the square of the gas Reynolds number near the middle of the heated length of Component 115.

CV 2027 calculates the gas Richardson number near the middle of the heated length of Component 115.

CV 2028 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 115. It does this by raising the square of the gas Re (CV 2026) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2029 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 115.

CV 2030 calculates the denominator for the buoyancy parameter Bo*.

CV 2031 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 115.

CV 2051 calculates the pressure difference (Pa) across the heated length of Component 132.

CV 2052 calculates the average pressure (Pa) along the heated length of Component 132.

CV 2053 calculates the gas temperature difference (K) across the heated length of Component 132.

CV 2054 calculates the average gas temperature (K) along the heated length of Component 132.

CV 2055 calculates the average gas density (kg/m^3) along the heated length of Component 132.

CV 2056 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 132.

CV 2057 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 132.

CV 2058 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 132.

CV 2059 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 132.

CV 2060 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 132.

CV 2061 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 132.

CV 2062 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 132.

CV 2063 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 132.

CV 2064 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 132.

CV 2065 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 132.

CV 2066 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 132.

CV 2067 calculates the gas Reynolds number near the middle of the heated length of Component 132.

CV 2068 calculates the gas Nusselt number near the middle of the heated length of Component 132.

CV 2069 calculates the gas Prandtl number near the middle of the heated length of Component 132.

CV 2070 calculates the gas Grashof number near the middle of the heated length of Component 132.

CV 2071 calculates the gas Froude number near the middle of the heated length of Component 132.

CV 2072 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2073 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2074 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 132.

CV 2075 calculates the acceleration parameter K_v near the middle of the heated length of Component 132.

CV 2076 calculates the square of the gas Reynolds number near the middle of the heated length of Component 132.

CV 2077 calculates the gas Richardson number near the middle of the heated length of Component 132.

CV 2078 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 132. It does this by raising the square of the gas Re (CV 2076) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2079 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 132.

CV 2080 calculates the denominator for the buoyancy parameter Bo*.

CV 2081 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 132.

CV 2101 calculates the pressure difference (Pa) across the heated length of Component 140.

CV 2102 calculates the average pressure (Pa) along the heated length of Component 140.

CV 2103 calculates the gas temperature difference (K) across the heated length of Component 140.

CV 2104 calculates the average gas temperature (K) along the heated length of Component 140.

CV 2105 calculates the average gas density (kg/m^3) along the heated length of Component 140.

CV 2106 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 140.

CV 2107 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 140.

CV 2108 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 140.

CV 2109 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 140.

CV 2110 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 140.

CV 2111 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 140.

CV 2112 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 140.

CV 2113 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 140.

CV 2114 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 140.

CV 2115 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 140.

CV 2116 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 140.

CV 2117 calculates the gas Reynolds number near the middle of the heated length of Component 140.

CV 2118 calculates the gas Nusselt number near the middle of the heated length of Component 140.

CV 2119 calculates the gas Prandtl number near the middle of the heated length of Component 140.

CV 2120 calculates the gas Grashof number near the middle of the heated length of Component 140.

CV 2121 calculates the gas Froude number near the middle of the heated length of Component1140.

CV 2122 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2123 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2124 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 140.

CV 2125 calculates the acceleration parameter K_v near the middle of the heated length of Component 140.

CV 2126 calculates the square of the gas Reynolds number near the middle of the heated length of Component 140.

CV 2127 calculates the gas Richardson number near the middle of the heated length of Component 140.

CV 2128 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 140. It does this by raising the square of the gas Re (CV 2126) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2129 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 140.

CV 2130 calculates the denominator for the buoyancy parameter Bo*.

CV 2131 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 140.

CV 2151 calculates the pressure difference (Pa) across the heated length of Component 145.

CV 2152 calculates the average pressure (Pa) along the heated length of Component 145.

CV 2153 calculates the gas temperature difference (K) across the heated length of Component 145.

CV 2154 calculates the average gas temperature (K) along the heated length of Component 145.

CV 2155 calculates the average gas density (kg/m^3) along the heated length of Component 145.

CV 2156 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 145.

CV 2157 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 145.

CV 2158 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 145.

CV 2159 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 145.

CV 2160 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 145.

CV 2161 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 145.

CV 2162 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 145.

CV 2163 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 145.

CV 2164 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 145.

CV 2165 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 145.

CV 2166 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 145.

CV 2167 calculates the gas Reynolds number near the middle of the heated length of Component 145.

CV 2168 calculates the gas Nusselt number near the middle of the heated length of Component 145.

CV 2169 calculates the gas Prandtl number near the middle of the heated length of Component 145.

CV 2170 calculates the gas Grashof number near the middle of the heated length of Component 145.

CV 2171 calculates the gas Froude number near the middle of the heated length of Component1132.

CV 2172 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2173 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2174 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 145.

CV 2175 calculates the acceleration parameter K_v near the middle of the heated length of Component 145.

CV 2176 calculates the square of the gas Reynolds number near the middle of the heated length of Component 145.

CV 2177 calculates the gas Richardson number near the middle of the heated length of Component 145.

CV 2178 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 145. It does this by raising the square of the gas Re (CV 2176) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2179 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 145.

CV 2180 calculates the denominator for the buoyancy parameter Bo*.

CV 2181 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 145.

CV 2201 calculates the pressure difference (Pa) across the heated length of Component 150.

CV 2202 calculates the average pressure (Pa) along the heated length of Component 150.

CV 2203 calculates the gas temperature difference (K) across the heated length of Component 150.

CV 2204 calculates the average gas temperature (K) along the heated length of Component 150.

CV 2205 calculates the average gas density (kg/m^3) along the heated length of Component 150.

CV 2206 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 150.

CV 2207 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 150.

CV 2208 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 150.

CV 2209 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 150.

CV 2210 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 150.

CV 2211 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 150.

CV 2212 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 150.

CV 2213 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 150.

CV 2214 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 150.

CV 2215 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 150.

CV 2216 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 150.

CV 2217 calculates the gas Reynolds number near the middle of the heated length of Component 150.

CV 2218 calculates the gas Nusselt number near the middle of the heated length of Component 150.

CV 2219 calculates the gas Prandtl number near the middle of the heated length of Component 150.

CV 2220 calculates the gas Grashof number near the middle of the heated length of Component 150.

CV 2221 calculates the gas Froude number near the middle of the heated length of Component1150.

CV 2222 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2223 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2224 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 150.

CV 2225 calculates the acceleration parameter K_v near the middle of the heated length of Component 150.

CV 2226 calculates the square of the gas Reynolds number near the middle of the heated length of Component 150.

CV 2227 calculates the gas Richardson number near the middle of the heated length of Component 150.

CV 2228 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 150. It does this by raising the square of the gas Re (CV 2226) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2229 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 150.

CV 2230 calculates the denominator for the buoyancy parameter Bo*.

CV 2231 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 150.

CV 2251 calculates the pressure difference (Pa) across the heated length of Component 162.

CV 2252 calculates the average pressure (Pa) along the heated length of Component 162.

CV 2253 calculates the gas temperature difference (K) across the heated length of Component 162.

CV 2254 calculates the average gas temperature (K) along the heated length of Component 162.

CV 2255 calculates the average gas density (kg/m^3) along the heated length of Component 162.

CV 2256 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 162.

CV 2257 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 162.

CV 2258 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 162.

CV 2259 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 162.

CV 2260 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 162.

CV 2261 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 162.

CV 2262 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 162.

CV 2263 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 162.

CV 2264 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 162.

CV 2265 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 162.

CV 2266 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 162.

CV 2267 calculates the gas Reynolds number near the middle of the heated length of Component 162.

CV 2268 calculates the gas Nusselt number near the middle of the heated length of Component 162.

CV 2269 calculates the gas Prandtl number near the middle of the heated length of Component 162.

CV 2270 calculates the gas Grashof number near the middle of the heated length of Component 162.

CV 2271 calculates the gas Froude number near the middle of the heated length of Component1132.

CV 2272 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2273 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2274 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 162.

CV 2275 calculates the acceleration parameter K_v near the middle of the heated length of Component 162.

CV 2276 calculates the square of the gas Reynolds number near the middle of the heated length of Component 162.

CV 2277 calculates the gas Richardson number near the middle of the heated length of Component 162.

CV 2278 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 162. It does this by raising the square of the gas Re (CV 2276) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2279 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 162.

CV 2280 calculates the denominator for the buoyancy parameter Bo*.

CV 2281 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 162.

CV 2301 calculates the pressure difference (Pa) across the heated length of Component 164.

CV 2302 calculates the average pressure (Pa) along the heated length of Component 164.

CV 2303 calculates the gas temperature difference (K) across the heated length of Component 164.

CV 2304 calculates the average gas temperature (K) along the heated length of Component 164.

CV 2305 calculates the average gas density (kg/m^3) along the heated length of Component 164.

CV 2306 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 164.

CV 2307 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 164.

CV 2308 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 164.

CV 2309 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 164.

CV 2310 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 164.

CV 2311 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 164.

CV 2312 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 164.

CV 2313 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 164.

CV 2314 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 164.

CV 2315 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 164.

CV 2316 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 164.

CV 2317 calculates the gas Reynolds number near the middle of the heated length of Component 164.

CV 2318 calculates the gas Nusselt number near the middle of the heated length of Component 164.

CV 2319 calculates the gas Prandtl number near the middle of the heated length of Component 164.

CV 2320 calculates the gas Grashof number near the middle of the heated length of Component 164.

CV 2321 calculates the gas Froude number near the middle of the heated length of Component1150.

CV 2322 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2323 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2324 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 164.

CV 2325 calculates the acceleration parameter K_v near the middle of the heated length of Component 164.

CV 2326 calculates the square of the gas Reynolds number near the middle of the heated length of Component 164.

CV 2327 calculates the gas Richardson number near the middle of the heated length of Component 164.

CV 2328 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 164. It does this by raising the square of the gas Re (CV 2326) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2329 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 164.

CV 2330 calculates the denominator for the buoyancy parameter Bo*.

CV 2331 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 164.

CV 2351 calculates the pressure difference (Pa) across the heated length of Component 166.

CV 2352 calculates the average pressure (Pa) along the heated length of Component 166.

CV 2353 calculates the gas temperature difference (K) across the heated length of Component 166.

CV 2354 calculates the average gas temperature (K) along the heated length of Component 166.

CV 2355 calculates the average gas density (kg/m^3) along the heated length of Component 166.

CV 2356 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 166.

CV 2357 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 166.

CV 2358 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 166.

CV 2359 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 166.

CV 2360 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 166.

CV 2361 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 166.

CV 2362 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 166.

CV 2363 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 166.

CV 2364 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 166.

CV 2365 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 166.

CV 2366 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 166.

CV 2367 calculates the gas Reynolds number near the middle of the heated length of Component 166.

CV 2368 calculates the gas Nusselt number near the middle of the heated length of Component 166.

CV 2369 calculates the gas Prandtl number near the middle of the heated length of Component 166.

CV 2370 calculates the gas Grashof number near the middle of the heated length of Component 166.

CV 2371 calculates the gas Froude number near the middle of the heated length of Component1132.

CV 2372 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2373 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2374 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 166.

CV 2375 calculates the acceleration parameter K_v near the middle of the heated length of Component 166.

CV 2376 calculates the square of the gas Reynolds number near the middle of the heated length of Component 166.

CV 2377 calculates the gas Richardson number near the middle of the heated length of Component 166.

CV 2378 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 166. It does this by raising the square of the gas Re (CV 2376) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2379 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 166.

CV 2380 calculates the denominator for the buoyancy parameter Bo*.

CV 2381 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 166.

CV 2401 calculates the pressure difference (Pa) across the heated length of Component 950.

CV 2402 calculates the average pressure (Pa) along the heated length of Component 950.

CV 2403 calculates the gas temperature difference (K) across the heated length of Component 950.

CV 2404 calculates the average gas temperature (K) along the heated length of Component 950.

CV 2405 calculates the average gas density (kg/m^3) along the heated length of Component 950.

CV 2406 calculates the gas specific heat capacity (J/kg-K) at the inlet of the heated length of Component 950.

CV 2407 calculates the gas specific heat capacity (J/kg-K) at the outlet of the heated length of Component 950.

CV 2408 calculates the average gas specific heat capacity (J/kg-K) along the heated length of Component 950.

CV 2409 calculates the gas viscosity (kg/m-s) near the middle of the heated length of Component 950.

CV 2410 calculates the reciprocal gas viscosity (m-s/kg) near the middle of the heated length of Component 950.

CV 2411 calculates the gas thermal expansion coefficient (1/ K) near the middle of the heated length of Component 950.

CV 2412 calculates the gas specific heat capacity (J/kg-K) near the middle of the heated length of Component 950.

CV 2413 calculates the gas thermal conductivity (W/m-K) near the middle of the heated length of Component 950.

CV 2414 calculates the reciprocal gas thermal conductivity (m-K/W) near the middle of the heated length of Component 950.

CV 2415 calculates the wall-to-gas temperature difference (K) near the middle of the heated length of Component 950.

CV 2416 calculates the gas mass flux (kg/m^2-s) near the middle of the heated length of Component 950.

CV 2417 calculates the gas Reynolds number near the middle of the heated length of Component 950.

CV 2418 calculates the gas Nusselt number near the middle of the heated length of Component 950.

CV 2419 calculates the gas Prandtl number near the middle of the heated length of Component 950.

CV 2420 calculates the gas Grashof number near the middle of the heated length of Component 950.

CV 2421 calculates the gas Froude number near the middle of the heated length of Component1150.

CV 2422 calculates the numerator for the non-dimensional heat flux parameter q^+.

CV 2423 calculates the denominator for the non-dimensional heat flux parameter q^+.

CV 2424 calculates the non-dimensional heat flux parameter q^+ near the middle of the heated length of Component 950.

CV 2425 calculates the acceleration parameter K_v near the middle of the heated length of Component 950.

CV 2426 calculates the square of the gas Reynolds number near the middle of the heated length of Component 950.

CV 2427 calculates the gas Richardson number near the middle of the heated length of Component 950.

CV 2428 calculates the gas $Re^{3.425}$ near the middle of the heated length of Component 950. It does this by raising the square of the gas Re (CV 2426) to the 1.7125 (=3.425/2) power to protect against trying to raise a negative number to a real power.

CV 2429 calculates the gas $Pr^{0.8}$ near the middle of the heated length of Component 950.

CV 2430 calculates the denominator for the buoyancy parameter Bo*.

CV 2431 calculates the buoyancy parameter Bo* near the middle of the heated length of Component 950.

The 3000 series CVs are intended to provide an approximation of the stored energy of the system. The volumetric heat capacity is in MJ/m^3-K and the stored energy is in MJ.

CV 3001 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 1.

CV 3002 calculates the stored energy (MJ) in Structure 1000, axial node 1.

CV 3003 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 2.

CV 3004 calculates the stored energy (MJ) in Structure 1000, axial node 2.

CV 3005 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 3.

CV 3006 calculates the stored energy (MJ) in Structure 1000, axial node 3.

CV 3007 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 4.

CV 3008 calculates the stored energy (MJ) in Structure 1000, axial node 4.

CV 3009 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 5.

CV 3010 calculates the stored energy (MJ) in Structure 1000, axial node 5.

CV 3011 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 6.

CV 3012 calculates the stored energy (MJ) in Structure 1000, axial node 6.

CV 3013 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 7.

CV 3014 calculates the stored energy (MJ) in Structure 1000, axial node 7.

CV 3015 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 8.

CV 3016 calculates the stored energy (MJ) in Structure 1000, axial node 8.

CV 3017 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 9.

CV 3018 calculates the stored energy (MJ) in Structure 1000, axial node 9.

CV 3019 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 10.

CV 3020 calculates the stored energy (MJ) in Structure 1000, axial node 10.

CV 3021 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 11.

CV 3022 calculates the stored energy (MJ) in Structure 1000, axial node 11.

CV 3023 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 12.

CV 3024 calculates the stored energy (MJ) in Structure 1000, axial node 12.

CV 3025 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 13.

CV 3026 calculates the stored energy (MJ) in Structure 1000, axial node 13.

CV 3027 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 14.

CV 3028 calculates the stored energy (MJ) in Structure 1000, axial node 14.

CV 3029 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 15.

CV 3030 calculates the stored energy (MJ) in Structure 1000, axial node 15.

CV 3031 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 16.

CV 3032 calculates the stored energy (MJ) in Structure 1000, axial node 16.

CV 3033 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1000, axial node 17.

CV 3034 calculates the stored energy (MJ) in Structure 1000, axial node 17.

CV 3035 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1001, axial node 1.

CV 3036 calculates the stored energy (MJ) in Structure 1001, axial node 1.

CV 3038 calculates the stored energy (MJ) in the pressure vessel cylinder and head, Structures 1000 and 1001.

CV 3041 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1050, axial node 1.

CV 3042 calculates the stored energy (MJ) in Structure 1050, axial node 1.

CV 3043 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1100, axial node 1.

CV 3044 calculates the stored energy (MJ) in Structure 1100, axial node 1.

CV 3049 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 1.

CV 3050 calculates the stored energy (MJ) in Structure 1150, axial node 1.

CV 3051 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 2.

CV 3052 calculates the stored energy (MJ) in Structure 1150, axial node 2.

CV 3053 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 3.

CV 3054 calculates the stored energy (MJ) in Structure 1150, axial node 3.

CV 3055 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 4.

CV 3056 calculates the stored energy (MJ) in Structure 1150, axial node 4.

CV 3057 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 5.

CV 3058 calculates the stored energy (MJ) in Structure 1150, axial node 5.

CV 3059 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 6.

CV 3060 calculates the stored energy (MJ) in Structure 1150, axial node 6.

CV 3061 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 7.

CV 3062 calculates the stored energy (MJ) in Structure 1150, axial node 7.

CV 3063 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 8.

CV 3064 calculates the stored energy (MJ) in Structure 1150, axial node 8.

CV 3065 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 9.

CV 3066 calculates the stored energy (MJ) in Structure 1150, axial node 9.

CV 3067 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 10.

CV 3068 calculates the stored energy (MJ) in Structure 1150, axial node 10.

CV 3069 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 11.

CV 3070 calculates the stored energy (MJ) in Structure 1150, axial node 11.

CV 3071 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 12.

CV 3072 calculates the stored energy (MJ) in Structure 1150, axial node 12.

CV 3073 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 13.

CV 3074 calculates the stored energy (MJ) in Structure 1150, axial node 13.

CV 3075 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 14.

CV 3076 calculates the stored energy (MJ) in Structure 1150, axial node 14.

CV 3077 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 15.

CV 3078 calculates the stored energy (MJ) in Structure 1150, axial node 15.

CV 3079 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1150, axial node 16.

CV 3080 calculates the stored energy (MJ) in Structure 1150, axial node 16.

CV 3081 calculates the stored energy (MJ) in the core barrel, Structure 1150.

CV 3083 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1200, axial node 1.

CV 3084 calculates the stored energy (MJ) in Structure 1200, axial node 1.

CV 3085 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1201, axial node 1.

CV 3086 calculates the stored energy (MJ) in Structure 1201, axial node 1.

CV 3087 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1202, axial node 1.

CV 3088 calculates the stored energy (MJ) in Structure 1202, axial node 1.

CV 3091 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 1.

CV 3092 calculates the stored energy (MJ) in Structure 1300, axial node 1.

CV 3093 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 2.

CV 3094 calculates the stored energy (MJ) in Structure 1300, axial node 2.

CV 3095 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 3.

CV 3096 calculates the stored energy (MJ) in Structure 1300, axial node 3.

CV 3097 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 4.

CV 3098 calculates the stored energy (MJ) in Structure 1300, axial node 4.

CV 3099 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 5.

CV 3100 calculates the stored energy (MJ) in Structure 1300, axial node 5.

CV 3101 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 6.

CV 3102 calculates the stored energy (MJ) in Structure 1300, axial node 6.

CV 3103 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 7.

CV 3104 calculates the stored energy (MJ) in Structure 1300, axial node 7.

CV 3105 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 8.

CV 3106 calculates the stored energy (MJ) in Structure 1300, axial node 8.

CV 3107 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 9.

CV 3108 calculates the stored energy (MJ) in Structure 1300, axial node 9.

CV 3109 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 10.

CV 3110 calculates the stored energy (MJ) in Structure 1300, axial node 10.

CV 3111 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 11.

CV 3112 calculates the stored energy (MJ) in Structure 1300, axial node 11.

CV 3113 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 12.

CV 3114 calculates the stored energy (MJ) in Structure 1300, axial node 12.

CV 3115 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 13.

CV 3116 calculates the stored energy (MJ) in Structure 1300, axial node 13.

CV 3117 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1300, axial node 14.

CV 3118 calculates the stored energy (MJ) in Structure 1300, axial node 14.

CV 3121 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 1.

CV 3122 calculates the stored energy (MJ) in Structure 1320, axial node 1.

CV 3123 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 2.

CV 3124 calculates the stored energy (MJ) in Structure 1320, axial node 2.

CV 3125 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 3.

CV 3126 calculates the stored energy (MJ) in Structure 1320, axial node 3.

CV 3127 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 4.

CV 3128 calculates the stored energy (MJ) in Structure 1320, axial node 4.

CV 3129 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 5.

CV 3130 calculates the stored energy (MJ) in Structure 1320, axial node 5.

CV 3131 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 6.

CV 3132 calculates the stored energy (MJ) in Structure 1320, axial node 6.

CV 3133 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 7.

CV 3134 calculates the stored energy (MJ) in Structure 1320, axial node 7.

CV 3135 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 8.

CV 3136 calculates the stored energy (MJ) in Structure 1320, axial node 8.

CV 3137 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 9.

CV 3138 calculates the stored energy (MJ) in Structure 1320, axial node 9.

CV 3139 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 10.

CV 3140 calculates the stored energy (MJ) in Structure 1320, axial node 10.

CV 3141 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 11.

CV 3142 calculates the stored energy (MJ) in Structure 1320, axial node 11.

CV 3143 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 12.

CV 3144 calculates the stored energy (MJ) in Structure 1320, axial node 12.

CV 3145 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 13.

CV 3146 calculates the stored energy (MJ) in Structure 1320, axial node 13.

CV 3147 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1320, axial node 14.

CV 3148 calculates the stored energy (MJ) in Structure 1320, axial node 14.

CV 3151 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 1.

CV 3152 calculates the stored energy (MJ) in Structure 1340, axial node 1.

CV 3153 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 2.

CV 3154 calculates the stored energy (MJ) in Structure 1340, axial node 2.

CV 3155 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 3.

CV 3156 calculates the stored energy (MJ) in Structure 1340, axial node 3.

CV 3157 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 4.

CV 3158 calculates the stored energy (MJ) in Structure 1340, axial node 4.

CV 3159 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 5.

CV 3160 calculates the stored energy (MJ) in Structure 1340, axial node 5.

CV 3161 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 6.

CV 3162 calculates the stored energy (MJ) in Structure 1340, axial node 6.

CV 3163 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 7.

CV 3164 calculates the stored energy (MJ) in Structure 1340, axial node 7.

CV 3165 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 8.

CV 3166 calculates the stored energy (MJ) in Structure 1340, axial node 8.

CV 3167 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 9.

CV 3168 calculates the stored energy (MJ) in Structure 1340, axial node 9.

CV 3169 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 10.

CV 3170 calculates the stored energy (MJ) in Structure 1340, axial node 10.

CV 3171 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 11.

CV 3172 calculates the stored energy (MJ) in Structure 1340, axial node 11.

CV 3173 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 12.

CV 3174 calculates the stored energy (MJ) in Structure 1340, axial node 12.

CV 3175 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 13.

CV 3176 calculates the stored energy (MJ) in Structure 1340, axial node 13.

CV 3177 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1340, axial node 14.

CV 3178 calculates the stored energy (MJ) in Structure 1340, axial node 14.

CV 3179 calculates the stored energy (MJ) in the central reflector, Structures 1300, 1320, and 1340.

CV 3181 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1400, axial node 1.

CV 3182 calculates the stored energy (MJ) in Structure 1400, axial node 1.

CV 3183 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1400, axial node 2.

CV 3184 calculates the stored energy (MJ) in Structure 1400, axial node 2.

CV 3185 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 1.

CV 3186 calculates the stored energy (MJ) in Structure 1401, axial node 1.

CV 3187 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 2.

CV 3188 calculates the stored energy (MJ) in Structure 1401, axial node 2.

CV 3189 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 3.

CV 3190 calculates the stored energy (MJ) in Structure 1401, axial node 3.

CV 3191 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 4.

CV 3192 calculates the stored energy (MJ) in Structure 1401, axial node 4.

CV 3193 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 5.

CV 3194 calculates the stored energy (MJ) in Structure 1401, axial node 5.

CV 3195 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 6.

CV 3196 calculates the stored energy (MJ) in Structure 1401, axial node 6.

CV 3197 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 7.

CV 3198 calculates the stored energy (MJ) in Structure 1401, axial node 7.

CV 3199 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 8.

CV 3200 calculates the stored energy (MJ) in Structure 1401, axial node 8.

CV 3201 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 9.

CV 3202 calculates the stored energy (MJ) in Structure 1401, axial node 9.

CV 3203 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1401, axial node 10.

CV 3204 calculates the stored energy (MJ) in Structure 1401, axial node 10.

CV 3205 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1402, axial node 1.

CV 3206 calculates the stored energy (MJ) in Structure 1402, axial node 1.

CV 3207 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1402, axial node 2.

CV 3208 calculates the stored energy (MJ) in Structure 1402, axial node 2.

CV 3211 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1450, axial node 1.

CV 3212 calculates the stored energy (MJ) in Structure 1450, axial node 1.

CV 3213 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1450, axial node 2.

CV 3214 calculates the stored energy (MJ) in Structure 1450, axial node 2.

CV 3215 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 1.

CV 3216 calculates the stored energy (MJ) in Structure 1451, axial node 1.

CV 3217 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 2.

CV 3218 calculates the stored energy (MJ) in Structure 1451, axial node 2.

CV 3219 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 3.

CV 3220 calculates the stored energy (MJ) in Structure 1451, axial node 3.

CV 3221 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 4.

CV 3222 calculates the stored energy (MJ) in Structure 1451, axial node 4.

CV 3223 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 5.

CV 3224 calculates the stored energy (MJ) in Structure 1451, axial node 5.

CV 3225 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 6.

CV 3226 calculates the stored energy (MJ) in Structure 1451, axial node 6.

CV 3227 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 7.

CV 3228 calculates the stored energy (MJ) in Structure 1451, axial node 7.

CV 3229 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 8.

CV 3230 calculates the stored energy (MJ) in Structure 1451, axial node 8.

CV 3231 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 9.

CV 3232 calculates the stored energy (MJ) in Structure 1451, axial node 9.

CV 3233 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1451, axial node 10.

CV 3234 calculates the stored energy (MJ) in Structure 1451, axial node 10.

CV 3235 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1452, axial node 1.

CV 3236 calculates the stored energy (MJ) in Structure 1452, axial node 1.

CV 3237 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1452, axial node 2.

CV 3238 calculates the stored energy (MJ) in Structure 1452, axial node 2.

CV 3241 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1500, axial node 1.

CV 3242 calculates the stored energy (MJ) in Structure 1500, axial node 1.

CV 3243 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1500, axial node 2.

CV 3244 calculates the stored energy (MJ) in Structure 1500, axial node 2.

CV 3245 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 1.

CV 3246 calculates the stored energy (MJ) in Structure 1501, axial node 1.

CV 3247 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 2.

CV 3248 calculates the stored energy (MJ) in Structure 1501, axial node 2.

CV 3249 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 3.

CV 3250 calculates the stored energy (MJ) in Structure 1501, axial node 3.

CV 3251 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 4.

CV 3252 calculates the stored energy (MJ) in Structure 1501, axial node 4.

CV 3253 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 5.

CV 3254 calculates the stored energy (MJ) in Structure 1501, axial node 5.

CV 3255 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 6.

CV 3256 calculates the stored energy (MJ) in Structure 1501, axial node 6.

CV 3257 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 7.

CV 3258 calculates the stored energy (MJ) in Structure 1501, axial node 7.

CV 3259 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 8.

CV 3260 calculates the stored energy (MJ) in Structure 1501, axial node 8.

CV 3261 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 9.

CV 3262 calculates the stored energy (MJ) in Structure 1501, axial node 9.

CV 3263 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1501, axial node 10.

CV 3264 calculates the stored energy (MJ) in Structure 1501, axial node 10.

CV 3265 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1502, axial node 1.

CV 3266 calculates the stored energy (MJ) in Structure 1502, axial node 1.

CV 3267 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1502, axial node 2.

CV 3268 calculates the stored energy (MJ) in Structure 1502, axial node 2.

CV 3269 calculates the stored energy (MJ) in the core ceramic, Structures 1400, 1401, 1402, 1450, 1451, 1452, 1500, 1501, and 1502.

CV 3271 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 1.

CV 3272 calculates the stored energy (MJ) in Structure 1403, axial node 1.

CV 3273 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 2.

CV 3274 calculates the stored energy (MJ) in Structure 1403, axial node 2.

CV 3275 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 3.

CV 3276 calculates the stored energy (MJ) in Structure 1403, axial node 3.

CV 3277 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 4.

CV 3278 calculates the stored energy (MJ) in Structure 1403, axial node 4.

CV 3279 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 5.

CV 3280 calculates the stored energy (MJ) in Structure 1403, axial node 5.

CV 3281 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 6.

CV 3282 calculates the stored energy (MJ) in Structure 1403, axial node 6.

CV 3283 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 7.

CV 3284 calculates the stored energy (MJ) in Structure 1403, axial node 7.

CV 3285 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 8.

CV 3286 calculates the stored energy (MJ) in Structure 1403, axial node 8.

CV 3287 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 9.

CV 3288 calculates the stored energy (MJ) in Structure 1403, axial node 9.

CV 3289 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1403, axial node 10.

CV 3290 calculates the stored energy (MJ) in Structure 1403, axial node 10.

CV 3291 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 1.

CV 3292 calculates the stored energy (MJ) in Structure 1453, axial node 1.

CV 3293 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 2.

CV 3294 calculates the stored energy (MJ) in Structure 1453, axial node 2.

CV 3295 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 3.

CV 3296 calculates the stored energy (MJ) in Structure 1453, axial node 3.

CV 3297 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 4.

CV 3298 calculates the stored energy (MJ) in Structure 1453, axial node 4.

CV 3299 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 5.

CV 3300 calculates the stored energy (MJ) in Structure 1453, axial node 5.

CV 3301 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 6.

CV 3302 calculates the stored energy (MJ) in Structure 1453, axial node 6.

CV 3303 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 7.

CV 3304 calculates the stored energy (MJ) in Structure 1453, axial node 7.

CV 3305 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 8.

CV 3306 calculates the stored energy (MJ) in Structure 1453, axial node 8.

CV 3307 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 9.

CV 3308 calculates the stored energy (MJ) in Structure 1453, axial node 9.

CV 3309 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1453, axial node 10.

CV 3310 calculates the stored energy (MJ) in Structure 1453, axial node 10.

CV 3311 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 1.

CV 3312 calculates the stored energy (MJ) in Structure 1503, axial node 1.

CV 3313 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 2.

CV 3314 calculates the stored energy (MJ) in Structure 1503, axial node 2.

CV 3315 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 3.

CV 3316 calculates the stored energy (MJ) in Structure 1503, axial node 3.

CV 3317 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 4.

CV 3318 calculates the stored energy (MJ) in Structure 1503, axial node 4.

CV 3319 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 5.

CV 3320 calculates the stored energy (MJ) in Structure 1503, axial node 5.

CV 3321 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 6.

CV 3322 calculates the stored energy (MJ) in Structure 1503, axial node 6.

CV 3323 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 7.

CV 3324 calculates the stored energy (MJ) in Structure 1503, axial node 7.

CV 3325 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 8.

CV 3326 calculates the stored energy (MJ) in Structure 1503, axial node 8.

CV 3327 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 9.

CV 3328 calculates the stored energy (MJ) in Structure 1503, axial node 9.

CV 3329 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1503, axial node 10.

CV 3330 calculates the stored energy (MJ) in Structure 1503, axial node 10.

CV 3331 calculates the stored energy (MJ) in the heater rods, Structures 1403, 1453, and 1503.

CV 3341 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 1.

CV 3342 calculates the stored energy (MJ) in Structure 1600, axial node 1.

CV 3343 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 2.

CV 3344 calculates the stored energy (MJ) in Structure 1600, axial node 2.

CV 3345 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 3.

CV 3346 calculates the stored energy (MJ) in Structure 1600, axial node 3.

CV 3347 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 4.

CV 3348 calculates the stored energy (MJ) in Structure 1600, axial node 4.

CV 3349 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 5.

CV 3350 calculates the stored energy (MJ) in Structure 1600, axial node 5.

CV 3351 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 6.

CV 3352 calculates the stored energy (MJ) in Structure 1600, axial node 6.

CV 3353 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 7.

CV 3354 calculates the stored energy (MJ) in Structure 1600, axial node 7.

CV 3355 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 8.

CV 3356 calculates the stored energy (MJ) in Structure 1600, axial node 8.

CV 3357 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 9.

CV 3358 calculates the stored energy (MJ) in Structure 1600, axial node 9.

CV 3359 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 10.

CV 3360 calculates the stored energy (MJ) in Structure 1600, axial node 10.

CV 3361 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 11.

CV 3362 calculates the stored energy (MJ) in Structure 1600, axial node 11.

CV 3363 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 12.

CV 3364 calculates the stored energy (MJ) in Structure 1600, axial node 12.

CV 3365 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 13.

CV 3366 calculates the stored energy (MJ) in Structure 1600, axial node 13.

CV 3367 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1600, axial node 14.

CV 3368 calculates the stored energy (MJ) in Structure 1600, axial node 14.

CV 3371 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 1.

CV 3372 calculates the stored energy (MJ) in Structure 1620, axial node 1.

CV 3373 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 2.

CV 3374 calculates the stored energy (MJ) in Structure 1620, axial node 2.

CV 3375 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 3.

CV 3376 calculates the stored energy (MJ) in Structure 1620, axial node 3.

CV 3377 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 4.

CV 3378 calculates the stored energy (MJ) in Structure 1620, axial node 4.

CV 3379 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 5.

CV 3380 calculates the stored energy (MJ) in Structure 1620, axial node 5.

CV 3381 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 6.

CV 3382 calculates the stored energy (MJ) in Structure 1620, axial node 6.

CV 3383 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 7.

CV 3384 calculates the stored energy (MJ) in Structure 1620, axial node 7.

CV 3385 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 8.

CV 3386 calculates the stored energy (MJ) in Structure 1620, axial node 8.

CV 3387 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 9.

CV 3388 calculates the stored energy (MJ) in Structure 1620, axial node 9.

CV 3389 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 10.

CV 3390 calculates the stored energy (MJ) in Structure 1620, axial node 10.

CV 3391 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 11.

CV 3392 calculates the stored energy (MJ) in Structure 1620, axial node 11.

CV 3393 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 12.

CV 3394 calculates the stored energy (MJ) in Structure 1620, axial node 12.

CV 3395 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 13.

CV 3396 calculates the stored energy (MJ) in Structure 1620, axial node 13.

CV 3397 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1620, axial node 14.

CV 3398 calculates the stored energy (MJ) in Structure 1620, axial node 14.

CV 3401 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 1.

CV 3402 calculates the stored energy (MJ) in Structure 1640, axial node 1.

CV 3403 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 2.

CV 3404 calculates the stored energy (MJ) in Structure 1640, axial node 2.

CV 3405 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 3.

CV 3406 calculates the stored energy (MJ) in Structure 1640, axial node 3.

CV 3407 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 4.

CV 3408 calculates the stored energy (MJ) in Structure 1640, axial node 4.

CV 3409 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 5.

CV 3410 calculates the stored energy (MJ) in Structure 1640, axial node 5.

CV 3411 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 6.

CV 3412 calculates the stored energy (MJ) in Structure 1640, axial node 6.

CV 3413 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 7.

CV 3414 calculates the stored energy (MJ) in Structure 1640, axial node 7.

CV 3415 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 8.

CV 3416 calculates the stored energy (MJ) in Structure 1640, axial node 8.

CV 3417 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 9.

CV 3418 calculates the stored energy (MJ) in Structure 1640, axial node 9.

CV 3419 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 10.

CV 3420 calculates the stored energy (MJ) in Structure 1640, axial node 10.

CV 3421 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 11.

CV 3422 calculates the stored energy (MJ) in Structure 1640, axial node 11.

CV 3423 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 12.

CV 3424 calculates the stored energy (MJ) in Structure 1640, axial node 12.

CV 3425 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 13.

CV 3426 calculates the stored energy (MJ) in Structure 1640, axial node 13.

CV 3427 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1640, axial node 14.

CV 3428 calculates the stored energy (MJ) in Structure 1640, axial node 14.

CV 3429 calculates the stored energy (MJ) in the side reflector, Structures 1600, 1620, and 1640.

CV 3431 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 1.

CV 3432 calculates the stored energy (MJ) in Structure 1660, axial node 1.

CV 3433 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 2.

CV 3434 calculates the stored energy (MJ) in Structure 1660, axial node 2.

CV 3435 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 3.

CV 3436 calculates the stored energy (MJ) in Structure 1660, axial node 3.

CV 3437 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 4.

CV 3438 calculates the stored energy (MJ) in Structure 1660, axial node 4.

CV 3439 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 5.

CV 3440 calculates the stored energy (MJ) in Structure 1660, axial node 5.

CV 3441 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 6.

CV 3442 calculates the stored energy (MJ) in Structure 1660, axial node 6.

CV 3443 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 7.

CV 3444 calculates the stored energy (MJ) in Structure 1660, axial node 7.

CV 3445 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 8.

CV 3446 calculates the stored energy (MJ) in Structure 1660, axial node 8.

CV 3447 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 9.

CV 3448 calculates the stored energy (MJ) in Structure 1660, axial node 9.

CV 3449 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 10.

CV 3450 calculates the stored energy (MJ) in Structure 1660, axial node 10.

CV 3451 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 11.

CV 3452 calculates the stored energy (MJ) in Structure 1660, axial node 11.

CV 3453 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 12.

CV 3454 calculates the stored energy (MJ) in Structure 1660, axial node 12.

CV 3455 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 13.

CV 3456 calculates the stored energy (MJ) in Structure 1660, axial node 13.

CV 3457 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1660, axial node 14.

CV 3458 calculates the stored energy (MJ) in Structure 1660, axial node 14.

CV 3459 calculates the stored energy (MJ) in the outer reflector, Structure 1660.

CV 3461 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1750, axial node 1.

CV 3462 calculates the stored energy (MJ) in Structure 1750, axial node 1.

CV 3463 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 1751, axial node 1.

CV 3464 calculates the stored energy (MJ) in Structure 1751, axial node 1.

CV 3466 calculates the stored energy (MJ) in the core region inside the core barrel.

CV 3468 calculates the stored energy (MJ) in the primary pressure vessel.

CV 3471 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2000, axial node 1.

CV 3472 calculates the stored energy (MJ) in Structure 2000, axial node 1.

CV 3473 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2000, axial node 2.

CV 3474 calculates the stored energy (MJ) in Structure 2000, axial node 2.

CV 3475 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2000, axial node 3.

CV 3476 calculates the stored energy (MJ) in Structure 2000, axial node 3.

CV 3477 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2000, axial node 4.

CV 3478 calculates the stored energy (MJ) in Structure 2000, axial node 4.

CV 3479 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2001, axial node 1.

CV 3480 calculates the stored energy (MJ) in Structure 2001, axial node 1.

CV 3481 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2001, axial node 2.

CV 3482 calculates the stored energy (MJ) in Structure 2001, axial node 2.

CV 3483 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2100, axial node 1.

CV 3484 calculates the stored energy (MJ) in Structure 2100, axial node 1.

CV 3485 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2150, axial node 1.

CV 3486 calculates the stored energy (MJ) in Structure 2150, axial node 1.

CV 3487 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2200, axial node 1.

CV 3488 calculates the stored energy (MJ) in Structure 2200, axial node 1.

CV 3489 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2201, axial node 1.

CV 3490 calculates the stored energy (MJ) in Structure 2201, axial node 1.

CV 3501 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 1.

CV 3502 calculates the stored energy (MJ) in Structure 2250, axial node 1.

CV 3503 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 2.

CV 3504 calculates the stored energy (MJ) in Structure 2250, axial node 2.

CV 3505 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 3.

CV 3506 calculates the stored energy (MJ) in Structure 2250, axial node 3.

CV 3507 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 4.

CV 3508 calculates the stored energy (MJ) in Structure 2250, axial node 4.

CV 3509 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 5.

CV 3510 calculates the stored energy (MJ) in Structure 2250, axial node 5.

CV 3511 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 6.

CV 3512 calculates the stored energy (MJ) in Structure 2250, axial node 6.

CV 3513 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 7.

CV 3514 calculates the stored energy (MJ) in Structure 2250, axial node 7.

CV 3515 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 8.

CV 3516 calculates the stored energy (MJ) in Structure 2250, axial node 8.

CV 3517 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 9.

CV 3518 calculates the stored energy (MJ) in Structure 2250, axial node 9.

CV 3519 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 10.

CV 3520 calculates the stored energy (MJ) in Structure 2250, axial node 10.

CV 3521 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 11.

CV 3522 calculates the stored energy (MJ) in Structure 2250, axial node 11.

CV 3523 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 12.

CV 3524 calculates the stored energy (MJ) in Structure 2250, axial node 12.

CV 3525 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 13.

CV 3526 calculates the stored energy (MJ) in Structure 2250, axial node 13.

CV 3527 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 14.

CV 3528 calculates the stored energy (MJ) in Structure 2250, axial node 14.

CV 3529 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 15.

CV 3530 calculates the stored energy (MJ) in Structure 2250, axial node 15.

CV 3531 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 16.

CV 3532 calculates the stored energy (MJ) in Structure 2250, axial node 16.

CV 3533 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 17.

CV 3534 calculates the stored energy (MJ) in Structure 2250, axial node 17.

CV 3535 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 18.

CV 3536 calculates the stored energy (MJ) in Structure 2250, axial node 18.

CV 3537 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 19.

CV 3538 calculates the stored energy (MJ) in Structure 2250, axial node 19.

CV 3539 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 20.

CV 3540 calculates the stored energy (MJ) in Structure 2250, axial node 20.

CV 3541 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 21.

CV 3542 calculates the stored energy (MJ) in Structure 2250, axial node 21.

CV 3543 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2250, axial node 22.

CV 3544 calculates the stored energy (MJ) in Structure 2250, axial node 22.

CV 3546 calculates the stored energy (MJ) in the steam generator tubes, Structure 2250.

CV 3547 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2251, axial node 1.

CV 3548 calculates the stored energy (MJ) in Structure 2251, axial node 1.

CV 3549 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2251, axial node 2.

CV 3550 calculates the stored energy (MJ) in Structure 2251, axial node 2.

CV 3551 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2280, axial node 1.

CV 3552 calculates the stored energy (MJ) in Structure 2280, axial node 1.

CV 3553 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2300, axial node 1.

CV 3554 calculates the stored energy (MJ) in Structure 2300, axial node 1.

CV 3555 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2350, axial node 1.

CV 3556 calculates the stored energy (MJ) in Structure 2350, axial node 1.

CV 3557 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2400, axial node 1.

CV 3558 calculates the stored energy (MJ) in Structure 2400, axial node 1.

CV 3559 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2500, axial node 1.

CV 3560 calculates the stored energy (MJ) in Structure 2500, axial node 1.

CV 3561 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2500, axial node 2.

CV 3562 calculates the stored energy (MJ) in Structure 2500, axial node 2.

CV 3563 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2500, axial node 3.

CV 3564 calculates the stored energy (MJ) in Structure 2500, axial node 3.

CV 3565 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2580, axial node 1.

CV 3566 calculates the stored energy (MJ) in Structure 2580, axial node 1.

CV 3567 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2600, axial node 1.

CV 3568 calculates the stored energy (MJ) in Structure 2600, axial node 1.

CV 3569 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2700, axial node 1.

CV 3570 calculates the stored energy (MJ) in Structure 2700, axial node 1.

CV 3571 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2700, axial node 2.

CV 3572 calculates the stored energy (MJ) in Structure 2700, axial node 2.

CV 3573 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2700, axial node 3.

CV 3574 calculates the stored energy (MJ) in Structure 2700, axial node 3.

CV 3575 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2700, axial node 4.

CV 3576 calculates the stored energy (MJ) in Structure 2700, axial node 4.

CV 3577 calculates the stored energy (MJ) in the PCS piping.

CV 3578 calculates the stored energy (MJ) in the PCS.

12. SPLIT HOT DUCT MODEL

An alternate model of the hot duct, outlet plenum, and RCST was developed for use in the double-ended hot duct break simulations. The phenomenon of interest in this scenario is single-phase countercurrent flow in the hot duct, with hot (or lighter) gas flowing from the pressure vessel outlet plenum to the RCST along the top of the pipe, with colder (or denser) gas returning from the RCST to the outlet plenum along the bottom of the pipe. Since the code cannot simulate this directly in a single control volume, the nodalization must be changed. Figure 7 shows the revised nodalization.

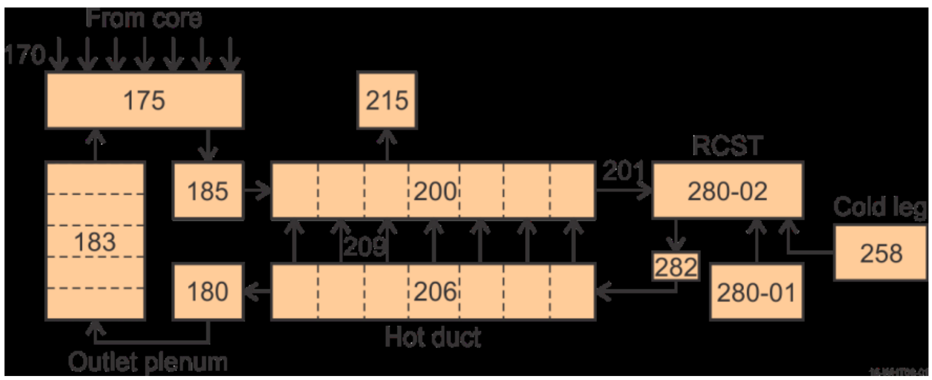

Figure 7. Revised nodalization for the split hot duct input model.

The basic approach is to split the hot duct into top and bottom halves (Components 200 and 206). The break valve (Component 205) is removed from the model, and the piping between the valve and the RCST (Component 210) is now included in the pipe. Each of the cells in the two pipes is connected by crossflow junctions (Component 209) to allow the pressure to equalize along the pipe. The pipe heat structures are also split into top and bottom halves; conduction between the two halves is not modeled.

The outlet plenum is changed from one component to four, with the objective being to allow the plenum to fill with the returning gas before it interacts with the hotter gas in the core. The existing volume (Component 175) is reduced in length so that no changes in the core channel connections are needed. Component 185 represents a small portion of the outlet plenum volume, and connects Component 175 to the top of the hot duct. Component 180 represents a small portion of the outlet plenum volume and is connected to the bottom half of the hot duct. There is no direct connection between Components 180 and 185. Component 183 represents most of the outlet plenum volume. It is connected to Component 180 at the inlet and Component 175 at the outlet. Only one heat structure, the plenum bottom plate, is changed. Other structures were not changed in that their response was not expected to be significant enough to warrant the effort of splitting them into a number of axial cells corresponding to the nodalization of pipe Component 183.

The second volume in the RCST is modified so that it connects to the top half of the hot duct while maintaining the connection to the cold leg side of the break (which is not renodalized). A small volume (Component 282) is added to make the connection from this second volume to the bottom half of the hot duct. The intent of the original model was for the second volume in the RCST to include all of the tank volume involved in the fluid mixing. This nodalization maintains that. By making the added component very small, its conditions should be very close to those in the mixing volume. No changes are needed for the heat structures.

A number of control variables were changed or added as a result of the renodalization.

Brief descriptions of the altered components are provided below.

Component 175 represents the top 2 cm of the pressure vessel outlet plenum. It is modeled as a branch with two junctions, both connected to the outlet. The first connects the outlet of this component to the inlet of Component 185, and the second connects the outlet of Component 183 to the outlet of this component. This component is also connected to all of the core channels by Component 170.

Component 180 represents a portion of the outlet plenum near the bottom half of the hot duct. It is modeled as a branch component with two junctions. The first junction connects the outlet of the bottom half of the hot duct, Component 206, to the middle of this component, and the second junction connects the outlet of this component to the inlet of Component 183.

Component 183 is a five-volume pipe representing the bulk of the outlet plenum. The number of pipe cells can be altered to try to reduce the effect of numerical diffusion in the calculations.

Component 185 represents a portion of the outlet plenum near the top half of the hot duct. It is modeled as a branch with one junction, connecting the middle of this component to the inlet of the top half of the hot duct, Component 200.

Component 200 is a pipe representing the top half of the hot duct connecting the pressure vessel outlet plenum to the RCST. It has seven internal volumes, the third of which is connected to the hot leg piping leading to the steam generator. The flow area is half that of the full pipe, the hydraulic diameter is the same as that of the full pipe, and the z-direction length is half the pipe diameter. The break valve loss coefficient is maintained at the fifth internal junction.

Component 201 connects the outlet of Component 200 to the middle of Component 280-02. It is modeled as a single junction. The smooth area change model is used, with forward and reverse loss coefficients of 1.0 and 0.5, respectively.

Component 206 is a pipe representing the bottom half of the hot duct. It has seven internal volumes, and is oriented so that positive flow is from the RCST to the outlet plenum. The flow area is half that of the full pipe, and the hydraulic diameter is the same as that of the full pipe. The z-direction length is less than half the pipe diameter, so that elevation closure is maintained with the connection to the outlet plenum. The break valve loss coefficient is maintained at the second internal junction.

Component 209 is a multiple junction component connecting the two halves of the hot duct. The seven junctions are oriented from the top of the volumes in Component 206 to the bottom of the volumes in Component 200. The junction area is set to the product of the pipe cell length and the diameter. Small loss coefficients of 0.1 are included to provide some resistance to unphysical recirculating flows that the code has had a tendency to predict in some previous calculations with similar geometry.

Component 280 is the RCST. The second volume has been compressed with this renodalization; it has the same volume as before, but now has a height of 0.14898 m instead of 4.0831 m. This allows the top of the hot duct to connect to the middle of the volume while the cold leg break connects to the bottom of the volume. All other input for the component is unchanged.

Component 282 is a small portion of the RCST between the inlet to Volume 280-02 and the inlet to the bottom half of the hot duct. It is modeled as a branch with two junctions: the first junction connects the inlet of Component 280-02 to the inlet of this component, and the second junction connects the outlet of this component to the inlet of Component 206. The area of this component is arbitrarily set to a small value, so that its fluid conditions should be nearly the same as those in Component 280-02, the mixed volume of the RCST, but not so small that its Courant limit affects the time step during the transient.

Forward and reverse loss coefficients of 0.5 and 1.0, respectively, are used at the connection to the hot duct. No heat structures are associated with this component.

Structure 1750 represents the outlet plenum lower plate. The only change from the original structure is that the left boundary volume is changed to 183010000 (from 175010000).

Structure 2000 represents a portion of the top half of the hot duct. It is identical to the original structure, except that the area factor is cut in half.

Structure 2001 represents a portion of the top half of the hot duct. It is identical to the original structure, except that the area factor is cut in half.

Structure 2002 represents the portion of the top half of the hot duct between the break valve and the RCST. It is identical to Structure 2100, except that the area factor is cut in half.

Structure 2060 represents the portion of the bottom half of the hot duct between the break valve and the RCST. It is identical to Structure 2100, except that the area factor is cut in half.

Structure 2061 represents a portion of the bottom half of the hot duct. It is identical to Structure 2001, except for the left boundary volumes.

Structure 2062 represents a portion of the bottom half of the hot duct. It is identical to Structure 2000, except for the left boundary volumes.

CV 1401 calculates the environmental heat loss (W) from Structures 2001 and 2061.

CV 1615 calculates the total fluid mass (kg) in the hot leg, Components 200 and 206.

CV 1621 calculates the total fluid mass (kg) in the RCST, Components 258, 280, and 282.

CV 3472 calculates the stored energy (MJ) in Structure 2000, axial node 1.

CV 3474 calculates the stored energy (MJ) in Structure 2000, axial node 2.

CV 3476 calculates the stored energy (MJ) in Structure 2000, axial node 3.

CV 3478 calculates the stored energy (MJ) in Structure 2000, axial node 4.

CV 3480 calculates the stored energy (MJ) in Structure 2001, axial node 1.

CV 3482 calculates the stored energy (MJ) in Structure 2001, axial node 2.

CV 3483 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2002, axial node 1.

CV 3484 calculates the stored energy (MJ) in Structure 2002, axial node 1.

CV 3577 calculates the stored energy (MJ) in the primary coolant system piping.

CV 3581 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2060, axial node 1.

CV 3582 calculates the stored energy (MJ) in Structure 2060, axial node 1.

CV 3583 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2061, axial node 1.

CV 3584 calculates the stored energy (MJ) in Structure 2061, axial node 1.

CV 3585 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2061, axial node 2.

CV 3586 calculates the stored energy (MJ) in Structure 2061, axial node 2.

CV 3587 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2062, axial node 1.

CV 3588 calculates the stored energy (MJ) in Structure 2062, axial node 1.

CV 3589 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2062, axial node 2.

CV 3590 calculates the stored energy (MJ) in Structure 2062, axial node 2.

CV 3591 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2062, axial node 3.

CV 3592 calculates the stored energy (MJ) in Structure 2062, axial node 3.

CV 3593 calculates the volumetric heat capacity (MJ/m^3-K) in Structure 2062, axial node 4.

CV 3594 calculates the stored energy (MJ) in Structure 2062, axial node 4.

13. NODALIZATION STUDY

All of the calculations have been performed at full power (2.2 MW) with helium as the primary coolant.

The steam generator was originally nodalized with 12 volumes in the tubes, six up and six down, with the bend in the tubes in Cells 6 and 7. The boiler and downcomer regions of the secondary side of the steam generator were modeled with node boundaries at the same elevations. A sensitivity calculation was performed in which the number of cells in the tubes was increased to 22, by doubling the number of nodes in the straight sections and leaving the bend alone; this region of the tubes was in single-phase vapor convection heat transfer on the secondary side anyway, so doubling the nodes here would provide no benefit, but would further reduce the Courant limit. The boiler and downcomer nodalizations were also increased to match the node boundaries on the primary side. For the first and last cells in the tubes, rather than dividing the tube cell length in two, the cell boundary was located at an elevation that divided the first cell in the boiler into equal length cells. This makes the first cell in the tubes longer than the second, because the first cell includes the length of tube in the tube sheet, and results in the system Courant limit being located in the second tube cell. The more detailed model produced more stable results than the coarser nodalization.

With the steam generator modeled, the Courant limit is a little above 0.002 s, determined by the second volume in the tubes. Without the steam generator, the Courant limit is about 0.0047 s.

14. COMPUTER FILES

Computer files associated with the input file are listed in Table 1. In addition to the file name, a description of the file is included, along with the checksum value (gnu command "cksum").

Table 1. Listing of computer files.

File name	Description	Checksum value
httf-base.i	RELAP5-3D input file	2319698913
HTTF base 2018-05-30QA.xlsx	Workbook containing the final version of the model and supporting calculations	2084154050
HTTF base 2015-02-10QA.xlsx	Excel workbook containing the version of the model and supporting calculations for the initial quality assurance review	3765750314
HTTF base 2015-06-22QA.xlsx	Excel workbook containing the version of the model and supporting calculations after the initial quality assurance review	392234047
HTTF base 2017-03-23QA.xlsx	Excel workbook containing the version of the model and supporting calculations for the second quality assurance review	2735886914
HTTF base 2017-03-30QA.xlsx	Excel workbook containing the version of the model and supporting calculations after the second quality assurance review	1132593988
HTTF base 2018-05-16QA.xlsx	Excel workbook containing the version of the model and supporting calculations for the final quality assurance review	921649429

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Table 2. HTTF drawings used in developing the input model.

Drawing Number	Sheet	Revision	Date
OSU-HTTF-CORE-DWG-001-R1	1	1	3/13/2018
OSU-HTTF-CORE-DWG-004-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-004-R0	2	A	4/1/2013
OSU-HTTF-CORE-DWG-005-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-005-R0	4	A	4/1/2013
OSU-HTTF-CORE-DWG-006-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-006-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-011-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-012-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-013-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-014-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-015-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-016-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-016-R0	2	A	4/1/2013
OSU-HTTF-CORE-DWG-016-R0	3	A	4/1/2013
OSU-HTTF-CORE-DWG-017-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-019-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-021-R0	1	A	4/1/2013
OSU-HTTF-CORE-DWG-021-R0	2	A	4/1/2013
OSU-HTTF-CORE-DWG-021-R0	3	A	4/1/2013
OSU-HTTF-CORE-DWG-026-R0	1	0	4/19/2018
OSU-HTTF-GEN-DWG-001B	2	1	6/1/2017
OSU-HTTF-GEN-DWG-009A	1	0	11/21/2016
OSU-HTTF-GEN-DWG-009C	3	0	11/21/2016
OSU-HTTF-GEN-DWG-009D	4	0	11/21/2016
OSU-HTTF-GEN-DWG-009E	5	0	11/21/2016
OSU-HTTF-GEN-DWG-009F	6	0	11/21/2016
OSU-HTTF-GEN-DWG-009G	7	0	11/21/2016
OSU-HTTF-GEN-DWG-009H	8	0	11/21/2016
OSU-HTTF-PRIM-DWG-002	1	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	3	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	5	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	6	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	7	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	8	1	2/15/2018
OSU-HTTF-PRIM-DWG-002	9	1	2/15/2018
OSU-HTTF-PRIM-DWG-004A	1	0	11/21/2016
OSU-HTTF-PRIM-DWG-005A	1	0	11/21/2016

Table 2. continued

Drawing Number	Sheet	Revision	Date
OSU-HTTF-PRIM-DWG-011	1	2	3/14/2018
OSU-HTTF-PRIM-DWG-012	1	1	3/1/2018
OSU-HTTF-PRIM-DWG-019	1	0	11/20/2017
OSU-HTTF-RCCS-DWG-006A	1	0	11/21/2016
OSU-HTTF-RCCS-DWG-007A	1	0	11/21/2016
OSU-HTTF-RCSS-DWG-008A	1	0	11/21/2016
OSU-HTTF-RCSS-DWG-008C	3	0	11/21/2016
OSU-HTTF-SEC-DWG-003A	1	0	11/21/2016
OSU-HTTF-SEC-DWG-003B	2	0	11/21/2016
OSU-HTTF-SEC-DWG-003C	3	0	11/21/2016

Appendix A

Input Model Listing

Appendix A. Input Model Listing

```
= HTTF system model
* base model
*
* This model represents the High Temperature Test Facility (HTTF) (prismatic core
* design), which is being built at Oregon State University to support the Advanced
* Reactor Technologies program.
*
* This is a full system model developed to perform assessment calculations using
* experiment data from the facility. The model includes the primary pressure vessel
* and internals, the primary coolant system, the secondary coolant system, and
* the reactor cavity cooling system (RCCS).
*
* The core is modeled with three parallel channels, each representing one of the
* three rings in the annular heated region. The heater rods radiate to the
* surrounding ceramic material. The helium gap between the rods and the
* ceramic is included.
*
* The central reflector is modeled in three pieces: a solid inner ring, a middle ring
* with coolant holes, and an outer solid ring next to the heated region.
*
* The side reflector is also modeled with a solid ring next to the heated portion of
* the core, a middle ring with coolant holes, and a solid ring outside it. The
* permanent side reflector is also modeled as a solid ring.
*
* The primary coolant system includes the hot and cold ducts, the steam
* generator plenums and tubes, the gas circulator, pressure relief and
* depressurization valves, the check valve at the steam generator inlet, the loop
* isolation valve, and connecting piping. Break valves at the end of the hot duct and
* in the cold leg piping connect to the reactor cavity simulation tank (RCST).
*
* The secondary coolant system includes the feedwater pump, steam generator,
* the steam line pressure control valve, the pressure relief valve, and associated
* piping. The feedwater piping is not modeled explicitly: the approximate length and
* correct elevation change are input, as the flow resistance of the feedwater piping
* is not important to the plant response.
*
* The RCCS is modeled as a set of panels completely surrounding the primary
* pressure vessel. Flowing water cools the front side of the panels, and natural
* convection heat transfer cools the back side.
*
* The tank that provides water to the feedwater and RCCS pumps is modeled,
* along with its water supply, drain valve, and vent line.
*
* The air cavity between the primary pressure vessel and the RCCS panels is
* also included in the model.
*
* Trips and control systems are provided for the circulator, the feedwater and RCCS
* pumps, the break and loop isolation valves, the pressure relief and depressurization
* valves, and the tank water supply and drain valves.
*
* All of the vertically-oriented heat structures have 2-D conduction turned on where
* possible. Axial conduction between the core and the top and
* bottom reflectors, and in three of the four solid reflector regions, is modeled
* using conduction enclosures.
*
* Core power of 2.2 MW.
* Inlet coolant temperature of 258.6 C.
* Outlet coolant temperature of 687 C.
*
```

```
*********************************************************
1  12  54
100  new  stdy-st
101  run
102  si  si
107  1  1  1
110  air  nitrogen
115  1.0  0.0
120  258010000  1.7907  hen  Primary
121  900010000  1.7907  n2  Contain
122  950030000  1.7907  h2o  SCS-RCCS
123  141010000  4.088765  hen  hegap1
124  146010000  4.088765  hen  hegap2
125  151010000  4.088765  hen  hegap3
201  30000.0  1.0-6  0.002  19  30000  6000000  60000000
*
*******************************************************
* additional plot variables
*******************************************************
*
20800001  htmode  225000101
20800002  htmode  225000201
20800003  htmode  225000301
20800004  htmode  225000401
20800005  htmode  225000501
20800006  htmode  225000601
20800007  htmode  225000701
20800008  htmode  225000801
20800009  htmode  225000901
20800010  htmode  225001001
20800011  htmode  225001101
20800012  htmode  225001201
20800013  htmode  225001301
20800014  htmode  225001401
20800015  htmode  225001501
20800016  htmode  225001601
20800017  htmode  225001701
20800018  htmode  225001801
20800019  htmode  225001901
20800020  htmode  225002001
20800021  htmode  225002101
20800022  htmode  225002201
20800031  systms  1
20800032  systms  5
*
*******************************************************
* trips
*******************************************************
*
20600000  expanded
*
* scram trip
20601000  time  0  ge  null  0  1.00E+06  l
*
* break trips
20602050  time  0  ge  null  0  1.00E+06  l  * open hot duct break valve
20602060  time  0  le  null  0  -1.0  l  * close hot duct break valve
20602550  time  0  ge  null  0  1.00E+06  l  * open cold leg break valve
20602560  time  0  le  null  0  -1.0  l  * close cold leg break valve
*20600250 time  0  le  null  0  -1.0  l  * open CRD break valve
*20600750 time  0  le  null  0  -1.0  l  * open vessel bottom break valve
*
* valve V-203 trips
```

```
20602450  time  0  ge  null  0  -1.0  l  * open valve
20602460  time  0  le  null  0  -1.0  l  * close valve
*
* primary coolant system relief valve trips
20602940  p  293010000  gt  null  0  1.16E+06  n  * opening pressure
20602950  p  293010000  lt  null  0  1.10E+06  n  * closing pressure
20612940  294  or  1295  n  * initial opening or already open
20612950  1294  and  -295  n  * open valve
*
* primary coolant system depressurization valve trips
20602960  time  0  ge  null  0  1.00E+06  n  * open valve manually
20602970  time  0  ge  null  0  1.00E+06  n  * close valve manually
20612960  296  and  -297  n  * open valve
*
* steam generator relief valve trips
20603940  p  390010000  gt  null  0  7.91E+05  n  * opening pressure
20603950  p  390010000  lt  null  0  7.70E+05  n  * closing pressure
20613940  394  or  1395  n  * initial opening or already open
20613950  1394  and  -395  n  * open valve
*
* water supply valve controls for tank T-010
20604100  cntrlvar  450  lt  cntrlvar  451  0.0  n  * low liquid level setpoint
20604110  cntrlvar  450  gt  cntrlvar  452  0.0  n  * high liquid level setpoint
20604120  cntrlvar  450  gt  cntrlvar  453  0.0  n  * level above mid-range
20614090  410  or  1410  n
20614100  1409  and  -412  n  * open supply valve
20614110  411  or  1412  n
20614120  1411  and  412  n  * close supply valve
*
*******************************************************
* hydrodynamics
*******************************************************
*
* steady state pressure control
*
2330000  PCSPctrl  sngljun
2330101  230010000  234000000  0.0  0.0  0.0  0
2330201  0  0.0  0.0  0.0
*
2340000  cmprssr  tmdpvol
2340101  0.03228  1.203  0.0  0.0  0.0  0.0  0.0  0.0  10
2340200  3
2340201  0.0  7.00E+05  531.75
2340200  3  0  cntrlvar  234
2340201  100000.0  1.00E+05  531.75
2340202  800000.0  8.00E+05  531.75
*
* pressure vessel inlet region
*
1000000  vesinlet  branch
1000001  2  1
1000101  0.0  0.39395  0.1532
1000102  0.0  -90.0  -0.39395
1000103  0.000046  0.1143  0
1000200  3  7.00E+05  531.75
1001101  270010000  100000000  0.0649  0.60  0.39  0000001
1002101  100010000  105000000  0.1208  0.0  0.0  0000102
1001110  0.0  0.0  1.0  1.0
1002110  0.0  0.0  1.0  1.0
1001201  0.0  1.0  0.0
1002201  0.0  1.0  0.0
*
* coolant volume in core support structure
```

```
*
1050000  corsuprt  pipe
1050001  2
1050101  0.19393  1
1050102  0.19393  2
1050301  0.7572  1
1050302  0.7572  2
1050401  0.0  2
1050601  7.7107  1
1050602  0.0  2
1050701  0.10160  1
1050702  0.0  2
1052201  0.0  0.0  0.0889  1
1052202  0.0  0.0  0.0889  2
1050801  0.000046  0.128  1
1050802  0.000046  0.136  2
1052401  0.000046  0.0  2
1050901  0.95  0.95  1
1051001  0  2
1051101  0  1
1051201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1051300  1
1051301  0.0  1.0  0.0  1
1051401  0.406  0.0  1.0  1.0  1
*
* jacket shell
*
1100000  jacketsh  branch
1100001  2  1
1100101  0.0923  0.403475  0.0
1100102  0.0  90.0  0.403475
1100103  0.000046  0.0381  0
1100200  3  7.00E+05  531.75
1101101  105010000  110000000  0.1208  0.0  0.0  0
1102101  110010000  115000000  0.0  0.0  0.0  100
1101110  0.0  0.0  1.0  1.0
1102110  0.0  0.0  1.0  1.0
1101201  0.0  1.0  0.0
1102201  0.0  1.0  0.0
*
* pressure vessel/core barrel gap
*
1150000  rv-bargp  pipe
1150001  15
1150101  0.28388  15
1150301  0.25146  1
1150302  0.25146  2
1150303  0.19812  12
1150304  0.19050  13
1150305  0.20320  14
1150306  0.27320  15
1150401  0.0  15
1150601  90.0  15
1150801  0.000046  0.114  15
1150901  0.0  0.0  14
1151001  0  15
1151101  0  14
1151201  3  7.00E+05  531.75  0.0  0.0  0.0  15
1151300  1
1151301  0.0  1.0  0.0  14
1151401  0.114  0.0  1.0  1.0  14
*
* core inlet plenum
```

```
*
1200000  inltplnm  branch
1200001  1  1
1200101  0.0  0.9557  1.4051
1200102  0.0  90.0  0.9557
1200103  0.000046  0.0  0
1200200  3  7.00E+05  531.75
1201101  115140002  120000000  0.0569  2.22  2.22  0
1201110  0.045  0.0  1.0  1.0
1201201  0.0  1.0  0.0
*
* core inlet junctions
*
1250000  corejuni  mtpljun
1250001  5  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1250011  120000000  132000000  0.0  0.5  1.0  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1250012  0  0  0.0  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1250021  120000000  140000000  0.0  0.5  1.0  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1250022  0  0  0.0  2
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1250031  120000000  145000000  0.0  0.5  1.0  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1250032  0  0  0.0  3
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1250041  120000000  150000000  0.0  0.5  1.0  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1250042  0  0  0.0  4
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1250051  120000000  162000000  0.0  0.5  1.0  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1250052  0  0  0.0  5
* 1nnm  mflowf  mflowg  #
1251011  0.0  0.01  1
1251021  0.0  0.05  2
1251031  0.0  0.05  3
1251041  0.0  0.05  4
1251051  0.0  0.01  5
* 2nnm  Dhyd  b  c  m  #
1252011  0.01905  0.0  1.0  1.0  1
1252021  0.0150  0.0  1.0  1.0  2
1252031  0.0159  0.0  1.0  1.0  3
1252041  0.0144  0.0  1.0  1.0  4
1252051  0.015875  0.0  1.0  1.0  5
*
* core bypass path through holes in central reflector ring 2
*
1320000  crcholes  pipe
1320001  14
1320101  0.0017101  14
1320301  0.20320  1
1320302  0.19050  2
1320303  0.19812  12
1320304  0.25146  13
1320305  0.25146  14
1320401  0.0  14
1320601  -90.0  14
1320801  0.00010  0.01905  14
1320901  0.08  0.08  13
1321001  0  14
```

```
1321101  0  13
1321201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1321202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1321203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1321204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1321205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1321206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1321207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1321208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1321209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1321210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1321211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1321212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1321300  1
1321301  0.0  0.01  0.0  13
1321401  0.01905  0.0  1.0  1.0  13
*
* inner core ring coolant channels
*
1400000  coreinnr  pipe
1400001  14
1400101  0.02214  14
1400301  0.20320  1
1400302  0.19050  2
1400303  0.19812  12
1400304  0.25146  13
1400305  0.25146  14
1400401  0.0  14
1400601  -90.0  14
1400801  0.00010  0.0150  14
1400901  0.08  0.08  13
1401001  0  14
1401101  0  13
1401201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1401202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1401203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1401204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1401205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1401206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1401207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1401208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1401209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1401210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1401211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1401212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1401300  1
1401301  0.0  0.05  0.0  13
1401401  0.0150  0.0  1.0  1.0  13
*
* inner core ring heater rod helium gap
*
1410000  hegapin  pipe
1410001  10
1410101  0.01911  10
1410301  0.19812  10
1410401  0.0  10
1410601  -90.0  10
1410801  0.00010  0.010887103 10
1410901  0.0  0.0  9
1411001  0  10
1411101  0  9
1411201  3  7.00E+05  900.0  0.0  0.0  0.0  10
1411300  1
```

```
1411301  0.0000  0.0  0.0  9
*
1420000  hegapin  sngljun
1420101  143010000  141000000  0.0  0.0  0.0  0
1420201  0  0.0  0.0  0.0
*
* helium gap boundary volume
*
1430000  hegapin  tmdpvol
1430101  0.01911  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
1430200  3  0  tempg  141010000
1430201  300.0  7.00E+05  300.0
1430202  2000.0  7.00E+05  2000.0
*
* middle core ring coolant channels
*
1450000  coremid  pipe
1450001  14
1450101  0.02850  14
1450301  0.20320  1
1450302  0.19050  2
1450303  0.19812  12
1450304  0.25146  13
1450305  0.25146  14
1450401  0.0  14
1450601  -90.0  14
1450801  0.00010  0.0159  14
1450901  0.08  0.08  13
1451001  0  14
1451101  0  13
1451201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1451202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1451203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1451204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1451205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1451206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1451207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1451208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1451209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1451210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1451211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1451212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1451300  1
1451301  0.0  0.05  0.0  13
1451401  0.0159  0.0  1.0  1.0  13
*
* middle core ring heater rod helium gap
*
1460000  hegapmid  pipe
1460001  10
1460101  0.02457  10
1460301  0.19812  10
1460401  0.0  10
1460601  -90.0  10
1460801  0.00010  0.010887103 10
1460901  0.0  0.0  9
1461001  0  10
1461101  0  9
1461201  3  7.00E+05  900.0  0.0  0.0  0.0  10
1461300  1
1461301  0.0  0.0  0.0  9
*
1470000  hegapmid  sngljun
```

```
1470101  148010000  146000000  0.0  0.0  0.0  0
1470201  0  0.0  0.0  0.0
*
* helium gap boundary volume
*
1480000  hegapmid  tmdpvol
1480101  0.02457  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
1480200  3  0  tempg  146010000
1480201  300.0  7.00E+05  300.0
1480202  2000.0  7.00E+05  2000.0
*
* outer core ring coolant channels
*
1500000  coreoutr  pipe
1500001  14
1500101  0.03249  14
1500301  0.20320  1
1500302  0.19050  2
1500303  0.19812  12
1500304  0.25146  13
1500305  0.25146  14
1500401  0.0  14
1500601  -90.0  14
1500801  0.00010  0.0144  14
1500901  0.08  0.08  13
1501001  0  14
1501101  0  13
1501201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1501202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1501203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1501204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1501205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1501206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1501207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1501208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1501209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1501210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1501211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1501212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1501300  1
1501301  0.0  0.05  0.0  13
1501401  0.0144  0.0  1.0  1.0  13
*
* outer core ring heater rod helium gap
*
1510000  hegapout  pipe
1510001  10
1510101  0.02799  10
1510301  0.19812  10
1510401  0.0  10
1510601  -90.0  10
1510801  0.00010  0.010887103 10
1510901  0.0  0.0  9
1511001  0  10
1511101  0  9
1511201  3  7.00E+05  900.0  0.0  0.0  0.0  10
1511300  1
1511301  0.0000  0.0  0.0  9
*
1520000  hegapout  sngljun
1520101  153010000  151000000  0.0  0.0  0.0  0
1520201  0  0.0  0.0  0.0
*
```

```
* helium gap boundary volume
*
1530000  hegapout  tmdpvol
1530101  0.02799  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
1530200  3  0  tempg  151010000
1530201  300.0  7.00E+05  300.0
1530202  2000.0  7.00E+05  2000.0
*
* coolant holes in side reflector
*
1620000  srcholes  pipe
1620001  14
1620101  0.00713  14
1620301  0.20320  1
1620302  0.19050  2
1620303  0.19812  12
1620304  0.25146  13
1620305  0.25146  14
1620401  0.0  14
1620601  -90.0  14
1620801  0.00010  0.015875  14
1620901  0.08  0.08  13
1621001  0  14
1621101  0  13
1621201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1621202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1621203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1621204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1621205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1621206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1621207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1621208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1621209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1621210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1621211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1621212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1621300  1
1621301  0.0  0.01  0.0  13
1621401  0.015875  0.0  1.0  1.0  13
*
* core bypass path - gap between side reflector and permanent side reflector
*
1640000  gapsr-ps  pipe
1640001  14
1640101  0.0342744  14
1640301  0.20320  1
1640302  0.19050  2
1640303  0.19812  12
1640304  0.25146  13
1640305  0.25146  14
1640401  0.0  14
1640601  -90.0  14
1640801  0.00010  0.01463  14
1640901  0.08  0.08  13
1641001  0  14
1641101  0  13
1641201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1641202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1641203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1641204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1641205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1641206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1641207  3  7.00E+05  745.95  0.0  0.0  0.0  8
```

```
1641208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1641209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1641210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1641211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1641212  3  7.00E+05  960.15  0.0  0.0  0.0  14
1641300  1
1641301  0.0  0.01  0.0  13
1641401  0.01463  0.0  1.0  1.0  13
*
* core bypass path - gap between permanent side reflector and core barrel
*
1660000  gapsr-cb  pipe
1660001  15
1660101  0.0301457  15
1660301  0.20320  1
1660302  0.19050  2
1660303  0.19812  12
1660304  0.25146  13
1660305  0.25146  14
1660306  0.22225  15
1660401  0.0  15
1660601  -90.0  15
1660801  0.00010  0.0127  15
1660901  0.08  0.08  14
1661001  0  15
1661101  0  14
1661201  3  7.00E+05  531.75  0.0  0.0  0.0  2
1661202  3  7.00E+05  531.75  0.0  0.0  0.0  3
1661203  3  7.00E+05  574.59  0.0  0.0  0.0  4
1661204  3  7.00E+05  617.43  0.0  0.0  0.0  5
1661205  3  7.00E+05  660.27  0.0  0.0  0.0  6
1661206  3  7.00E+05  703.11  0.0  0.0  0.0  7
1661207  3  7.00E+05  745.95  0.0  0.0  0.0  8
1661208  3  7.00E+05  788.79  0.0  0.0  0.0  9
1661209  3  7.00E+05  831.63  0.0  0.0  0.0  10
1661210  3  7.00E+05  874.47  0.0  0.0  0.0  11
1661211  3  7.00E+05  917.31  0.0  0.0  0.0  12
1661212  3  7.00E+05  960.15  0.0  0.0  0.0  15
1661300  1
1661301  0.0  0.01  0.0  14
1661401  0.0127  0.0  1.0  1.0  14
*
1680000  PSRoutlt  sngljun
1680101  166150004  175010003  0.00596  0.84  0.46  3
1680201  0  0.0  0.01  0.0
*
* core outlet junctions
*
1700000  corejuno  mtpljun
1700001  6  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1700011  132010000  175000000  0.0  1.0  0.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700012  0  0  0  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1700021  140010000  175000000  0.0  2.5  2.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700022  0  0  0  2
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1700031  145010000  175000000  0.0  2.5  2.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700032  0  0  0  3
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
```

```
1700041  150010000  175000000  0.0  2.5  2.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700042  0  0  0  4
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1700051  162010000  175000000  0.0  1.0  0.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700052  0  0  0  5
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
1700061  164010000  175000000  0.0  1.0  0.5  200  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
1700062  0  0  0  6
* 1nnm  mflowf  mflowg  #
1701011  0.0  0.01  1
1701021  0.0  0.05  2
1701031  0.0  0.05  3
1701041  0.0  0.05  4
1701051  0.0  0.01  5
1701061  0.0  0.00  6
* 2nnm  Dhyd  b  c  m  #
1702011  0.01905  0.0  1.0  1.0  1
1702021  0.0150  0.0  1.0  1.0  2
1702031  0.0159  0.0  1.0  1.0  3
1702041  0.0144  0.0  1.0  1.0  4
1702051  0.015875  0.0  1.0  1.0  5
1702061  0.01463  0.0  1.0  1.0  6
*
* core outlet plenum
*
1750000  outplenm  branch
1750001  1  1
1750101  0.7296  0.22225  0.0
1750102  0.0  -90.0  -0.22225
1750103  0.000046  0.097  0
1750200  3  7.00E+05  960.15
1751101  175010004  200000000  0.06973  0.0  0.0  0000002
1751110  0.0  0.0  1.0  1.0
1751201  0.0  1.0  0.0
*
* pressure vessel bottom head
*
1900000  lowrhead  branch
1900001  1  1
1900101  0.0  0.8192  1.1512
1900102  0.0  90.0  0.8192
1900103  0.000046  1.092  0
1900200  3  7.00E+05  531.75
1901101  190010000  105010005  0.00399  0.0  0.0  101
1901110  0.0  0.0  1.0  1.0
1901201  0.0  0.0  0.0
*
* hot duct
*
2000000  "hot duct" pipe
2000001  6
2000101  0.0697  4
2000102  0.0700  6
2000301  0.43180  1
2000302  0.65095  2
2000303  0.41270  3
2000304  0.41270  4
2000305  0.49058  5
2000306  0.49058  6
2001901  0.29797  6
```

```
2000401  0.0  6
2000601  0.0  6
2000801  0.000046  0.29797  4
2000802  0.000046  0.29845  6
2002401  0.0  0.0  6
2000901  0.0  0.0  4
2000902  0.057  0.057  5
2001001  0  6
2001101  0  5
2001201  3  7.00E+05  960.15  0.0  0.0  0.0  6
2001300  1
2001301  0.0  1.0  0.0  5
2001401  0.0  0.0  1.0  1.0  5
*
* valve V-313
*
2050000  V-313  valve
2050101  200010000  210000000  0.0700  0.0  0.0  0000200
2050201  0  0.0  0.0  0.0
2050300  mtrvlv
2050301  205  206  0.2  0.0
*
* hot duct pipe into RCST
*
2100000  hot-RCST  branch
2100001  1  1
2100101  0.0700  0.66040  0.0
2100102  0.0  0.0  0.0
2100103  0.000046  0.2985  0
2100200  3  1.00E+05  300.00
2101101  210010000  280020001  0.06996  1.0  0.5  0000000
* replace the card above with the one below for hot duct breaks with the RCST spool
piece installed
*2101101  282010000  210010000  0.0  0.0  0.0  0000100
2101201  0.0  0.0  0.0
*
* pipe from hot duct to SG - 10"-RCH-SS6-101
*
2150000  hot-SG  branch
2150001  1  1
2150101  0.0507  0.540516  0.0
2150102  0.0  90.0  0.540516
2150103  0.000046  0.254  0
2150200  3  7.00E+05  960.15
2151101  200030006  215000000  0.05067  1.6  1.6  0000000
2151110  0.254  0.0  1.0  1.0
2151201  0.0  1.0  0.0
*
* valve V-101
*
2170000  V-101  valve
2170101  215010000  220000000  0.05067  0.97  0.91  0000000
2170110  0.254  0.0  1.0  1.0
2170201  0  0.0  1.0  0.0
2170300  chkvlv
2170301  0  0.0  500.0  0
*
* orifice plate
*2170000  orifice  sngljun
*2170101  215010000  220000000  0.00785  61.43  61.37  0000200
*2170110  0.1  0.0  1.0  1.0
*2170201  0  0.0  1.0  0.0
*
```

```
* steam generator inlet plenum
*
2200000  SGinplen  branch
2200001  1  1
2200101  0.0  0.58420  0.0337
2200102  0.0  90.0  0.5842
2200103  0.000046  0.000  0
2200200  3  7.00E+05  960.15
2201101  220010000  225000000  0.04050  0.33  0.43  0000200
2201110  0.0165608  0.0  1.0  1.0
2201201  0.0  1.0  0.0
*
* steam generator tubes
*
2250000  "SG tubes" pipe
2250001  22
2250101  0.04050  22
2250301  0.22344  1
2250302  0.14089  2
2250303  0.14208  10
2250304  0.18170  12
2250305  0.14208  20
2250306  0.14089  21
2250307  0.22344  22
2250401  0.0  22
2250601  90.0  10
2250602  39.54022  11
2250603  -39.54022  12
2250604  -90.0  22
2250701  0.22344  1
2250702  0.14089  2
2250703  0.14208  10
2250704  0.11568  11
2250705  -0.11568  12
2250706  -0.14208  20
2250707  -0.14089  21
2250708  -0.22344  22
2250801  0.000002  0.0166  22
2250901  0.0  0.0  10
2250902  0.29  0.29  11
2250903  0.0  0.0  21
2251001  0  22
2251101  0  21
2251201  3  7.00E+05  960.15  0.0  0.0  0.0  22
2251300  1
2251301  0.0  1.0  0.0  21
2251401  0.0166  0.0  1.0  1.0  21
*
* steam generator outlet plenum
*
2280000  SGouplen  branch
2280001  2  1
2280101  0.0  0.51440  0.0236
2280102  0.0  -90.0  -0.51440
2280103  0.000046  0.0000  0
2280200  3  7.00E+05  531.75
2281101  225010000  228000000  0.0  0.43  0.33  0000200
2282101  228010000  230000000  0.03228  0.21  0.31  0000000
2281110  0.0166  0.0  1.0  1.0
2282110  0.2027  0.0  1.0  1.0
2281201  0.0  1.0  0.0
2282201  0.0  1.0  0.0
*
```

```
* pipe from steam generator to circulator - 8"-PCC-SS3-200
*
2300000  SG2cmprs  snglvol
2300101  0.03228  2.28273  0.0
2300102  0.0  -52.1  -1.80070
2300103  0.000046  0.2027  0
2300200  3  7.00E+05  531.75
*
* circulator
*
2350000  circultr  branch
2350001  1  1
2350101  0.0  1.2033  0.6791
2350102  0.0  -16.9  -0.34920
2350103  0.000046  0.0  0
2350200  3  7.00E+05  531.75
2351101  230010000  235000000  0.03228  0.46  0.46  0
2351110  0.0  0.0  1.0  1.0
2351201  0.0  1.0  0.0
*
2370000  circultr  tmdpjun
2370101  235010000  240000000  0.00000
2370200  1  0  cntrlvar  237
2370201  0.10  0.0  0.10  0.0
2370202  1.5  0.0  1.5  0.0
*
* pipe from circulator to valve V-203 - 8"-PCC-SS-201
*
2400000  cmprsout  snglvol
2400101  0.03228  1.29336  0.0
2400102  0.0  36.7944  0.77465
2400103  0.000046  0.2027  0
2400200  3  7.00E+05  531.75
*
* valve V-203
*
2450000  V-203  valve
2450101  240010000  250000000  0.03228  0.25  0.25  0000200
2450201  0  0.0  1.0  0.0
2450300  mtrvlv
2450301  245  246  0.2  1.0
*
* pipe from valve V-203 to break valve - 8"-PCC-SS3-201
*
2500000  clpipe  pipe
2500001  3
2500101  0.03228  3
2500301  1.09168  1
2500302  0.360896  2
2500303  0.6223  3
2500401  0.0  3
2500601  34.34827  1
2500602  0.0  3
2500701  0.61595  1
2500702  0.0  3
2500801  0.000046  0.2027174  3
2500901  0.20  0.20  1
2500902  0.0  0.0  2
2501001  0  3
2501101  0  2
2501201  3  7.00E+05  531.75  0.0  0.0  0.0  3
2501300  1
2501301  0.0  0.0  0.0  2
```

```
*
* valve V-311
*
2550000  V-311  valve
2550101  250010000  258000000  0.02946  0.05  0.1  0000200
2550201  0  0.0  0.0  0.0
2550300  mtrvlv
2550301  255  256  0.2  0.0
*
* cold leg pipe from valve V-311 to RCST
*
2580000  cld-RCST  branch
2580001  1  1
2580101  0.02946  1.02565  0.0
2580102  0.0  0.0  0.0
2580103  0.000046  0.194  0
2580200  3  1.00E+05  300.00
2581101  258010000  280020001  0.02946  0.5  1.0  0000200
* replace the card above with the one below for hot duct breaks with the RCST spool
piece installed
*2581101  258010000  282000000  0.0  0.0  0.0  0000000
2581201  0.0  0.0  0.0
*
* crossover pipe from cold leg tee to cold duct
*
2600000  clcross  branch
2600001  2  1
2600101  0.03228  0.36537  0.0
2600102  0.0  0.0  0.0
2600103  0.000046  0.2027  0
2600200  3  7.00E+05  531.75
2601101  250020004  260000000  0.03228  1.3  1.1  0000200
2602101  260010000  270010003  0.03228  2.8  2.2  0000200
2601201  0.0  1.0  0.0
2602201  0.0  1.0  0.0
*
* cold duct
*
2700000  coldduct  pipe
2700001  4
2700101  0.0649  4
2700301  0.41270  1
2700302  0.41270  2
2700303  0.65095  3
2700304  0.43180  4
2700401  0.0  4
2700601  0.0  4
2700801  0.000046  0.1075  4
2700901  0.0  0.0  3
2701001  0  4
2701101  0  3
2701201  3  7.00E+05  531.75  0.0  0.0  0.0  4
2701300  1
2701301  0.0  1.0  0.0  3
*
* reactor cavity simulation tank (two-volume configuration)
*
2800000  RCST  pipe
2800001  2
2800101  0.0  2
2800301  1.5240  1
2800302  4.0831  2
2800401  3.8  1
```

```
2800402  14.1  2
2800601  90.0  2
2800701  1.5240  1
2800702  4.0831  2
2800801  0.000046  2.0828  2
2800901  0.0  0.0  1
2801001  0  2
2801101  0  1
2801201  3  1.00E+05  300.00  0.0  0.0  0.0  2
2801300  1
2801301  0.0  0.0  0.0  1
*
* reactor cavity simulation tank (single-volume configuration)
*
*2800000  RCST  snglvol
*2800101  0.0  5.6071  17.9212
*2800102  0.0  90.0  5.6071
*2800103  0.000046  2.0828  0
*2800200  3  1.00E+05  300.00
*
* spool piece connecting the hot and cold leg break nozzles inside the RCST
*
*2820000  RCSTspol  snglvol
*2820101  0.0295  1.1172  0.0
*2820102  0.0  0.0  0.0
*2820103  0.000046  0.1937  0
*2820200  3  1.00E+05  300.00
*
* inlet piping for relief valve PSV-100
*
2930000  PSVinpip  branch
2930001  1  1
2930101  0.00191  0.35560  0.0
2930102  0.0  0.0000  0.0000
2930103  0.000046  0.0493  0
2930200  3  7.00E+05  531.75
2931101  240010004  293000000  0.00191  0.05  0.04  0000000
2931201  0.0  0.0  0.0
*
* valve PSV-100
*
2950000  PSV-100  valve
2950101  293010000  298000000  0.00056  0.0  0.0  0000200
2950201  0  0.0  0.0  0.0
2950300  trpvlv
2950301  1295
*
* valve V-400
*
2960000  V-400  valve
2960101  293010000  298000000  0.00191  0.06  0.06  0000000
2960201  0  0.0  0.0  0.0
2960300  trpvlv
2960301  1296
*
* outlet boundary volume for valve PSV-100
*
2980000  PSVout  tmdpvol
2980101  0.00056  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
2980200  3
2980201  0.0  1.00E+05  300.00
*
* feedwater pump P-010
```

```
*
3200000  inflow  tmdpjun
3200101  460010000  330000000  0.00050
3200200  1  0  cntrlvar  320
3200201  0.1  0.1  0.0  0.0
3200202  1.5  1.5  0.0  0.0
*
* feedwater pipe from feedwater pump to steam generator
*
3300000  fwline2  branch
3300001  1  1
3300101  0.00050  5.52607  0.0
3300102  0.0  56.4427  4.60506
3300103  0.000046  0.0253  0
3300200  3  1.00E+05  290.00
3301101  330010000  340010003  0.00050  1.0  1.0  0000201
3301201  1.0  0.0  0.0
*
* steam generator downcomer
*
3400000  SGdwncmr  pipe
3400001  11
3400101  0.0401  11
3400301  0.57012  1
3400302  0.63362  2
3400303  0.14208  10
3400304  0.14089  11
3400401  0.0  11
3400601  -90.0  11
3400801  0.000046  0.0445  11
3400901  0.0  0.0  10
3401001  0  11
3401101  0  10
3401201  3  5.15E+05  290.00  0.0  0.0  0.0  11
3401300  1
3401301  1.0  0.0  0.0  10
3401401  0.0445  0.0  1.0  1.0  10
*
3450000  SGdc-blr  sngljun
3450101  340010000  350010002  0.0401  0.6  0.4  200
3450201  1  1.0  0.0  0.0
*
* steam generator boiler
*
3500000  SGboiler  pipe
3500001  13
3500101  0.16045  1
3500102  0.0  2
3500103  0.12391  8
3500104  0.12406  10
3500105  0.0  11
3500106  0.23151  12
3500107  0.0  13
3500301  0.14089  2
3500302  0.14208  10
3500303  0.63362  12
3500304  0.50800  13
3500401  0.0  1
3500402  0.02413  2
3500403  0.0  10
3500404  0.12722  11
3500405  0.0  12
3500406  0.07357  13
```

```
3500601  90.0  13
3500801  0.000002  0.0262  1
3500802  0.000002  0.0279  2
3500803  0.000002  0.0203  8
3500804  0.000002  0.0204  10
3500805  0.000002  0.0984  11
3500806  0.000002  0.5429  12
3500807  0.000002  0.4235  13
3500901  0.0  0.0  1
3500902  20.766  20.766  2
3500903  0.0  0.0  3
3500904  20.766  20.766  4
3500905  0.0  0.0  5
3500906  20.766  20.766  6
3500907  0.0  0.0  7
3500908  20.766  20.766  8
3500909  0.0  0.0  9
3500910  20.766  20.766  10
3500911  0.0  0.0  12
3501001  100  11
3501002  0  13
3501101  0  12
3501201  3  5.15E+05  290.00  0.0  0.0  0.0  8
3501202  2  5.15E+05  1.0  0.0  0.0  0.0  13
3501300  1
3501301  1.0  0.0  0.0  12
3501401  0.0262  0.0  1.0  1.0  1
3501402  0.0279  0.0  1.0  1.0  2
3501403  0.0203  0.0  1.0  1.0  8
3501404  0.0204  0.0  1.0  1.0  10
3501405  0.5429  0.0  1.0  1.0  11
3501406  0.0  0.0  1.0  1.0  12
*
* steam generator steam dome
*
3550000  steamdom  branch
3550001  2  1
3550101  0.0  0.20665  0.03855
3550102  0.0  90.0  0.20665
3550103  0.000046  0.3573  0
3550200  2  5.15E+05  1.00
3551101  350010000  355000000  0.07297  0.0  0.0  0000000
3552101  355010000  390000000  0.00477  0.5  0.9  0000200
3551110  0.3048  0.0  1.0  1.0
3552110  0.0779  0.0  1.0  1.0
3551201  0.0  0.0  0.0
3552201  0.0  0.0  0.0
*
* steam generator steam annulus
*
3600000  steamann  branch
3600001  2  1
3600101  0.0  0.55880  0.0623
3600102  0.0  -90.0  -0.55880
3600103  0.000046  0.1338  0
3600200  2  5.15E+05  1.00
3601101  355000000  360000000  0.0  0.0  0.0  0000000
3602101  360010004  365000000  0.0  0.5  0.9  0000200
3601110  0.2731  0.0  1.0  1.0
3602110  0.1023  0.0  1.0  1.0
3601201  0.0  0.0  0.0
3602201  0.0  0.0  0.0
*
```

```
* steam line from steam generator to valve PCV-602
*
3650000  steamlin  snglvol
3650101  0.00920  0.50000  0.0
3650102  0.0  0.0000  0.0000
3650103  0.000046  0.1082  0
3650200  2  5.15E+05  1.00
*
* valve PCV-602
*
3700000  PCV-602  valve
3700101  365010000  375000000  0.0092  0.0  0.0  0000100
3700201  0  0.0  0.0  0.0
3700300  srvvlv
3700301  370
*
* outlet boundary volume for valve PCV-602

3750000  V602out  tmdpvol
3750101  0.00920  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
3750200  2
3750201  0.0  1.00E+05  1.0
*
* relief line from steam generator to valve PSV-600
*
3900000  reliefln  snglvol
3900101  0.00477  0.1556  0.0
3900102  0.0  90.0000  0.1556
3900103  0.000046  0.0779  0
3900200  2  5.15E+05  1.00
*
* valve PSV-600
*
3950000  PSV-600  valve
3950101  390010000  398000000  0.00477  0.0  0.0  0000100
3950201  0  0.0  0.0  0.0
3950300  trpvlv
3950301  1395
*
* outlet boundary volume for valve PSV-600
*
3980000  V600out  tmdpvol
3980101  0.00477  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
3980200  2
3980201  0.0  1.00E+05  1.0
*
* potable water source boundary volume
*
4000000  potsorce  tmdpvol
4000101  0.00050  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
4000200  3
4000201  0.0  1.50E+05  290.00
*
* valve LCV-010
*
4100000  LCV-010  valve
4100101  400010000  420000000  0.00050  0.0  0.0  0001100
4100201  0  0.0  0.0  0.0
4100300  srvvlv
4100301  410
*
* water pipe from valve LCV-010 to tank T-010
*
```

```
4200000  potwater  branch
4200001  1  1
4200101  0.00050  2.00000  0.0
4200102  0.0  0.0000  0.0
4200103  0.000046  0.0253  0
4200200  3  1.00E+05  290.00
4201101  420010000  450000000  0.00050  1.0  0.5  0001200
4201201  0.0  0.0  0.0
*
* water storage tank T-010
*
4500000  tankT010  pipe
4500001  6
4500101  0.0  6
4500301  0.03490  1
4500302  0.08260  2
4500303  0.03490  4
4500304  0.08260  5
4500305  0.03490  6
4500401  0.01255  1
4500402  0.05790  2
4500403  0.02866  4
4500404  0.05790  5
4500405  0.01262  6
4500601  90.0  6
4500801  0.000046  0.0  6
4500901  0.0  0.0  5
4501001  0000000  1
4501002  1100000  4
4501003  100000  5
4501004  0000000  6
4501101  1000  5
4501201  3  2.00E+05  290.00  0.0  0.0  0.0  4
4501202  8  1.00E+05  290.00  290.00  0.8  0.9  5
4501203  8  1.00E+05  290.00  290.00  1.0  0.9  6
4501300  1
4501301  0.0  0.0  0.0  5
4501401  0.0  0.0  1.0  1.0  5
*
* outlet line from tank to SG, RCCS, and drain
*
4600000  tankout  branch
4600001  1  1
4600101  0.00111  2.33918  0.0
4600102  0.0  -90.0  -2.33918
4600103  0.000046  0.03762  0
4600200  3  2.00E+05  290.00
4601101  450000000  460000000  0.00111  0.5  1.0  0001000
4601201  0.0  0.0  0.0
*
* water storage tank vent line
*
4900000  tankvent  branch
4900001  2  1
4900101  0.00131  0.35560  0.0
4900102  0.0  -90.0  -0.35560
4900103  0.000046  0.04089  0
4900200  4  1.00E+05  300.00  1.0
4901101  450060001  490000000  0.0  0.5  1.0  1200
4902101  490010000  498000000  0.0  1.0  0.5  1200
4901201  0.0  0.0  0.0
4902201  0.0  0.0  0.0
*
```

```
* outlet boundary volume for tank vent line
*
4980000  ventout  tmdpvol
4980101  0.00131  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
4980200  4
4980201  0.0  1.00E+05  300.00  1.0
*
* CRD break line connection from upper plenum
*
*050000  UP-CRD  sngljun
*050101  120010000  10000000  0.01174  0.48  0.91  0000200
*050201  0  0.0  0.0  0.0
*
* CRD break line pressure vessel nozzle
*
*100000  CRDnozzl  pipe
*100001  25
*100101  0.01174  25
*100301  0.01955  25
*100401  0.0  25
*100601  90.0  25
*100701  0.01955  25
*100801  0.000046  0.122  25
*100901  0.0  0.0  24
*101001  0  25
*101101  0  24
*101201  3  7.00E+05  531.75  0.0  0.0  0.0  25
*101300  1
*101301  0.0  0.0  0.0  24
*
* CRD break line connection from nozzle to pipe
*
*150000  UP-CRD  sngljun
*150101  10010000  20000000  0.00742  0.30  1.93  0000200
*150201  0  0.0  0.0  0.0
*
* CRD break line from nozzle to valve
*
*200000  CRDbrkp1  pipe
*200001  35
*200101  0.00742  35
*200301  0.02041  35
*200401  0.0  35
*200601  0.00000  35
*200701  0.00000  35
*200801  0.000046  0.09718  35
*200901  0.0  0.0  34
*201001  0  35
*201101  0  34
*201201  3  7.00E+05  531.75  0.0  0.0  0.0  35
*201300  1
*201301  0.0  0.0  0.0  34
*
* CRD break valve
*
*250000  CRDbrkv  valve  * valve V-332
*250101  20010000  30000000  0.00742  0.057  0.057  0000200
*250201  0  0.0  0.0  0.0
*250300  trpvlv
*250301  25
*
* CRD break line from valve to RCST
*
```

```
*300000  CRDbrkp2  pipe
*300001  92
*300101  0.00742  92
*300301  0.01998  92
*300401  0.0  92
*300601  -3.64256  92
*300701  -0.001269  92
*300801  0.000046  0.09718  92
*300901  0.0  0.0  91
*301001  0  92
*301101  0  91
*301201  3  7.00E+05  300.00  0.0  0.0  0.0  92
*301300  1
*301301  0.0  0.0  0.0  91
*
*310000  CRD-2-3  sngljun
*310101  30010000  32000000  0.00742  0.00  0.00  0000000
*310201  0  0.0  0.0  0.0
*
*320000  CRDbrkp3  pipe
*320001  92
*320101  0.00742  92
*320301  0.01998  92
*320401  0.0  92
*320601  -3.64256  92
*320701  -0.001269  92
*320801  0.000046  0.09718  92
*320901  0.0  0.0  91
*321001  0  92
*321101  0  91
*321201  3  7.00E+05  300.00  0.0  0.0  0.0  92
*321300  1
*321301  0.0  0.0  0.0  91
*
*330000  CRD-3-4  sngljun
*330101  32010000  34000000  0.00742  0.00  0.00  0000000
*330201  0  0.0  0.0  0.0
*
*340000  CRDbrkp4  pipe
*340001  92
*340101  0.00742  92
*340301  0.01998  92
*340401  0.0  92
*340601  -3.64256  92
*340701  -0.001269  92
*340801  0.000046  0.09718  92
*340901  0.0  0.0  91
*341001  0  92
*341101  0  91
*341201  3  7.00E+05  300.00  0.0  0.0  0.0  92
*341300  1
*341301  0.0  0.0  0.0  91
*
* CRD break line connection to RCST
*
*350000  CRD-RCST  sngljun
*350101  34010000  280010000  0.00742  1.00  0.50  0000200
*350201  0  0.0  0.0  0.0
*
* vessel bottom break line connection from core support region
*
*550000  vs-btbrk  sngljun
*550101  105010005  60000000  0.00742  0.50  0.99  0000202
```

```
*550201  0  0.0  0.0  0.0
*
* vessel bottom break line pressure vessel nozzle stub
*
*600000  vbtnozzl  pipe
*600001  43
*600101  0.00742  43
*600301  0.020084  43
*600401  0.0  43
*600601  -90.0  43
*600701  -0.0200837 43
*600801  0.000046  0.097  43
*600901  0.0  0.0  42
*601001  0  43
*601101  0  42
*601201  3  7.00E+05  531.75  0.0  0.0  0.0  43
*601300  1
*601301  0.0  0.0  0.0  42
*
* vessel bottom break line connection from nozzle to pipe
*
*650000  nozl-pip  sngljun
*650101  60010000  70000000  0.00742  0.5  1.0  0000200
*650201  0  0.0  0.0  0.0
*
* vessel bottom break line from nozzle to valve
*
*700000  vbtbrkp1  pipe
*700001  73
*700101  0.00742  73
*700301  0.02009  73
*700401  0.0  73
*700601  -5.33641  73
*700701  -0.001868  73
*700801  0.000046  0.09718  73
*700901  0.0  0.0  72
*701001  0  73
*701101  0  72
*701201  3  7.00E+05  531.75  0.0  0.0  0.0  73
*701300  1
*701301  0.0  0.0  0.0  72
*
*710000  vbt-1-2  sngljun
*710101  70010000  72000000  0.00742  0.0  0.0  0000000
*710201  0  0.0  0.0  0.0
*
* vessel bottom break line from nozzle to valve
*
*720000  vbtbrkp1  pipe
*720001  73
*720101  0.00742  73
*720301  0.02009  73
*720401  0.0  73
*720601  -5.33641  73
*720701  -0.001868  73
*720801  0.000046  0.09718  73
*720901  0.0  0.0  72
*721001  0  73
*721101  0  72
*721201  3  7.00E+05  531.75  0.0  0.0  0.0  73
*721300  1
*721301  0.0  0.0  0.0  72
*
```

```
* vessel bottom break valve
*
*750000  vbtbrkv  valve  * valve V-331
*750101  72010000  80000000  0.00742  0.057  0.057  0000200
*750201  0  0.0  0.0  0.0
*750300  trpvlv
*750301  75
*
* vessel bottom break line from valve to RCST
*
*800000  vbtbrkp3  pipe
*800001  96
*800101  0.00742  96
*800301  0.01999  96
*800401  0.0  96
*800601  0.00000  96
*800701  0.00000  96
*800801  0.000046  0.09718  96
*800901  0.0  0.0  95
*801001  0  96
*801101  0  95
*801201  3  1.00E+05  300.00  0.0  0.0  0.0  96
*801300  1
*801301  0.0  0.0  0.0  95
*
* vessel bottom break line connection to RCST
*
*850000  vbt-RCST  sngljun
*850101  80010000  280000000  0.00742  1.00  0.50  0000200
*850201  0  0.0  0.0  0.0
*
* cavity air volume
*
*9000000  cavity  pipe
*9000001  20
*9000101  3.8  20
*9000301  1.35230  1
*9000302  0.32728  2
*9000303  0.22225  3
*9000304  0.25146  4
*9000305  0.25146  5
*9000306  0.19812  15
*9000307  0.19050  16
*9000308  0.20320  17
*9000309  0.27320  18
*9000310  0.83185  19
*9000311  1.69969  20
*9000401  0.0  20
*9000601  90.0  20
*9000801  0.000046  0.0  20
*9000901  0  0.0  19
*9001001  0  20
*9001101  0  19
*9001201  4  1.00E+05  300.00  0.0  0.0  0.0  20
*9001300  1
*9001301  0.0  0.0  0.0  19
*9001401  0.0  0.0  1.0  1.0  19
*
9030000  confineo  sngljun
9030101  900010000  905000000  0.0  0.0  0.0  0
9030201  0  0.0  0.0  0.0
*
```

```
* The single volume below can be used instead of the pipe if axial conduction in the vessel and RCCS are not modeled
*  or if the code input provides the height for each structure instead of defaulting to that of the adjacent fluid volume.
*
9000000  cavity  snglvol
9000101  3.77189  5.8  0.0
9000102  0.0  90.0  5.8
9000103  0.000046  0  0
9000200  4  1.00E+05  300.00  0.0
*
9050000  confinea  tmdpvol
9050101  3.8  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
9050200  4
9050201  0.0  1.00E+05  300.00  0.0
*
* alternate RCCS source volume
*
*9150000  RCCSsrc  tmdpvol
*9150101  0.0011  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
*9150200  3
*9150201  0.0  1.00E+05  290.00
*
* RCCS pump
*
9200000  RCCSpump  tmdpjun
9200101  460010000  930000000  0.00050
* use the card below if the alternate source volume (Component 915) is used
*9200101  915010000  930000000  0.00050
9200200  1  0  cntrlvar  920
9200201  0.02  0.02  0.0  0.0
9200202  4.0  4.0  0.0  0.0
*
* RCCS piping from pump to inlet headers
*
9300000  RCCSinp2  snglvol
9300101  0.00050  3.00000  0.0
9300102  0.0  -3.7  -0.19320
9300103  0.000046  0.02527  0
9300200  3  2.00E+05  290.00
*
* RCCS inlet header
*
9400000  RCCSihdr  branch
9400001  1  1
9400101  0.00050  8.68680  0.0
9400102  0.0  0.0  0.0
9400103  0.000046  0.0  0
9400200  3  2.00E+05  290.00
9401101  930010000  940010003  0.00050  1.1  0.7  0001201
9401201  0.0  0.0  0.0
*
* RCCS panel inlet lines
*
9450000  RCCSpnli  branch
9450001  2  1
9450101  0.00225  1.00000  0.0
9450102  0.0  13.21466  0.22860
9450103  0.000046  0.01892  0
9450200  3  2.00E+05  290.00
9451101  940010004  945000000  0.0  0.0  0  1000
9452101  945010000  950000000  0.0  0.0  0.0  1000
9451201  0.0  0.0  0.0
```

```
9452201  0.0  0.0  0.0
*
* RCCS panels
*
9500000  RCCSpanl  pipe
9500001  19
9500101  0.2230  19
9500301  1.02210  1
9500302  0.32728  2
9500303  0.22225  3
9500304  0.25146  4
9500305  0.25146  5
9500306  0.19812  15
9500307  0.19050  16
9500308  0.20320  17
9500309  0.27320  18
9500310  0.74846  19
9500401  0.0  19
9500601  90.0  19
9500801  0.000046  0.051  19
9500901  0.0  0.0  18
9501001  0  19
9501101  1000  18
9501201  3  2.00E+05  290.00  0.0  0.0  0.0  19
9501300  1
9501301  0.01  0.0  0.0  18
9501401  0.051  0.0  1.0  1.0  18
*
* RCCS panel outlet lines
*
9550000  RCCSpnlo  branch
9550001  2  1
9550101  0.0022  1.0000  0.0
9550102  0.0  5.7  0.0987
9550103  0.000046  0.0189  0
9550200  3  2.00E+05  290.00
9551101  950010000  955000000  0.0  0.0  0.0  1000
9552101  955010000  960000000  0.0  0.0  0.0  1000
9551110  0.0189  0.0  1.0  1.0
9552110  0.0189  0.0  1.0  1.0
9551201  0.0  0.0  0.0
9552201  0.0  0.0  0.0
*
* RCCS outlet headers
*
9600000  RCCSohdr  branch
9600001  1  1
9600101  0.0  5.4758  0.009198
9600102  0.0  -33.6898  -3.0374
9600103  0.000046  0.0253  0
9600200  3  2.00E+05  290.00
9601101  960010000  450050003  0.0022  1.0  0.5  0001000
* use the card below for the once-through RCCS model (Component 965 enabled)
*9601101  960010000  965000000  0.0022  0.0  0.0  0001000
9601110  0.0376  0.0  1.0  1.0
9601201  0.0  0.0  0.0
*
* use this component for the once-through RCCS model
*
*9650000  RCCSout  tmdpvol
*9650101  0.0022  1.0  0.0  0.0  0.0  0.0  0.0  0.0  10
*9650200  3
*9650201  0.0  1.00E+05  290.00
```

```
*
*****************************************************
* heat structures
*****************************************************
*
* primary pressure vessel cylindrical wall - heat structure 1000
*
11000000  17  6  2  1  0.81915  3
11000100  0  1
11000101  5  0.83185
11000201  3  5  * 304 stainless steel
11000301  0.0  5
11000400  0
11000401  531.75  6
11000501  100010000  0  1  1  0.3273  1
11000502  100010000  0  1  1  0.2223  2
11000503  115010000  0  1  1  0.2515  3
11000504  115020000  0  1  1  0.2515  4
11000505  115030000  10000  1  1  0.1981  14
11000506  115130000  0  1  1  0.1905  15
11000507  115140000  0  1  1  0.2032  16
11000508  115150000  0  1  1  0.2732  17
11000600  1
11000601  900010000  0  1  1  0.3273  0.3273  1
11000602  900010000  0  1  1  0.2223  0.2223  2
11000603  900010000  0  1  1  0.2515  0.2515  3
11000604  900010000  0  1  1  0.2515  0.2515  4
11000605  900010000  0  1  1  0.1981  0.1981  14
11000606  900010000  0  1  1  0.1905  0.1905  15
11000607  900010000  0  1  1  0.2032  0.2032  16
11000608  900010000  0  1  1  0.2732  0.2732  17
11000701  0  0.0  0.0  0.0  17
11000800  1
11000801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.7  1.1  1.0  17
11000900  1
11000901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.7  1.1  1.0  17
*
* primary pressure vessel upper head/upper plenum shroud - heat structure 1001
*
11001000  1  14  3  1  0.7635875 0
11001100  0  1
11001101  2  0.76662534  * shroud
11001102  6  0.81915  * insulation
11001103  5  0.83185  * vessel head
11001201  -4  2  * Haynes 230
11001202  -8  8  * Cerablanket
11001203  3  13  * 304 stainless steel
11001301  0.0  13
11001400  0
11001401  531.75  14
11001501  120010000  0  1  1  0.5  1
11001601  900010000  0  1  1  0.5  1
11001701  0  0.0  0.0  0.0  1
11001800  1
11001801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.76  1.1  1.0  1
11001900  1
11001901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.83  1.1  1.0  1
*
* primary pressure vessel lower head - heat structure 1002
*
11002000  1  6  3  1  0.81915  0
11002100  0  1
11002101  5  0.83185
```

```
11002201  3  5
11002301  0.00  5
11002400  0
11002401  531.75  6
11002501  190010000  0  1  1  0.5  1
11002601  900010000  0  1  1  0.5  1
11002701  0  0.0  0.0  0.0  1
11002800  1
11002801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.82  1.1  1.0  1
11002900  1
11002901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.83  1.1  1.0  1
*
* middle distributor plate - heat structure 1050
*
11050000  1  3  1  1  0.0  0
11050100  0  1
11050101  2  0.01270
11050201  3  2
11050301  0.0  2
11050400  0
11050401  531.75  3
11050501  105010000  0  1  0  1.61089  1
11050601  105020000  0  1  0  1.61089  1
11050701  0  0.0  0.0  0.0  1
11050800  1
11050801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.01  1.1  1.0  1
11050900  1
11050901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.01  1.1  1.0  1
*
* jacket shell/coolant upcomer
*
11100000  1  4  2  1  0.78105  3
11100100  0  1
11100101  3  0.7858125
11100201  3  3
11100301  0  3
11100400  0
11100401  531.75  4
11100501  110010000  0  1  1  0.403475  1
11100601  100010000  0  1  1  0.403475  1
11100701  0  0  0  0  1
11100800  1
11100801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.40  1.1  1.0  1
11100900  1
11100901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.40  1.1  1.0  1
*
* core barrel - heat structure 1150
*
11150000  16  5  2  1  0.7572375 3
11150100  0  1
11150101  4  0.762
11150201  3  4
11150301  0.0  4
11150400  0
11150401  531.75  5
11150501  105010000  0  1  1  0.327275  1
11150502  166150000  0  1  1  0.22225  2
11150503  166140000  0  1  1  0.25146  3
11150504  166130000  0  1  1  0.25146  4
11150505  166120000  -10000  1  1  0.19812  14
11150506  166020000  0  1  1  0.1905  15
11150507  166010000  0  1  1  0.2032  16
11150601  100010000  0  1  1  0.327275  1
```

```
11150602  110010000  0  1  1  0.22225  2
11150603  115010000  0  1  1  0.25146  3
11150604  115020000  0  1  1  0.25146  4
11150605  115030000  10000  1  1  0.19812  14
11150606  115130000  0  1  1  0.19050  15
11150607  115140000  0  1  1  0.20320  16
11150701  0.0  0.0  0.0  0.0  16
11150800  1
11150801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.4  1.1  1.0  16
11150900  1
11150901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.4  1.1  1.0  16
*
* upper plenum cylinder - heat structure 1200
*
11200000  1  5  2  1  0.76359
11200100  0  1
11200101  4  0.76663
11200201  4  4
11200301  0.0  4
11200400  0
11200401  531.75  5
11200501  120010000  0  1  1  0.27320  1
11200601  115150000  0  1  1  0.27320  1
11200701  0  0.0  0.0  0.0  1
11200800  1
11200801  0.00  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.3  1.1  1.0  1
11200900  1
11200901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.3  1.1  1.0  1
*
* upper plenum floor - heat structure 1201
*
11201000  1  5  1  1  0.0  0
11201100  0  1
11201101  4  0.01270
11201201  2  4  * graphite
11201301  0.0  4
11201400  0
11201401  531.75  5
11201501  0  0  0  0  1.67326  1
11201601  120010000  0  1  0  1.67326  1
11201701  0  0.0  0.0  0.0  1
11201900  1
11201901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.01  1.1  1.0  1
*
* upper plenum internals - heat structure 1202
*
11202000  1  3  2  1  0.01100  0
11202100  0  1
11202101  2  0.01300
11202201  3  2
11202301  0  2
11202400  0
11202401  531.75  3
11202501  0  0  0  1  35.0622  1
11202601  120010000  0  1  1  35.0622  1
11202701  0  0.0  0.0  0.0  1
11202900  1
11202901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.96  1.1  1.0  1
*
* central reflector inner piece - heat structure 1300
*
11300000  14  7  2  0  0.0  3
11300100  0  1
```

```
11300101  6  0.0751364
11300201  1  6
11300301  0.0  6
11300400  -1
11300401  533.20  533.20  533.20  533.20  533.20  533.20  533.20
11300402  537.57  537.57  537.57  537.57  537.57  537.57  537.57
11300403  739.67  739.67  739.67  739.67  739.67  739.67  739.67
11300404  791.93  791.93  791.93  791.93  791.93  791.93  791.93
11300405  839.49  839.49  839.49  839.49  839.49  839.49  839.49
11300406  887.12  887.12  887.12  887.12  887.12  887.12  887.12
11300407  933.84  933.84  933.84  933.84  933.84  933.84  933.84
11300408  978.77  978.77  978.77  978.77  978.77  978.77  978.77
11300409  1024.2  1024.2  1024.2  1024.2  1024.2  1024.2  1024.2
11300410  1069.7  1069.7  1069.7  1069.7  1069.7  1069.7  1069.7
11300411  1115.2  1115.2  1115.2  1115.2  1115.2  1115.2  1115.2
11300412  1158.4  1158.4  1158.4  1158.4  1158.4  1158.4  1158.4
11300413  1025.5  1025.5  1025.5  1025.5  1025.5  1025.5  1025.5
11300414  1024.5  1024.5  1024.5  1024.5  1024.5  1024.5  1024.5
11300501  0  0  0  1  0.1905  1
11300502  0  0  0  1  0.1905  2
11300503  0  0  0  1  0.1981  12
11300504  0  0  0  1  0.2515  13
11300505  0  0  0  1  0.2515  14
11300600  1
11300601  0  0  0  1  0.1905  0.1905  1
11300602  0  0  0  1  0.1905  0.1905  2
11300603  0  0  0  1  0.1981  0.1981  12
11300604  0  0  0  1  0.2515  0.2515  13
11300605  0  0  0  1  0.2515  0.2515  14
11300701  0.0  0.0  0.0  0.0  14
11300900  1
11300901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
*
* central reflector middle piece - heat structure 1320
*
11320000  14  6  2  0  0.009525  3
11320100  0  1
11320101  5  0.0601091
11320201  1  5
11320301  0.0  5
11320400  -1
11320401  532.96  533.04  533.10  533.14  533.17  533.20
11320402  535.95  536.49  536.86  537.15  537.37  537.57
11320403  680.83  700.65  714.18  724.46  732.74  739.67
11320404  724.45  747.18  762.70  774.48  783.98  791.93
11320405  765.58  790.48  807.48  820.38  830.78  839.49
11320406  807.41  834.26  852.59  866.51  877.72  887.12
11320407  849.19  877.70  897.17  911.95  923.86  933.84
11320408  890.21  920.04  940.41  955.87  968.34  978.77
11320409  931.99  963.05  984.26  1000.4  1013.3  1024.2
11320410  974.19  1006.4  1028.3  1045.0  1058.4  1069.7
11320411  1016.8  1049.9  1072.6  1089.8  1103.6  1115.2
11320412  1058.1  1091.9  1114.9  1132.5  1146.6  1158.4
11320413  983.51  997.65  1007.3  1014.6  1020.5  1025.5
11320414  982.86  996.88  1006.5  1013.7  1019.6  1024.5
11320501  132010000  0  160  1  1.1430  1
11320502  132020000  0  160  1  1.1430  2
11320503  132030000  10000  160  1  1.1887  12
11320504  132130000  0  160  1  1.5088  13
11320505  132140000  0  160  1  1.5088  14
11320601  0  0  0  1  1.1430  1
11320602  0  0  0  1  1.1430  2
11320603  0  0  0  1  1.1887  12
```

```
11320604  0  0  0  1  1.5088  13
11320605  0  0  0  1  1.5088  14
11320701  0  0.0  0.0  0.0  14
11320800  1
11320801  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11320802  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
11320803  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  3
11320804  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  4
11320805  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  5
11320806  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  6
11320807  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  7
11320808  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  8
11320809  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  9
11320810  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  10
11320811  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  11
11320812  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  12
11320813  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  13
11320814  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
*
* central reflector outer piece - heat structure 1340
*
11340000  14  7  2  0  0.1653000 3
11340100  0  1
11340101  6  0.1771399
11340201  1  6
11340301  0.0  6
11340400  -1
11340401  533.20  533.20  533.20  533.20  533.20  533.20  533.20
11340402  537.57  537.57  537.57  537.57  537.57  537.57  537.57
11340403  739.67  739.67  739.67  739.67  739.67  739.67  739.67
11340404  791.93  791.93  791.93  791.93  791.93  791.93  791.93
11340405  839.49  839.49  839.49  839.49  839.49  839.49  839.49
11340406  887.12  887.12  887.12  887.12  887.12  887.12  887.12
11340407  933.84  933.84  933.84  933.84  933.84  933.84  933.84
11340408  978.77  978.77  978.77  978.77  978.77  978.77  978.77
11340409  1024.2  1024.2  1024.2  1024.2  1024.2  1024.2  1024.2
11340410  1069.7  1069.7  1069.7  1069.7  1069.7  1069.7  1069.7
11340411  1115.2  1115.2  1115.2  1115.2  1115.2  1115.2  1115.2
11340412  1158.4  1158.4  1158.4  1158.4  1158.4  1158.4  1158.4
11340413  1025.5  1025.5  1025.5  1025.5  1025.5  1025.5  1025.5
11340414  1024.5  1024.5  1024.5  1024.5  1024.5  1024.5  1024.5
11340500  1
11340501  0  0  0  1  0.1905  0.1905  1
11340502  0  0  0  1  0.1905  0.1905  2
11340503  0  0  0  1  0.1981  0.1981  12
11340504  0  0  0  1  0.2515  0.2515  13
11340505  0  0  0  1  0.2515  0.2515  14
11340601  0  0  0  1  0.1905  1
11340602  0  0  0  1  0.1905  2
11340603  0  0  0  1  0.1981  12
11340604  0  0  0  1  0.2515  13
11340605  0  0  0  1  0.2515  14
11340701  0.0  0.0  0.0  0.0  14
11340800  1
11340801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
11340900  1
11340901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
*
* upper reflector above inner core ring - heat structure 1400
*
11400000  2  3  2  1  0.0079375 3
11400100  0  1
11400101  2  0.0187832
```

```
11400201  1  2
11400301  0.0  2
11400400  0
11400401  533.2  3
11400501  140010000  0  160  1  23.32  1
11400502  140020000  0  160  1  23.32  2
11400601  0  0  0  1  23.32  1
11400602  0  0  0  1  23.32  2
11400701  0  0.0  0.0  0.0  2
11400800  1
11400801  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11400802  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
*
* inner core ring - heat structure 1401
*
11401000  10  5  2  1  0.0079375 3
11401100  0  1
11401101  4  0.0187832
11401201  1  4
11401301  0.0  4
11401400  -1
11401401  767.99  774.87  780.36  784.93  788.84
11401402  827.26  834.21  839.76  844.38  848.33
11401403  880.60  887.42  892.86  897.39  901.27
11401404  933.46  940.15  945.50  949.95  953.76
11401405  984.62  991.22  996.49  1000.9  1004.6
11401406  1033.0  1039.6  1044.8  1049.1  1052.8
11401407  1081.7  1088.2  1093.3  1097.6  1101.3
11401408  1130.2  1136.6  1141.7  1145.9  1149.5
11401409  1178.4  1184.7  1189.8  1194.0  1197.5
11401410  1223.8  1229.9  1234.8  1238.9  1242.3
11401501  140030000  10000  160  1  24.25  10
11401601  141010000  10000  1  1  24.25  10
11401701  0  0.0  0.0  0.0  10
11401800  1
11401801  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11401802  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
11401803  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  3
11401804  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  4
11401805  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  5
11401806  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  6
11401807  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  7
11401808  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  8
11401809  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  9
11401810  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  10
11401900  1
11401901  0.0  0.10  1.88  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  1
11401902  0.0  0.30  1.68  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  2
11401903  0.0  0.50  1.49  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  3
11401904  0.0  0.69  1.29  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  4
11401905  0.0  0.89  1.09  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  5
11401906  0.0  1.09  0.89  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  6
11401907  0.0  1.29  0.69  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  7
11401908  0.0  1.49  0.50  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  8
11401909  0.0  1.68  0.30  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  9
11401910  0.0  1.88  0.10  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* lower reflector below inner core ring - heat structure 1402
*
11402000  2  3  2  1  0.0079375 3
11402100  0  1
11402101  2  0.0187832
11402201  1  2
```

```
11402301  0.0  2
11402400  0
11402401  1070.0  3
11402501  140130000  0  160  1  30.78  1
11402502  140140000  0  160  1  30.78  2
11402601  0  0  0  1  30.78  1
11402602  0  0  0  1  30.78  2
11402701  0  0.0  0.0  0.0  2
11402800  1
11402801  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11402802  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
*
* inner core ring heater rod - heat structure 1403
*
11403000  10  4  2  1  0.0  3
11403100  0  1
11403101  3  0.007256448
11403201  2  3
11403301  1.0  3
11403400  -1
11403401  767.99  774.87  780.36  784.93
11403402  827.26  834.21  839.76  844.38
11403403  880.60  887.42  892.86  897.39
11403404  933.46  940.15  945.50  949.95
11403405  984.62  991.22  996.49  1000.9
11403406  1033.0  1039.6  1044.8  1049.1
11403407  1081.7  1088.2  1093.3  1097.6
11403408  1130.2  1136.6  1141.7  1145.9
11403409  1178.4  1184.7  1189.8  1194.0
11403410  1223.8  1229.9  1234.8  1238.9
11403501  0  0  0  1  11.09  10
11403600  1
11403601  0  0  0  1  11.09  0.19812  10
11403701  10940  0.1000  0.0  0.0  1
11403702  10940  0.1000  0.0  0.0  2
11403703  10940  0.1000  0.0  0.0  3
11403704  10940  0.1000  0.0  0.0  4
11403705  10940  0.1000  0.0  0.0  5
11403706  10940  0.1000  0.0  0.0  6
11403707  10940  0.1000  0.0  0.0  7
11403708  10940  0.1000  0.0  0.0  8
11403709  10940  0.1000  0.0  0.0  9
11403710  10940  0.1000  0.0  0.0  10
11403900  1
11403901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* upper reflector above middle core ring - heat structure 1450
*
11450000  2  3  2  1  0.0079375 3
11450100  0  1
11450101  2  0.0171146
11450201  1  2
11450301  0.0  2
11450400  0
11450401  533.2  3
11450501  145010000  0  160  1  27.43  1
11450502  145020000  0  160  1  27.43  2
11450601  0  0  0  1  27.43  1
11450602  0  0  0  1  27.43  2
11450701  0  0.0  0.0  0.0  2
11450800  1
11450801  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11450802  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
```

```
*
* middle core ring - heat structure 1451
*
11451000  10  5  2  1  0.0079375 3
11451100  0  1
11451101  4  0.0171146
11451201  1  4
11451301  0.0  4
11451400  -1
11451401  733.78  739.23  743.69  747.47  750.75
11451402  786.29  791.85  796.41  800.27  803.61
11451403  834.38  839.90  844.43  848.26  851.59
11451404  882.29  887.77  892.26  896.07  899.37
11451405  929.80  935.23  939.68  943.46  946.73
11451406  976.68  982.06  986.47  990.20  993.44
11451407  1023.4  1028.7  1033.1  1036.8  1040.0
11451408  1068.4  1073.7  1078.0  1081.7  1084.9
11451409  1112.3  1117.6  1122.0  1125.6  1128.8
11451410  1154.1  1159.3  1163.6  1167.2  1170.3
11451501  145030000  10000  160  1  28.53  10
11451601  146010000  10000  1  1  28.53  10
11451701  0  0.0  0.0  0.0  10
11451800  1
11451801  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11451802  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
11451803  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  3
11451804  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  4
11451805  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  5
11451806  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  6
11451807  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  7
11451808  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  8
11451809  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  9
11451810  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  10
11451900  1
11451901  0.0  0.10  1.88  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  1
11451902  0.0  0.30  1.68  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  2
11451903  0.0  0.50  1.49  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  3
11451904  0.0  0.69  1.29  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  4
11451905  0.0  0.89  1.09  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  5
11451906  0.0  1.09  0.89  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  6
11451907  0.0  1.29  0.69  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  7
11451908  0.0  1.49  0.50  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  8
11451909  0.0  1.68  0.30  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  9
11451910  0.0  1.88  0.10  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* lower reflector below middle core ring - heat structure 1452
*
11452000  2  3  2  1  0.0079375 3
11452100  0  1
11452101  2  0.0171146
11452201  1  2
11452301  0.0  2
11452400  0
11452401  1020.0  3
11452501  145130000  0  160  1  36.21  1
11452502  145140000  0  160  1  36.21  2
11452601  0  0  0  1  36.21  1
11452602  0  0  0  1  36.21  2
11452701  0  0.0  0.0  0.0  2
11452800  1
11452801  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11452802  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
*
```

```
* middle core ring heater rod - heat structure 1453
*
11453000  10  4  2  1  0.0  3
11453100  0  1
11453101  3  0.007256448
11453201  2  3
11453301  1.0  3
11453400  -1
11453401  767.99  774.87  780.36  784.93
11453402  827.26  834.21  839.76  844.38
11453403  880.60  887.42  892.86  897.39
11453404  933.46  940.15  945.50  949.95
11453405  984.62  991.22  996.49  1000.9
11453406  1033.0  1039.6  1044.8  1049.1
11453407  1081.7  1088.2  1093.3  1097.6
11453408  1130.2  1136.6  1141.7  1145.9
11453409  1178.4  1184.7  1189.8  1194.0
11453410  1223.8  1229.9  1234.8  1238.9
11453501  0  0  0  1  14.26  10
11453600  1
11453601  0  0  0  1  14.26  0.19812  10
11453701  10945  0.1000  0.0  0.0  1
11453702  10945  0.1000  0.0  0.0  2
11453703  10945  0.1000  0.0  0.0  3
11453704  10945  0.1000  0.0  0.0  4
11453705  10945  0.1000  0.0  0.0  5
11453706  10945  0.1000  0.0  0.0  6
11453707  10945  0.1000  0.0  0.0  7
11453708  10945  0.1000  0.0  0.0  8
11453709  10945  0.1000  0.0  0.0  9
11453710  10945  0.1000  0.0  0.0  10
11453900  1
11453901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* upper reflector above outer core ring - heat structure 1500
*
11500000  2  3  2  1  0.0079375 3
11500100  0  1
11500101  2  0.0198877
11500201  1  2
11500301  0.0  2
11500400  0
11500401  533.2  3
11500501  150010000  0  160  1  36.58  1
11500502  150020000  0  160  1  36.58  2
11500601  0  0  0  1  36.58  1
11500602  0  0  0  1  36.58  2
11500701  0  0  0  0  2
11500800  1
11500801  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11500802  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
*
* outer core ring - heat structure 1501
*
11501000  10  5  2  1  0.0079375 3
11501100  0  1
11501101  4  0.0198877
11501201  1  4
11501301  0.0  4
11501400  -1
11501401  695.29  701.05  705.62  709.39  712.61
11501402  737.65  743.55  748.21  752.08  755.37
11501403  776.46  782.33  786.97  790.81  794.09
```

```
11501404  815.25  821.09  825.71  829.54  832.80
11501405  854.03  859.84  864.44  868.25  871.50
11501406  892.74  898.53  903.11  906.90  910.14
11501407  931.48  937.25  941.81  945.59  948.82
11501408  969.96  975.71  980.25  984.02  987.22
11501409  1008.3  1014.0  1018.5  1022.3  1025.5
11501410  1044.5  1050.1  1054.5  1058.2  1061.4
11501501  150030000  10000  160  1  38.04  10
11501601  151010000  10000  1  1  38.04  10
11501701  0  0.0  0.0  0.0  10
11501800  1
11501801  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11501802  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
11501803  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  3
11501804  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  4
11501805  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  5
11501806  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  6
11501807  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  7
11501808  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  8
11501809  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  9
11501810  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  10
11501900  1
11501901  0.0  0.10  1.88  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  1
11501902  0.0  0.30  1.68  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  2
11501903  0.0  0.50  1.49  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  3
11501904  0.0  0.69  1.29  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  4
11501905  0.0  0.89  1.09  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  5
11501906  0.0  1.09  0.89  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  6
11501907  0.0  1.29  0.69  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  7
11501908  0.0  1.49  0.50  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  8
11501909  0.0  1.68  0.30  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  9
11501910  0.0  1.88  0.10  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* lower reflector below outer core ring - heat structure 1502
*
11502000  2  3  2  1  0.0079375 3
11502100  0  1
11502101  2  0.0198877
11502201  1  2
11502301  0.0  2
11502400  0
11502401  929.0  3
11502501  150130000  0  160  1  48.28  1
11502502  150140000  0  160  1  48.28  2
11502601  0  0  0  1  48.28  1
11502602  0  0  0  1  48.28  2
11502701  0  0.0  0.0  0.0  2
11502800  1
11502801  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11502802  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
*
* outer core ring heater rod - heat structure 1503
*
11503000  10  4  2  1  0.0  3
11503100  0  1
11503101  3  0.007256448
11503201  2  3
11503301  1.0  3
11503400  -1
11503401  767.99  774.87  780.36  784.93
11503402  827.26  834.21  839.76  844.38
11503403  880.60  887.42  892.86  897.39
11503404  933.46  940.15  945.50  949.95
```

```
11503405  984.62  991.22  996.49  1000.9
11503406  1033.0  1039.6  1044.8  1049.1
11503407  1081.7  1088.2  1093.3  1097.6
11503408  1130.2  1136.6  1141.7  1145.9
11503409  1178.4  1184.7  1189.8  1194.0
11503410  1223.8  1229.9  1234.8  1238.9
11503501  0  0  0  1  16.25  10
11503600  1
11503601  0  0  0  1  16.25  0.19812  10
11503701  10950  0.1000  0.0  0.0  1
11503702  10950  0.1000  0.0  0.0  2
11503703  10950  0.1000  0.0  0.0  3
11503704  10950  0.1000  0.0  0.0  4
11503705  10950  0.1000  0.0  0.0  5
11503706  10950  0.1000  0.0  0.0  6
11503707  10950  0.1000  0.0  0.0  7
11503708  10950  0.1000  0.0  0.0  8
11503709  10950  0.1000  0.0  0.0  9
11503710  10950  0.1000  0.0  0.0  10
11503900  1
11503901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.0  1.1  1.0  10
*
* side reflector inner ring - heat structure 1600
*
11600000  14  7  2  0  0.4734264 3
11600100  0  1
11600101  6  0.5082523
11600201  1  6
11600301  0.0  6
11600400  -1
11600401  532.45  532.49  532.52  532.54  532.56  532.58  532.60
11600402  533.68  533.85  533.98  534.08  534.17  534.25  534.31
11600403  610.58  617.55  622.90  627.24  630.89  634.04  636.82
11600404  638.11  646.48  652.91  658.13  662.52  666.30  669.64
11600405  664.63  674.11  681.39  687.29  692.27  696.56  700.33
11600406  691.84  702.33  710.39  716.93  722.43  727.18  731.35
11600407  719.76  731.19  739.96  747.08  753.07  758.24  762.79
11600408  748.37  760.65  770.08  777.73  784.17  789.73  794.62
11600409  777.65  790.73  800.77  808.92  815.78  821.70  826.90
11600410  807.46  821.26  831.86  840.46  847.70  853.95  859.44
11600411  837.78  852.25  863.36  872.37  879.96  886.51  892.27
11600412  867.64  882.63  894.15  903.49  911.35  918.14  924.11
11600413  831.52  838.99  844.73  849.39  853.31  856.70  859.67
11600414  831.19  838.63  844.34  848.97  852.88  856.24  859.21
11600500  1
11600501  0  0  0  1  0.1905  0.1905  1
11600502  0  0  0  1  0.1905  0.1905  2
11600503  0  0  0  1  0.1981  0.1981  12
11600504  0  0  0  1  0.2515  0.2515  13
11600505  0  0  0  1  0.2515  0.2515  14
11600601  0  0  0  1  0.1905  1
11600602  0  0  0  1  0.1905  2
11600603  0  0  0  1  0.1981  12
11600604  0  0  0  1  0.2515  13
11600605  0  0  0  1  0.2515  14
11600701  0.0  0.0  0.0  0.0  14
11600800  1
11600801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
11600900  1
11600901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
*
* side reflector middle ring - heat structure 1620
*
```

```
11620000  14  7  2  0  0.007938  3
11620100  0  1
11620101  6  0.045085
11620201  1  6
11620301  0.0  6
11620400  -1
11620401  532.45  532.49  532.52  532.54  532.56  532.58  532.60
11620402  533.68  533.85  533.98  534.08  534.17  534.25  534.31
11620403  610.58  617.55  622.90  627.24  630.89  634.04  636.82
11620404  638.11  646.48  652.91  658.13  662.52  666.30  669.64
11620405  664.63  674.11  681.39  687.29  692.27  696.56  700.33
11620406  691.84  702.33  710.39  716.93  722.43  727.18  731.35
11620407  719.76  731.19  739.96  747.08  753.07  758.24  762.79
11620408  748.37  760.65  770.08  777.73  784.17  789.73  794.62
11620409  777.65  790.73  800.77  808.92  815.78  821.70  826.90
11620410  807.46  821.26  831.86  840.46  847.70  853.95  859.44
11620411  837.78  852.25  863.36  872.37  879.96  886.51  892.27
11620412  867.64  882.63  894.15  903.49  911.35  918.14  924.11
11620413  831.52  838.99  844.73  849.39  853.31  856.70  859.67
11620414  831.19  838.63  844.34  848.97  852.88  856.24  859.21
11620501  162010000  0  160  1  6.8580  1
11620502  162020000  0  160  1  6.8580  2
11620503  162030000  10000  160  1  7.1323  12
11620504  162130000  0  160  1  9.0526  13
11620505  162140000  0  160  1  9.0526  14
11620601  0  0  0  1  6.8580  1
11620602  0  0  0  1  6.8580  2
11620603  0  0  0  1  7.1323  12
11620604  0  0  0  1  9.0526  13
11620605  0  0  0  1  9.0526  14
11620701  0  0.0  0.0  0.0  14
11620800  1
11620801  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  1
11620802  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  2
11620803  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  3
11620804  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  4
11620805  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  5
11620806  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  6
11620807  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  7
11620808  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  8
11620809  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  9
11620810  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  10
11620811  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  11
11620812  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  12
11620813  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  13
11620814  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.0  14
*
* side reflector outer ring - heat structure 1640
*
11640000  14  7  2  0  0.575757  3
11640100  0  1
11640101  6  0.604430
11640201  1  6
11640301  0.0  6
11640400  -1
11640401  532.63  532.67  532.71  532.75  532.78  532.82  532.85
11640402  534.12  533.91  533.71  533.52  533.33  533.16  532.98
11640403  629.11  620.77  612.75  605.04  597.61  590.44  583.52
11640404  662.39  654.55  647.01  639.76  632.78  626.04  619.53
11640405  693.39  685.87  678.66  671.71  665.02  658.56  652.32
11640406  724.55  717.18  710.11  703.30  696.74  690.41  684.29
11640407  756.03  748.73  741.71  734.95  728.44  722.16  716.10
11640408  787.87  780.57  773.56  766.81  760.31  754.03  747.97
```

```
11640409  820.13  812.80  805.76  798.98  792.45  786.15  780.07
11640410  852.63  845.27  838.19  831.38  824.81  818.48  812.36
11640411  885.42  878.00  870.88  864.02  857.42  851.05  844.89
11640412  917.30  909.94  902.87  896.06  889.50  883.17  877.06
11640413  859.88  860.11  860.32  860.53  860.73  860.92  861.10
11640414  859.48  859.77  860.05  860.32  860.58  860.83  861.08
11640501  0  0  0  1  0.1905  1
11640502  0  0  0  1  0.1905  2
11640503  0  0  0  1  0.1981  12
11640504  0  0  0  1  0.2515  13
11640505  0  0  0  1  0.2515  14
11640601  164010000  0  160  1  0.1905  1
11640602  164020000  0  160  1  0.1905  2
11640603  164030000  10000  160  1  0.1981  12
11640604  164130000  0  160  1  0.2515  13
11640605  164140000  0  160  1  0.2515  14
11640701  0  0.0  0.0  0.0  14
11640900  1
11640901  0.0  0.10  2.77  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  1
11640902  0.0  0.29  2.58  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  2
11640903  0.0  0.48  2.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  3
11640904  0.0  0.68  2.19  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  4
11640905  0.0  0.88  1.99  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  5
11640906  0.0  1.07  1.79  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  6
11640907  0.0  1.27  1.59  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  7
11640908  0.0  1.47  1.39  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  8
11640909  0.0  1.67  1.20  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  9
11640910  0.0  1.87  1.00  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  10
11640911  0.0  2.07  0.80  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  11
11640912  0.0  2.26  0.60  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  12
11640913  0.0  2.49  0.38  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  13
11640914  0.0  2.74  0.13  0.0  0.0  0.0  0.0  1.0  2.9  1.1  1.23  14
*
* permanent side reflector - heat structure 1660
*
11660000  15  7  2  1  0.613389  3
11660100  0  1
11660101  6  0.750875
11660201  5  6
11660301  0.0  6
11660400  -1
11660401  532.63  532.67  532.71  532.75  532.78  532.82  532.85
11660402  534.12  533.91  533.71  533.52  533.33  533.16  532.98
11660403  629.11  620.77  612.75  605.04  597.61  590.44  583.52
11660404  662.39  654.55  647.01  639.76  632.78  626.04  619.53
11660405  693.39  685.87  678.66  671.71  665.02  658.56  652.32
11660406  724.55  717.18  710.11  703.30  696.74  690.41  684.29
11660407  756.03  748.73  741.71  734.95  728.44  722.16  716.10
11660408  787.87  780.57  773.56  766.81  760.31  754.03  747.97
11660409  820.13  812.80  805.76  798.98  792.45  786.15  780.07
11660410  852.63  845.27  838.19  831.38  824.81  818.48  812.36
11660411  885.42  878.00  870.88  864.02  857.42  851.05  844.89
11660412  917.30  909.94  902.87  896.06  889.50  883.17  877.06
11660413  859.88  860.11  860.32  860.53  860.73  860.92  861.10
11660414  859.48  859.77  860.05  860.32  860.58  860.83  861.08
11660415  859.48  859.77  860.05  860.32  860.58  860.83  861.08
11660501  164010000  0  1  1  0.1905  1
11660502  164020000  0  1  1  0.1905  2
11660503  164030000  10000  1  1  0.1981  12
11660504  164130000  0  1  1  0.2515  13
11660505  164140000  0  1  1  0.2515  14
11660506  175010000  0  1  1  0.2223  15
11660601  166010000  0  160  1  0.1905  1
```

```
11660602  166020000  0  160  1  0.1905  2
11660603  166030000  10000  160  1  0.1981  12
11660604  166130000  0  160  1  0.2515  13
11660605  166140000  0  160  1  0.2515  14
11660606  166150000  0  160  1  0.2223  15
11660701  0  0.0  0.0  0.0  15
11660800  1
11660801  0.0  0.10  3.00  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  1
11660802  0.0  0.29  2.80  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  2
11660803  0.0  0.48  2.61  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  3
11660804  0.0  0.68  2.41  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  4
11660805  0.0  0.88  2.21  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  5
11660806  0.0  1.07  2.01  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  6
11660807  0.0  1.27  1.81  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  7
11660808  0.0  1.47  1.62  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  8
11660809  0.0  1.67  1.42  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  9
11660810  0.0  1.87  1.22  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  10
11660811  0.0  2.07  1.02  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  11
11660812  0.0  2.26  0.82  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  12
11660813  0.0  2.49  0.60  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  13
11660814  0.0  2.74  0.35  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  14
11660815  0.0  2.98  0.11  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.22  15
11660900  1
11660901  0.0  0.10  3.00  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  1
11660902  0.0  0.29  2.80  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  2
11660903  0.0  0.48  2.61  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  3
11660904  0.0  0.68  2.41  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  4
11660905  0.0  0.88  2.21  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  5
11660906  0.0  1.07  2.01  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  6
11660907  0.0  1.27  1.81  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  7
11660908  0.0  1.47  1.62  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  8
11660909  0.0  1.67  1.42  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  9
11660910  0.0  1.87  1.22  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  10
11660911  0.0  2.07  1.02  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  11
11660912  0.0  2.26  0.82  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  12
11660913  0.0  2.49  0.60  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  13
11660914  0.0  2.74  0.35  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  14
11660915  0.0  2.98  0.11  0.0  0.0  0.0  0.0  1.0  3.1  1.1  1.0  15
*
* outlet plenum lower plate - heat structure 1750
*
11750000  1  9  1  1  0.0  0
11750100  0  1
11750101  4  0.079375
11750102  2  0.111375
11750103  2  0.136775
11750201  -1  4
11750202  -1  6
11750203  3  8
11750301  0.0  8
11750400  0
11750401  700.0  9
11750501  175010000  0  1  1  1.7713  1
11750601  105020000  0  1  1  1.7713  1
11750701  0  0.0  0.0  0.0  1
11750800  1
11750801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.14  1.1  1.0  1
11750900  1
11750901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.14  1.1  1.0  1
*
* outlet plenum support columns - heat structure 1751
*
11751000  1  4  2  1  0.0  0
```

```
11751100  0  1
11751101  3  0.028575
11751201  1  3
11751301  0.0  3
11751400  0
11751401  960.15  4
11751501  0  0  0  1  37.1412  1
11751601  175010000  0  1  1  37.1412  1
11751701  0  0.0  0.0  0.0  1
11751900  1
11751901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.22  1.1  1.0  1
*
* hot duct - heat structure 2000
*
12000000  4  9  2  1  0.148984  0
12000100  0  1
12000101  1  0.1524
12000102  4  0.161925
12000103  3  0.1653413
12000201  3  1  * 304 stainless steel
12000202  -8  5  * alumina silica insulation
12000203  3  8  * 304 stainless steel
12000301  0.0  8
12000400  0
12000401  960.15  9
12000501  200010000  0  1  1  0.4318  1
12000502  200020000  0  1  1  0.6510  2
12000503  200030000  0  1  1  0.4127  3
12000504  200040000  0  1  1  0.4127  4
12000601  270040000  0  1  1  0.4318  1
12000602  270030000  0  1  1  0.6510  2
12000603  270020000  0  1  1  0.4127  3
12000604  270010000  0  1  1  0.4127  4
12000701  0  0.0  0.0  0.0  4
12000800  1
12000801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  4
12000900  1
12000901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.33  1.1  1.0  4
*
* hot leg - heat structure 2001
*
12001000  2  7  2  1  0.149225  0
12001100  0  1
12001101  3  0.161925
12001102  3  0.212925
12001201  3  3  * 304 stainless steel
12001202  -9  6  * pipe insulation
12001301  0  6
12001400  0
12001401  960.15  7
12001501  200050000  10000  1  1  0.4906  2
12001601  -950  0  3951  1  0.4906  2
12001701  0  0.0  0.0  0.0  2
12001800  1
12001801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  2
*
* hot leg from valve V-311 into RCST - heat structure 2100
*
12100000  1  4  2  1  0.1492  0
12100100  0  1
12100101  3  0.161925
12100201  3  3  * 304 stainless steel
12100301  0.0  3
```

```
12100400  0
12100401  960.15  4
12100501  210010000  0  1  1  0.6604  1
12100601  280020000  0  1  1  0.6604  1
*12100601 280010000  0  1  1  0.6604  1  * use with single-volume RCST
12100701  0  0.0  0.0  0.0  1
12100800  1
12100801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  1
12100900  1
12100901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.32  1.1  1.0  1
*
* pipe from hot duct to steam generator inlet plenum - heat structure 2150
*
12150000  1  7  2  1  0.1270  0
12150100  0  1
12150101  3  0.16195
12150102  3  0.21295
12150201  3  3  * 304 stainless steel
12150202  -9  6  * pipe insulation
12150301  0.0  6
12150400  0
12150401  960.15  7
12150501  215010000  0  1  1  0.5405  1
12150601  -950  0  3951  1  0.5405  1
12150701  0  0.0  0.0  0.0  1
12150800  1
12150801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.54  1.1  1.0  1
*
* steam generator inlet plenum - heat structure 2200
*
12200000  1  7  2  1  0.1752  0
12200100  0  1
12200101  3  0.1912
12200102  3  0.2422
12200201  3  3
12200202  -6  6  * permanent insulation
12200301  0.0  6
12200400  0
12200401  960.15  7
12200501  220010000  0  1  1  0.58  1
12200601  -950  0  3951  1  0.58  1
12200701  0  0.0  0.0  0.0  1
12200800  1
12200801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.58  1.1  1.0  1
*
* steam generator plenum divider ("pass partition") - heat structure 2201
*
12201000  1  3  1  1  0.0
12201100  0  1
12201101  2  0.0127
12201201  3  2
12201301  0.0  2
12201400  0
12201401  960.15  3
12201501  220010000  0  1  1  0.0893  1
12201601  228010000  0  1  1  0.0893  1
12201701  0  0.0  0.0  0.0  1
12201800  1
12201801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.16  1.1  1.0  1
12201900  1
12201901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.16  1.1  1.0  1
*
* steam generator tubes - heat structure 2250
```

```
*
12250000  22  4  2  1  0.008280  3
12250100  0  1
12250101  3  0.009525
12250201  3  3
12250301  0.0  3
12250400  0
12250401  960.15  4
12250501  225010000  10000  1  1  26.4874  2
12250502  225030000  10000  1  1  26.7113  10
12250503  225110000  10000  1  1  34.1603  12
12250504  225130000  10000  1  1  26.7113  20
12250505  225200000  10000  1  1  26.4874  22
12250601  350010000  10000  111  1  26.4874  2
12250602  350030000  10000  111  1  26.7113  10
12250603  350110000  0  111  1  34.1603  12
12250604  350100000  -10000  111  1  26.7113  20
12250605  350020000  -10000  111  1  26.4874  22
12250701  0  0.0  0.0  0.0  22
12250800  1
12250801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  1.62  1.1  1.0  22
12250900  1
12250901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  1.62  1.25  1.0  22
*
* steam generator tube sheet - heat structure 2251
*
12251000  2  3  2  1  0.008280
12251100  0  1
12251101  2  0.015719
12251201  3  2
12251301  0.0  2
12251400  0
12251401  960.15  3
12251501  225010000  210000  1  1  15.5194  2
12251601  0  0  0  1  15.5194  2
12251701  0  0.0  0.0  0.0  2
12251800  1
12251801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.08  1.1  1.0  2
*
* steam generator outlet plenum - heat structure 2280
*
12280000  1  7  2  1  0.1667  0
12280100  0  1
12280101  3  0.182786133
12280102  3  0.233786133
12280201  3  3
12280202  -6  6  * permanent insulation
12280301  0  6
12280400  0
12280401  531.75  7
12280501  228010000  0  1  1  0.51  1
12280601  -950  0  3951  1  0.51  1
12280701  0  0.0  0.0  0.0  1
12280800  1
12280801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.51  1.1  1.0  1
*
* pipe from steam generator outlet plenum to circulator inlet - heat structure 2300
*
12300000  1  7  2  1  0.1014  0
12300100  0  1
12300101  3  0.1095375
12300102  3  0.1605375
12300201  3  3
```

```
12300202  -9  6  * pipe insulation
12300301  0.0  6
12300400  0
12300401  531.75  7
12300501  230010000  0  1  1  2.2827  1
12300601  -950  0  3951  1  2.2827  1
12300701  0  0.0  0.0  0.0  1
12300800  1
12300801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  1.80  1.1  1.0  1
*
* circulator - heat structure 2350
*
12350000  1  7  2  1  0.5000  0
12350100  0  1
12350101  3  0.6
12350102  3  0.6508
12350201  3  3
12350202  -9  6  * pipe insulation
12350301  0.0  6
12350400  0
12350401  531.75  7
12350501  235010000  0  1  1  0.5000  1
12350601  -950  0  3951  1  0.5000  1
12350701  0  0.0  0.0  0.0  1
12350800  1
12350801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.35  1.1  1.0  1
*
* pipe from circulator outlet to valve V-203 - heat structure 2400
*
12400000  1  7  2  1  0.1014  0
12400100  0  1
12400101  3  0.1095375
12400102  3  0.1605375
12400201  3  3
12400202  -9  6  * pipe insulation
12400301  0.0  6
12400400  0
12400401  531.75  7
12400501  240010000  0  1  1  1.2934  1
12400601  -950  0  3951  1  1.2934  1
12400701  0  0.0  0.0  0.0  1
12400800  1
12400801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.77  1.1  1.0  1
*
* pipe from valve V-203 to cold leg break valve - heat structure 2500
*
12500000  3  7  2  1  0.1014  0
12500100  0  1
12500101  3  0.1095375
12500102  3  0.1605375
12500201  3  3
12500202  -9  6  * pipe insulation
12500301  0.0  6
12500400  0
12500401  531.75  7
12500501  250010000  0  1  1  1.0917  1
12500502  250020000  0  1  1  0.3609  2
12500503  250030000  0  1  1  0.6223  3
12500601  -950  0  3951  1  1.0917  1
12500602  -950  0  3951  1  0.3609  2
12500603  -950  0  3951  1  0.6223  3
12500701  0  0.0  0.0  0.0  3
12500800  1
```

```
12500801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.62  1.1  1.0  1
12500802  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.20  1.1  1.0  3
*
* cold duct from valve V-311 into RCST - heat structure 2580
*
12580000  1  4  2  1  0.0968  0
12580100  0  1
12580101  3  0.1095375
12580201  3  3
12580301  0.0  3
12580400  0
12580401  531.75  4
12580501  258010000  0  1  1  0.6604  1
12580601  280020000  0  1  1  0.6604  1
*12580601 280010000  0  1  1  0.6604  1  * for single-volume RCST
12580701  0  0.0  0.0  0.0  1
12580800  1
12580801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.19  1.1  1.0  1
12580900  1
12580901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.22  1.1  1.0  1
*
* crossover line from cold leg to cold duct - heat structure 2600
*
12600000  1  7  2  1  0.1014  0
12600100  0  1
12600101  3  0.1095375
12600102  3  0.1605375
12600201  3  3
12600202  -9  6  * pipe insulation
12600301  0.0  6
12600400  0
12600401  531.75  7
12600501  260010000  0  1  1  0.3654  1
12600601  -950  0  3951  1  0.3654  1
12600701  0  0.0  0.0  0.0  1
12600800  1
12600801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.20  1.1  1.0  1
*
* cold duct - heat structure 2700
*
12700000  4  7  2  1  0.2191  0
12700100  0  1
12700101  3  0.2286
12700102  3  0.2796
12700201  3  3
12700202  -9  6  * pipe insulation
12700301  0.0  6
12700400  0
12700401  531.75  7
12700501  270010000  0  1  1  0.4127  1
12700502  270020000  0  1  1  0.4127  2
12700503  270030000  0  1  1  0.6510  3
12700504  270040000  0  1  1  0.4318  4
12700601  -950  0  3951  1  0.4127  1
12700602  -950  0  3951  1  0.4127  2
12700603  -950  0  3951  1  0.6510  3
12700604  -950  0  3951  1  0.4318  4
12700701  0  0.0  0.0  0.0  4
12700800  1
12700801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.44  1.1  1.0  4
*
* RCST - heat structure 2800 (two-volume configuration)
*
```

```
12800000  2  7  2  1  1.0414  0
12800100  0  1
12800101  3  1.0509
12800102  3  1.1019
12800201  3  3  * 304 stainless steel
12800202  -6  6  * permanent insulation
12800301  0.0  6
12800400  0
12800401  300.00  7
12800501  280010000  0  1  1  1.2954  1
12800502  280020000  0  1  1  4.3117  2
12800601  -950  0  3951  1  1.2954  1
12800602  -950  0  3951  1  4.3117  2
12800701  0  0.0  0.0  0.0  2
12800800  1
12800801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.61  1.1  1.0  2
*
* RCST - heat structure 2800 (single-volume configuration)
*
*12800000 1  7  2  1  1.0414  0
*12800100 0  1
*12800101 3  1.0509
*12800102 3  1.1019
*12800201 3  3  * 304 stainless steel
*12800202 -6  6  * permanent insulation
*12800301 0.0  6
*12800400 0
*12800401 300.00  7
*12800501 280010000  0  1  1  5.6071  1
*12800601 -950  0  3951  1  5.6071  1
*12800701 0  0.0  0.0  0.0  1
*12800800 1
*12800801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.61  1.1  1.0  1
*
* hot duct break spool piece - heat structure 2820
*
*12820000 1  7  2  1  0.0968  0
*12820100 0  1
*12820101 3  0.1095
*12820102 3  0.1603
*12820201 3  3  * 304 stainless steel
*12820202 9  6  * pipe insulation
*12820301 0.0  6
*12820400 0
*12820401 300.00  7
*12820501 282010000  0  1  1  1.1172  1
*12820601 280010000  0  1  1  1.1172  1
*12820701 0  0.0  0.0  0.0  1
*12820800 1
*12820801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.19  1.1  1.0  1
*12820900 1
*12820901 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.32  1.1  1.0  1
*
* steam generator outer cylindrical shell - heat structure 3400
*
13400000  13  7  2  1  0.2985  0
13400100  0  1
13400101  3  0.3048
13400102  3  0.3558
13400201  3  3
13400202  -6  6  * permanent insulation
13400301  0.0  6
13400400  0
```

```
13400401  290.00  7
13400501  350010000  0  1  1  0.1409  1
13400502  340110000  0  1  1  0.1409  2
13400503  340100000  -10000  1  1  0.1421  10
13400504  340020000  0  1  1  0.6336  11
13400505  340010000  0  1  1  0.5701  12
13400506  360010000  0  1  1  0.5588  13
13400601  -950  0  3951  1  0.1409  2
13400602  -950  0  3951  1  0.1421  10
13400603  -950  0  3951  1  0.6336  11
13400604  -950  0  3951  1  0.5701  12
13400605  -950  0  3951  1  0.5588  13
13400701  0  0.0  0.0  0.0  13
13400800  1
13400801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.18  1.1  1.0  13
13400900  1
13400901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  3.18  1.1  1.0  13
*
* steam generator inner cylindrical shell - heat structure 3500
*
13500000  11  4  2  1  0.2715  0
13500100  0  1
13500101  3  0.276225
13500201  3  3
13500301  0.0  3
13500400  0
13500401  290.00  4
13500501  350020000  0  1  1  0.1409  1
13500502  350030000  10000  1  1  0.1421  9
13500503  350110000  0  1  1  0.6336  10
13500504  350120000  0  1  1  0.5701  11
13500601  340110000  0  1  1  0.1409  1
13500602  340100000  -10000  1  1  0.1421  9
13500603  340020000  0  1  1  0.6336  10
13500604  340010000  0  1  1  0.5701  11
13500701  0  0.0  0.0  0.0  11
13500800  1
13500801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.48  1.1  1.0  11
13500900  1
13500901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  2.48  1.1  1.0  11
*
* steam generator upper head - heat structure 3550
*
13550000  1  7  3  1  0.2739  0
13550100  0  1
13550101  3  0.280208376
13550102  3  0.331208376
13550201  3  3
13550202  -6  6  * permanent insulation
13550301  0.0  6
13550400  0
13550401  960.15  7
13550501  355010000  0  1  1  0.5  1
13550601  -950  0  3951  1  0.5  1
13550701  0  0.0  0.0  0.0  1
13550800  1
13550801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.27  1.1  1.0  1
13550900  1
13550901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.33  1.1  1.0  1
*
* CRD break nozzle - heat structure 0100
*
*10100000 25  7  2  1  0.0611  0
```

```
*10100100 0  1
*10100101 3  0.0707
*10100102 3  0.1217
*10100201 3  3
*10100202 -9  6  * pipe insulation
*10100301 0.0  6
*10100400 0
*10100401 531.75  7
*10100501 10010000  10000  1  1  0.0196  25
*10100601 -950  0  3951  1  0.0196  25
*10100701 0  0.0  0.0  0.0  25
*10100800 1
*10100801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.00  1.1  1.0  25
*
* CRD break line piping from pressure vessel nozzle to valve V-332 - heat structure
0200
*
*10200000 35  7  2  1  0.0486  0
*10200100 0  1
*10200101 3  0.05715
*10200102 3  0.10815
*10200201 3  3
*10200202 -9  6  * pipe insulation
*10200301 0.0  6
*10200400 0
*10200401 531.75  7
*10200501 20010000  10000  1  1  0.0204  35
*10200601 -950  0  3951  1  0.0204  35
*10200701 0  0.0  0.0  0.0  35
*10200800 1
*10200801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.00  1.1  1.0  35
*
* CRD break line piping from valve V-332 to RCST, section 1 - heat structure 0300
*
*10300000 92  7  2  1  0.0486  0
*10300100 0  1
*10300101 3  0.05715
*10300102 3  0.10815
*10300201 3  3
*10300202 -9  6  * pipe insulation
*10300301 0.0  6
*10300400 0
*10300401 300.00  7
*10300501 30010000  10000  1  1  0.0200  92
*10300601 -950  0  3951  1  0.0200  92
*10300701 0  0.0  0.0  0.0  92
*10300800 1
*10300801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.10  1.1  1.0  92
*
* CRD break line piping from valve V-332 to RCST, section 2 - heat structure 0320
*
*10320000 92  7  2  1  0.0486  0
*10320100 0  1
*10320101 3  0.05715
*10320102 3  0.10815
*10320201 3  3
*10320202 -9  6  * pipe insulation
*10320301 0.0  6
*10320400 0
*10320401 300.00  7
*10320501 32010000  10000  1  1  0.0200  92
*10320601 -950  0  3951  1  0.0200  92
*10320701 0  0.0  0.0  0.0  92
```

```
*10320800 1
*10320801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.10  1.1  1.0  92
*
* CRD break line piping from valve V-332 to RCST, section 3 - heat structure 0340
*
*10340000 92  7  2  1  0.0486  0
*10340100 0  1
*10340101 3  0.05715
*10340102 3  0.10815
*10340201 3  3
*10340202 -9  6  * pipe insulation
*10340301 0.0  6
*10340400 0
*10340401 300.00  7
*10340501 34010000  10000  1  1  0.0200  92
*10340601 -950  0  3951  1  0.0200  92
*10340701 0  0.0  0.0  0.0  92
*10340800 1
*10340801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.10  1.1  1.0  92
*
* pressure vessel bottom break line piping from pressure vessel nozzle stub to valve
V-331, section 1 - heat structure 0700
*
*10700000 73  7  2  1  0.0486  0
*10700100 0  1
*10700101 3  0.05715
*10700102 3  0.10815
*10700201 3  3
*10700202 -9  6  * pipe insulation
*10700301 0.0  6
*10700400 0
*10700401 531.75  7
*10700501 70010000  10000  1  1  0.0201  73
*10700601 -950  0  3951  1  0.0201  73
*10700701 0  0.0  0.0  0.0  73
*10700800 1
*10700801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.27  1.1  1.0  73
*
* pressure vessel bottom break line piping from pressure vessel nozzle stub to valve
V-331, section 1 - heat structure 0720
*
*10720000 73  7  2  1  0.0486  0
*10720100 0  1
*10720101 3  0.05715
*10720102 3  0.10815
*10720201 3  3
*10720202 -9  6  * pipe insulation
*10720301 0.0  6
*10720400 0
*10720401 531.75  7
*10720501 72010000  10000  1  1  0.0201  73
*10720601 -950  0  3951  1  0.0201  73
*10720701 0  0.0  0.0  0.0  73
*10720800 1
*10720801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.27  1.1  1.0  73
*
* pressure vessel bottom break line piping from valve V-331 to RCST - heat structure
0800
*
*10800000 96  7  2  1  0.0486  0
*10800100 0  1
*10800101 3  0.05715
*10800102 3  0.10815
```

```
*10800201 3  3
*10800202 -9  6  * pipe insulation
*10800301 0.0  6
*10800400 0
*10800401 300.00  7
*10800501 80010000  10000  1  1  0.0200  96
*10800601 -950  0  3951  1  0.0200  96
*10800701 0  0.0  0.0  0.0  96
*10800800 1
*10800801 0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.10  1.1  1.0  96
*
* RCCS front panel (facing vessel) - heat structure 9500
*
19500000  19  4  1  1  0.0  0
19500100  0  1
19500101  3  0.00267
19500201  3  3
19500301  0.0  3
19500400  0
19500401  300.00  4
19500501  900010000  0  1  1  9.9692  1
19500502  900010000  0  1  1  3.1921  2
19500503  900010000  0  1  1  2.1677  3
19500504  900010000  0  1  1  2.4526  4
19500505  900010000  0  1  1  2.4526  5
19500506  900010000  0  1  1  1.9324  15
19500507  900010000  0  1  1  1.8581  16
19500508  900010000  0  1  1  1.9819  17
19500509  900010000  0  1  1  2.6647  18
19500510  900010000  0  1  1  7.3001  19
19500601  950010000  0  1  1  9.9692  1
19500602  950020000  0  1  1  3.1921  2
19500603  950030000  0  1  1  2.1677  3
19500604  950040000  0  1  1  2.4526  4
19500605  950050000  0  1  1  2.4526  5
19500606  950060000  10000  1  1  1.9324  15
19500607  950160000  0  1  1  1.8581  16
19500608  950170000  0  1  1  1.9819  17
19500609  950180000  0  1  1  2.6647  18
19500610  950190000  0  1  1  7.3001  19
19500701  0  0.0  0.0  0.0  19
19500800  1
19500801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.3  1.1  1.0  19
19500900  1
19500901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.3  1.1  1.0  19
*
* RCCS rear panel - heat structure 9501
*
19501000  19  7  1  1  0.0  0
19501100  0  1
19501101  3  0.000902
19501102  3  0.038902
19501201  3  3  * stainless steel
19501202  -6  6  * permanent insulation
19501301  0.0  6
19501400  0
19501401  290.0  7
19501501  950010000  0  1  1  9.9692  1
19501502  950020000  0  1  1  3.1921  2
19501503  950030000  0  1  1  2.1677  3
19501504  950040000  0  1  1  2.4526  4
19501505  950050000  0  1  1  2.4526  5
19501506  950060000  10000  1  1  1.9324  15
```

```
19501507  950160000  0  1  1  1.8581  16
19501508  950170000  0  1  1  1.9819  17
19501509  950180000  0  1  1  2.6647  18
19501510  950190000  0  1  1  7.3001  19
19501601  -950  0  3951  1  9.9692  1
19501602  -950  0  3951  1  3.1921  2
19501603  -950  0  3951  1  2.1677  3
19501604  -950  0  3951  1  2.4526  4
19501605  -950  0  3951  1  2.4526  5
19501606  -950  0  3951  1  1.9324  15
19501607  -950  0  3951  1  1.8581  16
19501608  -950  0  3951  1  1.9819  17
19501609  -950  0  3951  1  2.6647  18
19501610  -950  0  3951  1  7.3001  19
19501701  0  0.0  0.0  0.0  19
19501800  1
19501801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.3  1.1  1.0  19
19501900  1
19501901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  5.3  1.1  1.0  19
*
*******************************************************
* conduction/radiation sets
*******************************************************
*
60000000  12
*
* central reflector radial conduction
*
60100000  -42  0.0  0.0  601
*
* upper reflector, top
60101001  1300001  1  46.9
60102001  1320001  1  46.9
60103001  1340001  0  46.9
* upper reflector, bottom
60104001  1300002  1  46.9
60105001  1320002  1  46.9
60106001  1340002  0  46.9
* core level 1
60107001  1300003  1  46.9
60108001  1320003  1  46.9
60109001  1340003  0  46.9
* core level 2
60110001  1300004  1  46.9
60111001  1320004  1  46.9
60112001  1340004  0  46.9
* core level 3
60113001  1300005  1  46.9
60114001  1320005  1  46.9
60115001  1340005  0  46.9
* core level 4
60116001  1300006  1  46.9
60117001  1320006  1  46.9
60118001  1340006  0  46.9
* core level 5
60119001  1300007  1  46.9
60120001  1320007  1  46.9
60121001  1340007  0  46.9
* core level 6
60122001  1300008  1  46.9
60123001  1320008  1  46.9
60124001  1340008  0  46.9
* core level 7
```

```
60125001  1300009  1  46.9
60126001  1320009  1  46.9
60127001  1340009  0  46.9
* core level 8
60128001  1300010  1  46.9
60129001  1320010  1  46.9
60130001  1340010  0  46.9
* core level 9
60131001  1300011  1  46.9
60132001  1320011  1  46.9
60133001  1340011  0  46.9
* core level 10
60134001  1300012  1  46.9
60135001  1320012  1  46.9
60136001  1340012  0  46.9
* bottom reflector, upper
60137001  1300013  1  46.9
60138001  1320013  1  46.9
60139001  1340013  0  46.9
* bottom reflector, lower
60140001  1300014  1  46.9
60141001  1320014  1  46.9
60142001  1340014  0  46.9
* conduction area factors
* upper reflector, top
60101101  0.0  1  1.340979  2  0.0  42
60102101  0.279371  1  0.0  2  0.614615  3  0.0  42
60103101  0.0  1  1.340979  2  0.0  42
* upper reflector, bottom
60104101  0.0  4  1.340979  5  0.0  42
60105101  0.0  3  0.279371  4  0.0  5  0.614615  6  0.0  42
60106101  0.0  4  1.340979  5  0.0  42
* core level 1
60107101  0.0  7  1.340979  8  0.0  42
60108101  0.0  6  0.279371  7  0.0  8  0.614615  9  0.0  42
60109101  0.0  7  1.340979  8  0.0  42
* core level 2
60110101  0.0  10  1.340979  11  0.0  42
60111101  0.0  9  0.279371  10  0.0  11  0.614615  12  0.0  42
60112101  0.0  10  1.340979  11  0.0  42
* core level 3
60113101  0.0  13  1.340979  14  0.0  42
60114101  0.0  12  0.279371  13  0.0  14  0.614615  15  0.0  42
60115101  0.0  13  1.340979  14  0.0  42
* core level 4
60116101  0.0  16  1.340979  17  0.0  42
60117101  0.0  15  0.279371  16  0.0  17  0.614615  18  0.0  42
60118101  0.0  16  1.340979  17  0.0  42
* core level 5
60119101  0.0  19  1.340979  20  0.0  42
60120101  0.0  18  0.279371  19  0.0  20  0.614615  21  0.0  42
60121101  0.0  19  1.340979  20  0.0  42
* core level 6
60122101  0.0  22  1.340979  23  0.0  42
60123101  0.0  21  0.279371  22  0.0  23  0.614615  24  0.0  42
60124101  0.0  22  1.340979  23  0.0  42
* core level 7
60125101  0.0  25  1.340979  26  0.0  42
60126101  0.0  24  0.279371  25  0.0  26  0.614615  27  0.0  42
60127101  0.0  25  1.340979  26  0.0  42
* core level 8
60128101  0.0  28  1.340979  29  0.0  42
60129101  0.0  27  0.279371  28  0.0  29  0.614615  30  0.0  42
```

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60130101  0.0  28  1.340979  29  0.0  42
* core level 9
60131101  0.0  31  1.340979  32  0.0  42
60132101  0.0  30  0.279371  31  0.0  32  0.614615  33  0.0  42
60133101  0.0  31  1.340979  32  0.0  42
* core level 10
60134101  0.0  34  1.340979  35  0.0  42
60135101  0.0  33  0.279371  34  0.0  35  0.614615  36  0.0  42
60136101  0.0  34  1.340979  35  0.0  42
* bottom reflector, upper
60137101  0.0  37  1.340979  38  0.0  42
60138101  0.0  36  0.279371  37  0.0  38  0.614615  39  0.0  42
60139101  0.0  37  1.340979  38  0.0  42
* bottom reflector, lower
60140101  0.0  40  1.340979  41  0.0  42
60141101  0.0  39  0.279371  40  0.0  41  0.614615  42
60142101  0.0  40  1.340979  41  0.0  42
*
* core region radial and axial conduction
*
60200000  -71  0.0  0.0  601
* upper reflector, top
60201001  1340001  1  46.9
60202001  1400001  0  46.9
60203001  1450001  0  46.9
60204001  1500001  0  46.9
60205001  1600001  0  46.9
* upper reflector, bottom
60206001  1340002  1  46.9
60207001  1400002  0  46.9
60208001  1450002  0  46.9
60209001  1500002  0  46.9
60210001  1600002  0  46.9
* core level 1
60211001  1340003  1  46.9
60212001  1401001  0  46.9
60213001  1451001  0  46.9
60214001  1501001  0  46.9
60215001  1600003  0  46.9
* core level 2
60216001  1340004  1  46.9
60217001  1401002  0  46.9
60218001  1451002  0  46.9
60219001  1501002  0  46.9
60220001  1600004  0  46.9
* core level 3
60221001  1340005  1  46.9
60222001  1401003  0  46.9
60223001  1451003  0  46.9
60224001  1501003  0  46.9
60225001  1600005  0  46.9
* core level 4
60226001  1340006  1  46.9
60227001  1401004  0  46.9
60228001  1451004  0  46.9
60229001  1501004  0  46.9
60230001  1600006  0  46.9
* core level 5
60231001  1340007  1  46.9
60232001  1401005  0  46.9
60233001  1451005  0  46.9
60234001  1501005  0  46.9
60235001  1600007  0  46.9
```

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* core level 6
60236001  1340008  1  46.9
60237001  1401006  0  46.9
60238001  1451006  0  46.9
60239001  1501006  0  46.9
60240001  1600008  0  46.9
* core level 7
60241001  1340009  1  46.9
60242001  1401007  0  46.9
60243001  1451007  0  46.9
60244001  1501007  0  46.9
60245001  1600009  0  46.9
* core level 8
60246001  1340010  1  46.9
60247001  1401008  0  46.9
60248001  1451008  0  46.9
60249001  1501008  0  46.9
60250001  1600010  0  46.9
* core level 9
60251001  1340011  1  46.9
60252001  1401009  0  46.9
60253001  1451009  0  46.9
60254001  1501009  0  46.9
60255001  1600011  0  46.9
* core level 10
60256001  1340012  1  46.9
60257001  1401010  0  46.9
60258001  1451010  0  46.9
60259001  1501010  0  46.9
60260001  1600012  0  46.9
* bottom reflector, upper
60261001  1340013  1  46.9
60262001  1402001  0  46.9
60263001  1452001  0  46.9
60264001  1502001  0  46.9
60265001  1600013  0  46.9
* bottom reflector, lower
60266001  1340014  1  46.9
60267001  1402002  0  46.9
60268001  1452002  0  46.9
60269001  1502002  0  46.9
60270001  1600014  0  46.9
* upper plenum plate
60271001  1201001  0  46.9
* conduction area factors
* upper reflector, top
60201101  0.0  1  1.115715  2  0.0  70  0.038996  71
60202101  0.203425  1  0.0  2  0.190291  3  0.0  70  0.062205  71
60203101  0.0  1  0.161747  2  0.0  3  0.215708  4  0.0  70
60203102  0.049348  71
60204101  0.0  2  0.161781  3  0.0  4  0.370550  5  0.0  70
60204102  0.071373  71
60205101  0.0  3  1.192833  4  0.0  70  0.123034  71
60271101  0.004941  1  0.043232  2  0.040349  3  0.077810  4  0.041667  5
60271102  0.0  71
* upper reflector, bottom
60206101  0.0  6  1.115715  7  0.0  71
60207101  0.0  5  0.203425  6  0.0  7  0.190291  8  0.0  11
60207102  0.015477  12  0.0  71
60208101  0.0  6  0.161747  7  0.0  8  0.215708  9  0.0  12
60208102  0.013957  13  0.0  71
60209101  0.0  7  0.161781  8  0.0  9  0.370550  10  0.0  13
60209102  0.016411  14  0.0  71
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60210101  0.0  8  1.192833  9  0.0  71
* core level 1
60211101  0.0  11  1.661174  12  0.0  71
60212101  0.0  6  0.014881  7  0.0  10  0.302877  11  0.0  12
60212102  0.293809  13  0.0  71
60213101  0.0  7  0.013421  8  0.0  11  0.249738  12  0.0  13
60213102  0.323498  14  0.0  71
60214101  0.0  8  0.015780  9  0.0  12  0.242623  13  0.0  14
60214102  0.523730  15  0.0  71
60215101  0.0  13  1.685933  14  0.0  71
* core level 2
60216101  0.0  16  1.661174  17  0.0  71
60217101  0.0  15  0.302877  16  0.0  17  0.293809  18  0.0  71
60218101  0.0  16  0.249738  17  0.0  18  0.323498  19  0.0  71
60219101  0.0  17  0.242623  18  0.0  19  0.523730  20  0.0  71
60220101  0.0  18  1.685933  19  0.0  71
* core level 3
60221101  0.0  21  1.661174  22  0.0  71
60222101  0.0  20  0.302877  21  0.0  22  0.293809  23  0.0  71
60223101  0.0  21  0.249738  22  0.0  23  0.323498  24  0.0  71
60224101  0.0  22  0.242623  23  0.0  24  0.523730  25  0.0  71
60225101  0.0  23  1.685933  24  0.0  71
* core level 4
60226101  0.0  26  1.661174  27  0.0  71
60227101  0.0  25  0.302877  26  0.0  27  0.293809  28  0.0  71
60228101  0.0  26  0.249738  27  0.0  28  0.323498  29  0.0  71
60229101  0.0  27  0.242623  28  0.0  29  0.523730  30  0.0  71
60230101  0.0  28  1.685933  29  0.0  71
* core level 5
60231101  0.0  31  1.661174  32  0.0  71
60232101  0.0  30  0.302877  31  0.0  32  0.293809  33  0.0  71
60233101  0.0  31  0.249738  32  0.0  33  0.323498  34  0.0  71
60234101  0.0  32  0.242623  33  0.0  34  0.523730  35  0.0  71
60235101  0.0  33  1.685933  34  0.0  71
* core level 6
60236101  0.0  36  1.661174  37  0.0  71
60237101  0.0  35  0.302877  36  0.0  37  0.293809  38  0.0  71
60238101  0.0  36  0.249738  37  0.0  38  0.323498  39  0.0  71
60239101  0.0  37  0.242623  38  0.0  39  0.523730  40  0.0  71
60240101  0.0  38  1.685933  39  0.0  71
* core level 7
60241101  0.0  41  1.661174  42  0.0  71
60242101  0.0  40  0.302877  41  0.0  42  0.293809  43  0.0  71
60243101  0.0  41  0.249738  42  0.0  43  0.323498  44  0.0  71
60244101  0.0  42  0.242623  43  0.0  44  0.523730  45  0.0  71
60245101  0.0  43  1.685933  44  0.0  71
* core level 8
60246101  0.0  46  1.661174  47  0.0  71
60247101  0.0  45  0.302877  46  0.0  47  0.293809  48  0.0  71
60248101  0.0  46  0.249738  47  0.0  48  0.323498  49  0.0  71
60249101  0.0  47  0.242623  48  0.0  49  0.523730  50  0.0  71
60250101  0.0  48  1.685933  49  0.0  71
* core level 9
60251101  0.0   51  1.661174  52  0.0  71
60252101  0.0  50  0.302877  51  0.0  52  0.293809  53  0.0  71
60253101  0.0  51  0.249738  52  0.0  53  0.323498  54  0.0  71
60254101  0.0  52  0.242623  53  0.0  54  0.523730  55  0.0  71
60255101  0.0  53  1.685933  54  0.0  71
* core level 10
60256101  0.0  56  1.661174  57  0.0  71
60257101  0.0  55  0.302877  56  0.0  57  0.293809  58  0.0  61
60257102  0.012522  62  0.0  71
60258101  0.0  56  0.249738  57  0.0  58  0.323498  59  0.0  62
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60258102  0.011229  63  0.0  71
60259101  0.0  57  0.242623  58  0.0  59  0.523730  60  0.0  63
60259102  0.013323  64  0.0  71
60260101  0.0  58  1.685933  59  0.0  71
* bottom reflector, upper
60261101  0.0  61  1.115715  62  0.0  71
60262101  0.0  56  0.009866  57  0.0  60  0.203425  61  0.0  62
60262102  0.190291  63  0.0  71
60263101  0.0  57  0.008847  58  0.0  61  0.161747  62  0.0  63
60263102  0.215708  64  0.0  71
60264101  0.0  58  0.010497  59  0.0  62  0.161781  63  0.0  64
60264102  0.370550  65  0.0  71
60265101  0.0  63  1.192833  64  0.0  71
* bottom reflector, lower
60266101  0.0  66  1.115715  67  0.0  71
60267101  0.0  65  0.203425  66  0.0  67  0.190291  68  0.0  71
60268101  0.0  66  0.161747  67  0.0  68  0.215708  69  0.0  71
60269101  0.0  67  0.161781  68  0.0  69  0.370550  70  0.0  71
60270101  0.0  68  1.192833  69  0.0  71
*
* side reflector radial conduction
*
60300000  -42  0.0  0.0  601
*
* upper reflector, top
60301001  1600001  1  46.9
60302001  1620001  1  46.9
60303001  1640001  0  46.9
* upper reflector, bottom
60304001  1600002  1  46.9
60305001  1620002  1  46.9
60306001  1640002  0  46.9
* core level 1
60307001  1600003  1  46.9
60308001  1620003  1  46.9
60309001  1640003  0  46.9
* core level 2
60310001  1600004  1  46.9
60311001  1620004  1  46.9
60312001  1640004  0  46.9
* core level 3
60313001  1600005  1  46.9
60314001  1620005  1  46.9
60315001  1640005  0  46.9
* core level 4
60316001  1600006  1  46.9
60317001  1620006  1  46.9
60318001  1640006  0  46.9
* core level 5
60319001  1600007  1  46.9
60320001  1620007  1  46.9
60321001  1640007  0  46.9
* core level 6
60322001  1600008  1  46.9
60323001  1620008  1  46.9
60324001  1640008  0  46.9
* core level 7
60325001  1600009  1  46.9
60326001  1620009  1  46.9
60327001  1640009  0  46.9
* core level 8
60328001  1600010  1  46.9
60329001  1620010  1  46.9
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60330001  1640010  0  46.9
* core level 9
60331001  1600011  1  46.9
60332001  1620011  1  46.9
60333001  1640011  0  46.9
* core level 10
60334001  1600012  1  46.9
60335001  1620012  1  46.9
60336001  1640012  0  46.9
* bottom reflector, upper
60337001  1600013  1  46.9
60338001  1620013  1  46.9
60339001  1640013  0  46.9
* bottom reflector, lower
60340001  1600014  1  46.9
60341001  1620014  1  46.9
60342001  1640014  0  46.9
* conduction area factors
* upper reflector, top
60301101  0.0  1  1.781545  2  0.0  42
60302101  0.557881  1  0.0  2  0.631977  3  0.0  42
60303101  0.0  1  1.781545  2  0.0  42
* upper reflector, bottom
60304101  0.0  4  1.781545  5  0.0  42
60305101  0.0  3  0.557881  4  0.0  5  0.631977  6  0.0  42
60306101  0.0  4  1.781545  5  0.0  42
* core level 1
60307101  0.0  7  1.781545  8  0.0  42
60308101  0.0  6  0.557881  7  0.0  8  0.631977  9  0.0  42
60309101  0.0  7  1.781545  8  0.0  42
* core level 2
60310101  0.0  10  1.781545  11  0.0  42
60311101  0.0  9  0.557881  10  0.0  11  0.631977  12  0.0  42
60312101  0.0  10  1.781545  11  0.0  42
* core level 3
60313101  0.0  13  1.781545  14  0.0  42
60314101  0.0  12  0.557881  13  0.0  14  0.631977  15  0.0  42
60315101  0.0  13  1.781545  14  0.0  42
* core level 4
60316101  0.0  16  1.781545  17  0.0  42
60317101  0.0  15  0.557881  16  0.0  17  0.631977  18  0.0  42
60318101  0.0  16  1.781545  17  0.0  42
* core level 5
60319101  0.0  19  1.781545  20  0.0  42
60320101  0.0  18  0.557881  19  0.0  20  0.631977  21  0.0  42
60321101  0.0  19  1.781545  20  0.0  42
* core level 6
60322101  0.0  22  1.781545  23  0.0  42
60323101  0.0  21  0.557881  22  0.0  23  0.631977  24  0.0  42
60324101  0.0  22  1.781545  23  0.0  42
* core level 7
60325101  0.0  25  1.781545  26  0.0  42
60326101  0.0  24  0.557881  25  0.0  26  0.631977  27  0.0  42
60327101  0.0  25  1.781545  26  0.0  42
* core level 8
60328101  0.0  28  1.781545  29  0.0  42
60329101  0.0  27  0.557881  28  0.0  29  0.631977  30  0.0  42
60330101  0.0  28  1.781545  29  0.0  42
* core level 9
60331101  0.0  31  1.781545  32  0.0  42
60332101  0.0  30  0.557881  31  0.0  32  0.631977  33  0.0  42
60333101  0.0  31  1.781545  32  0.0  42
* core level 10
```

```
60334101  0.0  34  1.781545  35  0.0  42
60335101  0.0  33  0.557881  34  0.0  35  0.631977  36  0.0  42
60336101  0.0  34  1.781545  35  0.0  42
* bottom reflector, upper
60337101  0.0  37  1.781545  38  0.0  42
60338101  0.0  36  0.557881  37  0.0  38  0.631977  39  0.0  42
60339101  0.0  37  1.781545  38  0.0  42
* bottom reflector, lower
60340101  0.0  40  1.781545  41  0.0  42
60341101  0.0  39  0.557881  40  0.0  41  0.631977  42
60342101  0.0  40  1.781545  41  0.0  42
*
* radiation from heater rod to ceramic, inner core ring
*
61100000  20  300.0  0.0
*
61101001  1403001  1  0.810
61102001  1401001  1  0.581
61103001  1403002  1  0.810
61104001  1401002  1  0.581
61105001  1403003  1  0.810
61106001  1401003  1  0.581
61107001  1403004  1  0.810
61108001  1401004  1  0.581
61109001  1403005  1  0.810
61110001  1401005  1  0.581
61111001  1403006  1  0.810
61112001  1401006  1  0.581
61113001  1403007  1  0.810
61114001  1401007  1  0.581
61115001  1403008  1  0.810
61116001  1401008  1  0.581
61117001  1403009  1  0.810
61118001  1401009  1  0.581
61119001  1403010  1  0.810
61120001  1401010  1  0.581
*
61101101  0.0  1  1.0  2  0.0  20
61102101  0.176751  1  0.823249  2  0.0  20
61103101  0.0  3  1.0  4  0.0  20
61104101  0.0  2  0.176751  3  0.823249  4  0.0  20
61105101  0.0  5  1.0  6  0.0  20
61106101  0.0  4  0.176751  5  0.823249  6  0.0  20
61107101  0.0  7  1.0  8  0.0  20
61108101  0.0  6  0.176751  7  0.823249  8  0.0  20
61109101  0.0  9  1.0  10  0.0  20
61110101  0.0  8  0.176751  9  0.823249  10  0.0  20
61111101  0.0  11  1.0  12  0.0  20
61112101  0.0  10  0.176751  11  0.823249  12  0.0  20
61113101  0.0  13  1.0  14  0.0  20
61114101  0.0  12  0.176751  13  0.823249  14  0.0  20
61115101  0.0  15  1.0  16  0.0  20
61116101  0.0  14  0.176751  15  0.823249  16  0.0  20
61117101  0.0  17  1.0  18  0.0  20
61118101  0.0  16  0.176751  17  0.823249  18  0.0  20
61119101  0.0  19  1.0  20
61120101  0.0  18  0.176751  19  0.823249  20
*
* radiation from heater rod to ceramic, middle core ring
*
61200000  20  300.0  0.0
*
61201001  1453001  1  0.810
```

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61202001  1451001  1  0.581
61203001  1453002  1  0.810
61204001  1451002  1  0.581
61205001  1453003  1  0.810
61206001  1451003  1  0.581
61207001  1453004  1  0.810
61208001  1451004  1  0.581
61209001  1453005  1  0.810
61210001  1451005  1  0.581
61211001  1453006  1  0.810
61212001  1451006  1  0.581
61213001  1453007  1  0.810
61214001  1451007  1  0.581
61215001  1453008  1  0.810
61216001  1451008  1  0.581
61217001  1453009  1  0.810
61218001  1451009  1  0.581
61219001  1453010  1  0.810
61220001  1451010  1  0.581
*
61201101  0.0  1  1.0  2  0.0  20
61202101  0.211996  1  0.788004  2  0.0  20
61203101  0.0  3  1.0  4  0.0  20
61204101  0.0  2  0.211996  3  0.788004  4  0.0  20
61205101  0.0  5  1.0  6  0.0  20
61206101  0.0  4  0.211996  5  0.788004  6  0.0  20
61207101  0.0  7  1.0  8  0.0  20
61208101  0.0  6  0.211996  7  0.788004  8  0.0  20
61209101  0.0  9  1.0  10  0.0  20
61210101  0.0  8  0.211996  9  0.788004  10  0.0  20
61211101  0.0  11  1.0  12  0.0  20
61212101  0.0  10  0.211996  11  0.788004  12  0.0  20
61213101  0.0  13  1.0  14  0.0  20
61214101  0.0  12  0.211996  13  0.788004  14  0.0  20
61215101  0.0  15  1.0  16  0.0  20
61216101  0.0  14  0.211996  15  0.788004  16  0.0  20
61217101  0.0  17  1.0  18  0.0  20
61218101  0.0  16  0.211996  17  0.788004  18  0.0  20
61219101  0.0  19  1.0  20
61220101  0.0  18  0.211996  19  0.788004  20
*
* radiation from heater rod to ceramic, outer core ring
*
61300000  20  300.0  0.0
*
61301001  1503001  1  0.810
61302001  1501001  1  0.581
61303001  1503002  1  0.810
61304001  1501002  1  0.581
61305001  1503003  1  0.810
61306001  1501003  1  0.581
61307001  1503004  1  0.810
61308001  1501004  1  0.581
61309001  1503005  1  0.810
61310001  1501005  1  0.581
61311001  1503006  1  0.810
61312001  1501006  1  0.581
61313001  1503007  1  0.810
61314001  1501007  1  0.581
61315001  1503008  1  0.810
61316001  1501008  1  0.581
61317001  1503009  1  0.810
61318001  1501009  1  0.581
```

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61319001  1503010  1  0.810
61320001  1501010  1  0.581
*
61301101  0.0  1  1.0  2  0.0  20
61302101  0.155830  1  0.844170  2  0.0  20
61303101  0.0  3  1.0  4  0.0  20
61304101  0.0  2  0.155830  3  0.844170  4  0.0  20
61305101  0.0  5  1.0  6  0.0  20
61306101  0.0  4  0.155830  5  0.844170  6  0.0  20
61307101  0.0  7  1.0  8  0.0  20
61308101  0.0  6  0.155830  7  0.844170  8  0.0  20
61309101  0.0  9  1.0  10  0.0  20
61310101  0.0  8  0.155830  9  0.844170  10  0.0  20
61311101  0.0  11  1.0  12  0.0  20
61312101  0.0  10  0.155830  11  0.844170  12  0.0  20
61313101  0.0  13  1.0  14  0.0  20
61314101  0.0  12  0.155830  13  0.844170  14  0.0  20
61315101  0.0  15  1.0  16  0.0  20
61316101  0.0  14  0.155830  15  0.844170  16  0.0  20
61317101  0.0  17  1.0  18  0.0  20
61318101  0.0  16  0.155830  17  0.844170  18  0.0  20
61319101  0.0  19  1.0  20
61320101  0.0  18  0.155830  19  0.844170  20
*
* radiation from side reflector to permanent reflector
*
61400000  28  300.0  0.0
*
61401001  1640001  1  0.788
61402001  1660001  0  0.707
61403001  1640002  1  0.788
61404001  1660002  0  0.707
61405001  1640003  1  0.788
61406001  1660003  0  0.707
61407001  1640004  1  0.788
61408001  1660004  0  0.707
61409001  1640005  1  0.788
61410001  1660005  0  0.707
61411001  1640006  1  0.788
61412001  1660006  0  0.707
61413001  1640007  1  0.788
61414001  1660007  0  0.707
61415001  1640008  1  0.788
61416001  1660008  0  0.707
61417001  1640009  1  0.788
61418001  1660009  0  0.707
61419001  1640010  1  0.788
61420001  1660010  0  0.707
61421001  1640011  1  0.788
61422001  1660011  0  0.707
61423001  1640012  1  0.788
61424001  1660012  0  0.707
61425001  1640013  1  0.788
61426001  1660013  0  0.707
61427001  1640014  1  0.788
61428001  1660014  0  0.707
*
61401101  0.0  1  1.0  2  0.0  28
61402101  0.985395  1  0.014605  2  0.0  28
61403101  0.0  2  0.0  3  1.0  4  0.0  28
61404101  0.0  2  0.985395  3  0.014605  4  0.0  28
61405101  0.0  4  0.0  5  1.0  6  0.0  28
61406101  0.0  4  0.985395  5  0.014605  6  0.0  28
```

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61407101  0.0  6  0.0  7  1.0  8  0.0  28
61408101  0.0  6  0.985395  7  0.014605  8  0.0  28
61409101  0.0  8  0.0  9  1.0  10  0.0  28
61410101  0.0  8  0.985395  9  0.014605  10  0.0  28
61411101  0.0  10  0.0  11  1.0  12  0.0  28
61412101  0.0  10  0.985395  11  0.014605  12  0.0  28
61413101  0.0  12  0.0  13  1.0  14  0.0  28
61414101  0.0  12  0.985395  13  0.014605  14  0.0  28
61415101  0.0  14  0.0  15  1.0  16  0.0  28
61416101  0.0  14  0.985395  15  0.014605  16  0.0  28
61417101  0.0  16  0.0  17  1.0  18  0.0  28
61418101  0.0  16  0.985395  17  0.014605  18  0.0  28
61419101  0.0  18  0.0  19  1.0  20  0.0  28
61420101  0.0  18  0.985395  19  0.014605  20  0.0  28
61421101  0.0  20  0.0  21  1.0  22  0.0  28
61422101  0.0  20  0.985395  21  0.014605  22  0.0  28
61423101  0.0  22  0.0  23  1.0  24  0.0  28
61424101  0.0  22  0.985395  23  0.014605  24  0.0  28
61425101  0.0  24  0.0  25  1.0  26  0.0  28
61426101  0.0  24  0.985395  25  0.014605  26  0.0  28
61427101  0.0  26  0.0  27  1.0  28
61428101  0.0  26  0.985395  27  0.014605  28
*
* radiation from permanent side reflector to core barrel
*
61500000  30  300.0  0.0
*
61501001  1660001  1  0.721
61502001  1150016  0  0.075
61503001  1660002  1  0.721
61504001  1150015  0  0.075
61505001  1660003  1  0.721
61506001  1150014  0  0.075
61507001  1660004  1  0.721
61508001  1150013  0  0.075
61509001  1660005  1  0.721
61510001  1150012  0  0.075
61511001  1660006  1  0.721
61512001  1150011  0  0.075
61513001  1660007  1  0.721
61514001  1150010  0  0.075
61515001  1660008  1  0.721
61516001  1150009  0  0.075
61517001  1660009  1  0.721
61518001  1150008  0  0.075
61519001  1660010  1  0.721
61520001  1150007  0  0.075
61521001  1660011  1  0.721
61522001  1150006  0  0.075
61523001  1660012  1  0.721
61524001  1150005  0  0.075
61525001  1660013  1  0.721
61526001  1150004  0  0.075
61527001  1660014  1  0.721
61528001  1150003  0  0.075
61529001  1660015  1  0.721
61530001  1150002  0  0.075
*
61501101  0.0  1  1.0  2  0.0  30
61502101  0.929623  1  0.070377  2  0.0  30
61503101  0.0  3  1.0  4  0.0  30
61504101  0.0  2  0.991597  3  0.008403  4  0.0  30
61505101  0.0  5  1.0  6  0.0  30
```

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61506101  0.0  4  0.991597  5  0.008403  6  0.0  30
61507101  0.0  7  1.0  8  0.0  30
61508101  0.0  6  0.991597  7  0.008403  8  0.0  30
61509101  0.0  9  1.0  10  0.0  30
61510101  0.0  8  0.991597  9  0.008403  10  0.0  30
61511101  0.0  11  1.0  12  0.0  30
61512101  0.0  10  0.991597  11  0.008403  12  0.0  30
61513101  0.0  13  1.0  14  0.0  30
61514101  0.0  12  0.991597  13  0.008403  14  0.0  30
61515101  0.0  15  1.0  16  0.0  30
61516101  0.0  14  0.991597  15  0.008403  16  0.0  30
61517101  0.0  17  1.0  18  0.0  30
61518101  0.0  16  0.991597  17  0.008403  18  0.0  30
61519101  0.0  19  1.0  20  0.0  30
61520101  0.0  18  0.991597  19  0.008403  20  0.0  30
61521101  0.0  21  1.0  22  0.0  30
61522101  0.0  20  0.991597  21  0.008403  22  0.0  30
61523101  0.0  23  1.0  24  0.0  30
61524101  0.0  22  0.991597  23  0.008403  24  0.0  30
61525101  0.0  25  1.0  26  0.0  30
61526101  0.0  24  0.991597  25  0.008403  26  0.0  30
61527101  0.0  27  1.0  28  0.0  30
61528101  0.0  26  0.991597  27  0.008403  28  0.0  30
61529101  0.0  29  1.0  30
61530101  0.0  28  0.991597  29  0.008403  30
*
* radiation from upper plenum plate to upper plenum shield/upper head
*
61600000  4  300.0  0.0
*
61601001  1201001  1  0.810
61602001  1202001  1  0.075
61603001  1001001  0  0.072
61604001  1200001  0  0.075
*
61601101  0.0  1  0.049499  2  0.850501  3  0.100000  4
61602101  0.028920  1  0.400000  2  0.367582  3  0.203498  4
61603101  0.388455  1  0.287355  2  0.224190  3  0.100000  4
61604101  0.127657  1  0.444634  2  0.279498  3  0.148211  4
*
* radiation from bottom reflector to outlet plenum bottom plate
*
61800000  8  300.0  0.0
*
61801001  1320014  0  0.702
61802001  1402002  1  0.612
61803001  1452002  1  0.612
61804001  1502002  1  0.612
61805001  1620014  0  0.747
61806001  1751001  1  0.630
61807001  1660015  0  0.494
61808001  1750001  0  0.747
*
61801101  0.264687  1  0  5  0.514719  6  0.0  7  0.220594  8
61802101  0.0  1  0.961510  2  0.0  5  0.026943  6
61802102  0.0  7  0.011547  8
61803101  0.0  2  0.963920  3  0.0  5  0.025256  6
61803102  0.0  7  0.010824  8
61804101  0.0  3  0.959868  4  0.0  5  0.028093  6
61804102  0.0  7  0.012040  8
61805101  0.0  4  0.506591  5  0.345386  6  0.0  7  0.148023  8
61806101  0.006970  1  0.014677  2  0.014748  3  0.025416  4
61806102  0.023384  5  0.600000  6  0.102613  7  0.212193  8
```

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61807101  0.0  5  0.798854  6  0.069445  7  0.131701  8
61808101  0.011245  1  0.023680  2  0.023795  3  0.041008  4
61808102  0.037729  5  0.798854  6  0.063689  7  0.0  8
*
* radiation from core barrel to primary pressure vessel
*
61900000  36  300.0  0.0
* core support region
61901001  1150001  1  0.075
61902001  1000001  0  0.075
* outlet plenum
61903001  1150002  1  0.075
61904001  1100001  0  0.075
61905001  1100001  1  0.075
61906001  1000002  0  0.075
*bottom reflector, bottom
61907001  1150003  1  0.075
61908001  1000003  0  0.075
* bottom reflector, top
61909001  1150004  1  0.075
61910001  1000004  0  0.075
* core level 10
61911001  1150005  1  0.075
61912001  1000005  0  0.075
* core level 9
61913001  1150006  1  0.075
61914001  1000006  0  0.075
* core level 8
61915001  1150007  1  0.075
61916001  1000007  0  0.075
* core level 7
61917001  1150008  1  0.075
61918001  1000008  0  0.075
* core level 6
61919001  1150009  1  0.075
61920001  1000009  0  0.075
* core level 5
61921001  1150010  1  0.075
61922001  1000010  0  0.075
* core level 4
61923001  1150011  1  0.075
61924001  1000011  0  0.075
* core level 3
61925001  1150012  1  0.075
61926001  1000012  0  0.075
* core level 2
61927001  1150013  1  0.075
61928001  1000013  0  0.075
* core level 1
61929001  1150014  1  0.075
61930001  1000014  0  0.075
* upper reflector, bottom
61931001  1150015  1  0.075
61932001  1000015  0  0.075
* upper reflector, top
61933001  1150016  1  0.075
61934001  1000016  0  0.075
* upper plenum region
61935001  1200001  1  0.075
61936001  1000017  0  0.075
* view factors
* core support region
61901101  0.0  1  1.0  2  0.0  36
```

```
61902101  0.930233  1  0.069767  2  0.0  36
* outlet plenum
61903101  0.0  3  1.0  4  0.0  36
61904101  0.0  2  0.537  3  0.462596  4  0.0  36
61905101  0.0  4  0.425791  5  0.574209  6  0.0  36
61906101  0.0  4  1.0  5  0.0  6  0.0  36
*bottom reflector, bottom
61907101  0.0  7  1.0  8  0.0  36
61908101  0.0  6  0.930233  7  0.069767  8  0.0  36
* bottom reflector, top
61909101  0.0  9  1.0  10  0.0  36
61910101  0.0  8  0.930233  9  0.069767  10  0.0  36
* core level 10
61911101  0.0  11  1.0  12  0.0  36
61912101  0.0  10  0.930233  11  0.069767  12  0.0  36
* core level 9
61913101  0.0  13  1.0  14  0.0  36
61914101  0.0  12  0.930233  13  0.069767  14  0.0  36
* core level 8
61915101  0.0  15  1.0  16  0.0  36
61916101  0.0  14  0.930233  15  0.069767  16  0.0  36
* core level 7
61917101  0.0  17  1.0  18  0.0  36
61918101  0.0  16  0.930233  17  0.069767  18  0.0  36
* core level 6
61919101  0.0  19  1.0  20  0.0  36
61920101  0.0  18  0.930233  19  0.069767  20  0.0  36
* core level 5
61921101  0.0  21  1.0  22  0.0  36
61922101  0.0  20  0.930233  21  0.069767  22  0.0  36
* core level 4
61923101  0.0  23  1.0  24  0.0  36
61924101  0.0  22  0.930233  23  0.069767  24  0.0  36
* core level 3
61925101  0.0  25  1.0  26  0.0  36
61926101  0.0  24  0.930233  25  0.069767  26  0.0  36
* core level 2
61927101  0.0  27  1.0  28  0.0  36
61928101  0.0  26  0.930233  27  0.069767  28  0.0  36
* core level 1
61929101  0.0  29  1.0  30  0.0  36
61930101  0.0  28  0.930233  29  0.069767  30  0.0  36
* upper reflector, bottom
61931101  0.0  31  1.0  32  0.0  36
61932101  0.0  30  0.930233  31  0.069767  32  0.0  36
* upper reflector, top
61933101  0.0  33  1.0  34  0.0  36
61934101  0.0  32  0.930233  33  0.069767  34  0.0  36
* upper plenum region
61935101  0.0  35  1.0  36
61936101  0.0  34  0.935879  35  0.064121  36
*
* radiation from primary pressure vessel to RCCS
*
62100000  38  300.0  0.000
* lower head region
62101001  1002001  1  0.075
62102001  9500001  0  0.075
* core support region
62103001  1000001  1  0.075
62104001  9500002  0  0.075
* outlet plenum
62105001  1000002  1  0.075
```

```
62106001  9500003  0  0.075
* bottom reflector, bottom
62107001  1000003  1  0.075
62108001  9500004  0  0.075
* bottom reflector, top
62109001  1000004  1  0.075
62110001  9500005  0  0.075
* core level 10
62111001  1000005  1  0.075
62112001  9500006  0  0.075
* core level 9
62113001  1000006  1  0.075
62114001  9500007  0  0.075
* core level 8
62115001  1000007  1  0.075
62116001  9500008  0  0.075
* core level 7
62117001  1000008  1  0.075
62118001  9500009  0  0.075
* core level 6
62119001  1000009  1  0.075
62120001  9500010  0  0.075
* core level 5
62121001  1000010  1  0.075
62122001  9500011  0  0.075
* core level 4
62123001  1000011  1  0.075
62124001  9500012  0  0.075
* core level 3
62125001  1000012  1  0.075
62126001  9500013  0  0.075
* core level 2
62127001  1000013  1  0.075
62128001  9500014  0  0.075
* core level 1
62129001  1000014  1  0.075
62130001  9500015  0  0.075
* upper reflector, bottom
62131001  1000015  1  0.075
62132001  9500016  0  0.075
* upper reflector, top
62133001  1000016  1  0.075
62134001  9500017  0  0.075
* upper plenum cylinder
62135001  1000017  1  0.075
62136001  9500018  0  0.075
* upper head
62137001  1001001  1  0.075
62138001  9500019  0  0.075
*
* view factors
* lower head region
62101101  0.0  1  1.0  2  0.0  38
62102101  0.436126  1  0.563874  2  0.0  38
* core support region
62103101  0.0  2  0.0  3  1.0  4  0.0  38
62104101  0.0  2  0.535871  3  0.464129  4  0.0  38
* outlet plenum
62105101  0.0  4  0.0  5  1.0  6  0.0  38
62106101  0.0  4  0.535871  5  0.464129  6  0.0  38
* bottom reflector, bottom
62107101  0.0  6  0.0  7  1.0  8  0.0  38
62108101  0.0  6  0.535871  7  0.464129  8  0.0  38
```

```
* bottom reflector, top
62109101  0.0  8  0.0  9  1.0  10  0.0  38
62110101  0.0  8  0.535871  9  0.464129  10  0.0  38
* core level 10
62111101  0.0  10  0.0  11  1.0  12  0.0  38
62112101  0.0  10  0.535871  11  0.464129  12  0.0  38
* core level 9
62113101  0.0  12  0.0  13  1.0  14  0.0  38
62114101  0.0  12  0.535871  13  0.464129  14  0.0  38
* core level 8
62115101  0.0  14  0.0  15  1.0  16  0.0  38
62116101  0.0  14  0.535871  15  0.464129  16  0.0  38
* core level 7
62117101  0.0  16  0.0  17  1.0  18  0.0  38
62118101  0.0  16  0.535871  17  0.464129  18  0.0  38
* core level 6
62119101  0.0  18  0.0  19  1.0  20  0.0  38
62120101  0.0  18  0.535871  19  0.464129  20  0.0  38
* core level 5
62121101  0.0  20  0.0  21  1.0  22  0.0  38
62122101  0.0  20  0.535871  21  0.464129  22  0.0  38
* core level 4
62123101  0.0  22  0.0  23  1.0  24  0.0  38
62124101  0.0  22  0.535871  23  0.464129  24  0.0  38
* core level 3
62125101  0.0  24  0.0  25  1.0  26  0.0  38
62126101  0.0  24  0.535871  25  0.464129  26  0.0  38
* core level 2
62127101  0.0  26  0.0  27  1.0  28  0.0  38
62128101  0.0  26  0.535871  27  0.464129  28  0.0  38
* core level 1
62129101  0.0  28  0.0  29  1.0  30  0.0  38
62130101  0.0  28  0.535871  29  0.464129  30  0.0  38
* upper reflector, bottom
62131101  0.0  30  0.0  31  1.0  32  0.0  38
62132101  0.0  30  0.535871  31  0.464129  32  0.0  38
* upper reflector, top
62133101  0.0  32  0.0  33  1.0  34  0.0  38
62134101  0.0  32  0.535871  33  0.464129  34  0.0  38
* upper plenum cylinder
62135101  0.0  34  0.0  35  1.0  36  0.0  38
62136101  0.0  34  0.535871  35  0.464129  36  0.0  38
* upper head
62137101  0.0  36  0.0  37  1.0  38
62138101  0.0  36  0.595579  37  0.404421  38
*
******************************************************
* material properties
******************************************************
*
* Greencast-94F plus ceramic
*
20100100  tbl/fctn  1  1
*20100101 250.0  5.25
*20100102 478.0  5.25
*20100103 698.0  3.58
*20100104 923.0  2.83
*20100105 1143.0  2.49
*20100106 1368.0  2.47
*20100107 2000.0  2.47
* curve-fit values
20100101  250.0  7.37
20100102  300.0  7.37
```

```
20100103  400.0  6.06
20100104  500.0  5.01
20100105  600.0  4.18
20100106  700.0  3.56
20100107  800.0  3.10
20100108  900.0  2.78
20100109  1000.0  2.58
20100110  1100.0  2.46
20100111  1200.0  2.40
20100112  1300.0  2.37
20100113  1400.0  2.33
20100114  1500.0  2.27
20100115  1600.0  2.15
20100116  1700.0  1.95
20100117  1800.0  1.63
20100118  1900.0  1.17
20100119  2000.0  0.54
*
20100151  250.0  2.74E+06
20100152  335.5  2.74E+06
20100153  422.1  3.21E+06
20100154  506.4  3.65E+06
20100155  589.3  3.68E+06
20100156  671.3  3.45E+06
20100157  752.4  3.45E+06
20100158  832.8  3.47E+06
20100159  912.5  3.50E+06
20100160  991.4  3.53E+06
20100161  1069.8  3.65E+06
20100162  1147.5  3.50E+06
20100163  1224.6  3.50E+06
20100164  1301.3  3.45E+06
20100165  1377.7  3.47E+06
20100166  1453.9  3.56E+06
20100167  1530.0  3.77E+06
20100168  1606.1  3.77E+06
20100169  1682.3  3.77E+06
20100170  1758.2  8.91E+06
20100171  1834.3  3.71E+06
20100172  2000.0  3.71E+06
*
* heater rod
*
20100200  tbl/fctn  1  1
20100201  250.0  93.00
20100202  293.2  93.00
20100203  443.2  81.84
20100204  593.2  69.75
20100205  773.2  61.38
20100206  1003.2  51.15
20100207  1123.2  46.50
20100208  1273.2  42.78
20100209  1673.2  29.76
20100210  3000.0  29.76
*
20100251  250.0  1.25E+06
20100252  300.0  1.25E+06
20100253  400.0  1.68E+06
20100254  500.0  2.08E+06
20100255  600.0  2.40E+06
20100256  700.0  2.65E+06
20100257  800.0  2.86E+06
20100258  900.0  3.02E+06
```

```
20100259  1000.0  3.14E+06
20100260  1100.0  3.24E+06
20100261  1200.0  3.33E+06
20100262  1300.0  3.40E+06
20100263  1400.0  3.45E+06
20100264  1500.0  3.50E+06
20100265  1600.0  3.54E+06
20100266  1700.0  3.58E+06
20100267  1800.0  3.62E+06
20100268  1900.0  3.65E+06
20100269  2000.0  3.68E+06
20100270  2100.0  3.70E+06
20100271  2200.0  3.73E+06
20100272  2300.0  3.75E+06
20100273  2400.0  3.77E+06
20100274  2500.0  3.79E+06
20100275  2600.0  3.80E+06
20100276  2700.0  3.82E+06
20100277  2800.0  3.84E+06
20100278  2900.0  3.85E+06
20100279  3000.0  3.87E+06
*
* 304 stainless steel
*
20100300  tbl/fctn  1  1
20100301  250.0  13.25
20100302  300.0  13.25
20100303  1671.0  39.1619
20100304  1727.0  20.0
20100305  3000.0  20.0
*
20100351  250.0  3.72E+06
20100352  300.0  3.72E+06
20100353  400.0  3.94E+06
20100354  500.0  4.12E+06
20100355  600.0  4.29E+06
20100356  700.0  4.44E+06
20100357  800.0  4.57E+06
20100358  900.0  4.69E+06
20100359  1000.0  4.81E+06
20100360  1100.0  4.92E+06
20100361  1200.0  5.01E+06
20100362  1300.0  5.11E+06
20100363  1400.0  5.19E+06
20100364  1500.0  5.27E+06
20100365  1600.0  5.35E+06
20100366  1671.0  5.40E+06
20100367  3000.0  5.40E+06
*
* Haynes 230
*
20100400  tbl/fctn  1  1
20100401  250.0  8.9
20100402  293.0  8.9
20100403  373.0  10.4
20100404  473.0  12.4
20100405  573.0  14.4
20100406  673.0  16.4
20100407  773.0  18.4
20100408  873.0  20.4
20100409  973.0  22.4
20100410  1073.0  24.4
20100411  1173.0  26.4
```

```
20100412  1273.0  28.4
20100413  1573.0  28.4
*
20100451  250.0  3.59E+06
20100452  293.0  3.59E+06
20100453  373.0  3.79E+06
20100454  473.0  3.94E+06
20100455  573.0  4.05E+06
20100456  673.0  4.21E+06
20100457  773.0  4.28E+06
20100458  873.0  4.40E+06
20100459  973.0  5.19E+06
20100460  1073.0  5.38E+06
20100461  1173.0  5.51E+06
20100462  1273.0  5.58E+06
20100463  1573.0  5.58E+06
*
* Shot-Tech SiC 80 ceramic
*
20100500  tbl/fctn  1  1
20100501  250.0  7.56
20100502  473.0  7.56
20100503  673.0  6.58
20100504  873.0  6.73
20100505  1073.0  6.95
20100506  1573.0  6.95
*
20100551  250.0  1.78E+06
20100552  327.3  1.78E+06
20100553  397.9  2.11E+06
20100554  466.9  2.30E+06
20100555  534.7  2.42E+06
20100556  601.6  2.54E+06
20100557  668.0  2.61E+06
20100558  733.8  2.68E+06
20100559  799.2  2.70E+06
20100560  864.1  2.75E+06
20100561  928.4  2.77E+06
20100562  992.2  2.80E+06
20100563  1055.7  2.80E+06
20100564  1118.9  2.87E+06
20100565  1181.7  2.87E+06
20100566  1244.1  2.89E+06
20100567  1306.2  2.87E+06
20100568  1368.1  2.63E+06
20100569  1429.9  2.89E+06
20100570  1573.0  2.89E+06
*
* Enerwrap MA 960 insulation
*
20100600  tbl/fctn  1  1
20100601  250.0  0.036
20100602  311.0  0.036
20100603  366.0  0.043
20100604  423.0  0.049
20100605  477.0  0.058
20100606  533.0  0.069
20100607  589.0  0.084
20100608  644.0  0.098
20100609  3000.0  0.098
*
20100651  7.64E+04
*
```

```
* Structural insulation
*
20100700  tbl/fctn  1  1
20100701  250.0  0.078
20100702  366.0  0.078
20100703  477.0  0.088
20100704  588.0  0.097
20100705  700.0  0.105
20100706  3000.0  0.105
*
20100751  250.0  1.31E+05
20100752  294.0  1.31E+05
20100753  366.0  1.35E+05
20100754  477.0  1.44E+05
20100755  589.0  1.53E+05
20100756  700.0  1.61E+05
20100757  811.0  1.70E+05
20100758  922.0  1.79E+05
20100759  1033.0  1.87E+05
20100760  1144.0  1.96E+05
20100761  1255.0  2.04E+05
20100762  1366.0  2.13E+05
20100763  3000.0  2.13E+05
*
* Cerablanket alumina-silica insulation
*
20100800  tbl/fctn  1  1
20100801  250.0  0.070
20100802  473.0  0.070
20100803  673.0  0.120
20100804  873.0  0.200
20100805  1073.0  0.300
20100806  1273.0  0.430
20100807  3000.0  0.430
*
20100851  7.23E+04
*
* Lewco Needled 10# E Glass Blanket insulation
*
20100900  tbl/fctn  1  1
20100901  250.0  0.050
20100902  422.0  0.050
20100903  533.2  0.069
20100904  644.3  0.092
20100905  755.4  0.112
20100906  2000.0  0.112
*
20100951  1.07E+05
*
*******************************************************
* general tables
*******************************************************
*
* volumetric heat capacities
*
* Greencast-94F plus ceramic
20200100  reac-t
20200101  250.0  2744800.0
20200102  335.5  2744800.0
20200103  422.1  3212000.0
20200104  506.4  3650000.0
20200105  589.3  3679200.0
20200106  671.3  3445600.0
```

```
20200107  752.4  3445600.0
20200108  832.8  3474800.0
20200109  912.5  3504000.0
20200110  991.4  3533200.0
20200111  1069.8  3650000.0
20200112  1147.5  3504000.0
20200113  1224.6  3504000.0
20200114  1301.3  3445600.0
20200115  1377.7  3474800.0
20200116  1453.9  3562400.0
20200117  1530.0  3766800.0
20200118  1606.1  3766800.0
20200119  1682.3  3766800.0
20200120  1758.2  8906000.0
20200121  1834.3  3708400.0
20200122  2000.0  3708400.0
*
* heater rod
20200200  reac-t
20200201  300.0  1247750.0
20200202  400.0  1681750.0
20200203  500.0  2077250.0
20200204  600.0  2397500.0
20200205  700.0  2653000.0
20200206  800.0  2856000.0
20200207  900.0  3015250.0
20200208  1000.0  3143000.0
20200209  1100.0  3244500.0
20200210  1200.0  3326750.0
20200211  1300.0  3395000.0
20200212  1400.0  3451000.0
20200213  1500.0  3500000.0
20200214  1600.0  3542000.0
20200215  1700.0  3580500.0
20200216  1800.0  3615500.0
20200217  1900.0  3645250.0
20200218  2000.0  3675000.0
20200219  2100.0  3701250.0
20200220  2200.0  3725750.0
20200221  2300.0  3748500.0
20200222  2400.0  3769500.0
20200223  2500.0  3788750.0
20200224  2600.0  3804500.0
20200225  2700.0  3822000.0
20200226  2800.0  3837750.0
20200227  2900.0  3853500.0
20200228  3000.0  3872750.0
*
* 304 stainless steel
20200300  reac-t
20200301  250.0  3724428.5
20200302  300.0  3724428.5
20200303  400.0  3937320.4
20200304  500.0  4122643.2
20200305  600.0  4287368.5
20200306  700.0  4435836.2
20200307  800.0  4570983.8
20200308  900.0  4694918.8
20200309  1000.0  4809219.3
20200310  1100.0  4915106.5
20200311  1200.0  5013550.6
20200312  1300.0  5105338.8
20200313  1400.0  5191121.1
```

```
20200314  1500.0  5271442.7
20200315  1600.0  5346766.2
20200316  1671.0  5397444.0
20200317  3000.0  5397444.0
*
* Haynes 230
20200400  reac-t
20200401  250.0  3592850.0
20200402  293.0  3592850.0
20200403  373.0  3791950.0
20200404  473.0  3936750.0
20200405  573.0  4054400.0
20200406  673.0  4208250.0
20200407  773.0  4280650.0
20200408  873.0  4398300.0
20200409  973.0  5194700.0
20200410  1073.0  5384750.0
20200411  1173.0  5511450.0
20200412  1273.0  5583850.0
20200413  1573.0  5583850.0
*
* Shot-Tech SiC 80 ceramic
20200500  reac-t
20200501  250.0  1777500.0
20200502  327.3  1777500.0
20200503  397.9  2109300.0
20200504  466.9  2298900.0
20200505  534.7  2417400.0
20200506  601.6  2535900.0
20200507  668.0  2607000.0
20200508  733.8  2678100.0
20200509  799.2  2701800.0
20200510  864.1  2749200.0
20200511  928.4  2772900.0
20200512  992.2  2796600.0
20200513  1055.7  2796600.0
20200514  1118.9  2867700.0
20200515  1181.7  2867700.0
20200516  1244.1  2891400.0
20200517  1306.2  2867700.0
20200518  1368.1  2630700.0
20200519  1429.9  2891400.0
20200520  1573.0  2891400.0
*
* Temperature-dependent conductance
*
20260100  htc-temp
20260101  300.0  130.64
20260102  400.0  114.02
20260103  500.0  99.34
20260104  600.0  86.60
20260105  700.0  77.85
20260106  800.0  70.61
20260107  900.0  66.09
20260108  1000.0  63.68
20260109  1100.0  56.00
20260110  1200.0  53.48
20260111  1300.0  51.30
20260112  1400.0  50.03
20260113  1500.0  52.82
20260114  1600.0  52.54
20260115  1700.0  39.06
20260116  1800.0  36.33
```

```
20260117  1900.0  32.35
20260118  2000.0  26.83
*
* power in heater 101
*
20290100  power  100  1.0  1.0
20290101  -1.0  220000.0
20290102  0.0  56700.0
20290103  30.0  56700.0
20290104  30.0  38200.0
20290105  75.0  38200.0
20290106  75.0  31900.0
20290107  200.0  31900.0
20290108  200.0  27881.8
20290109  300.0  27881.8
20290110  300.0  25956.5
20290111  400.0  25956.5
20290112  400.0  24504.4
20290113  500.0  24504.4
20290114  500.0  22703.2
20290115  750.0  22703.2
20290116  750.0  20708.8
20290117  1000.0  20708.8
20290118  1000.0  18039.7
20290119  2000.0  18039.7
20290120  2000.0  15304.5
20290121  3000.0  15304.5
20290122  3000.0  13863.9
20290123  4000.0  13863.9
20290124  4000.0  12932.5
20290125  5000.0  12932.5
20290126  5000.0  11921.7
20290127  7500.0  11921.7
20290128  7500.0  10906.8
20290129  10000.0  10906.8
20290130  10000.0  9696.9
20290131  20000.0  9696.9
20290132  20000.0  8453.4
20290133  30000.0  8453.4
20290134  30000.0  7754.1
20290135  40000.0  7754.1
20290136  40000.0  7274.1
20290137  50000.0  7274.1
20290138  50000.0  6721.0
20290139  75000.0  6721.0
20290140  75000.0  6135.8
20290141  100000.0  6135.8
20290142  100000.0  5362.9
20290143  200000.0  5362.9
20290144  200000.0  4534.1
20290145  300000.0  4534.1
20290146  300000.0  4053.0
20290147  400000.0  4053.0
20290148  400000.0  3727.4
20290149  500000.0  3727.4
20290150  500000.0  3369.0
20290151  750000.0  3369.0
20290152  750000.0  3002.8
20290153  1000000.0  3002.8
20290154  1000000.0  2552.4
20290155  2000000.0  2552.4
*
* power in heater 102
```

```
*
20290200  power  100  1.0  1.0
20290201  -1.0  220000.0
20290202  0.0  56700.0
20290203  30.0  56700.0
20290204  30.0  38200.0
20290205  75.0  38200.0
20290206  75.0  31900.0
20290207  200.0  31900.0
20290208  200.0  27881.8
20290209  300.0  27881.8
20290210  300.0  25956.5
20290211  400.0  25956.5
20290212  400.0  24504.4
20290213  500.0  24504.4
20290214  500.0  22703.2
20290215  750.0  22703.2
20290216  750.0  20708.8
20290217  1000.0  20708.8
20290218  1000.0  18039.7
20290219  2000.0  18039.7
20290220  2000.0  15304.5
20290221  3000.0  15304.5
20290222  3000.0  13863.9
20290223  4000.0  13863.9
20290224  4000.0  12932.5
20290225  5000.0  12932.5
20290226  5000.0  11921.7
20290227  7500.0  11921.7
20290228  7500.0  10906.8
20290229  10000.0  10906.8
20290230  10000.0  9696.9
20290231  20000.0  9696.9
20290232  20000.0  8453.4
20290233  30000.0  8453.4
20290234  30000.0  7754.1
20290235  40000.0  7754.1
20290236  40000.0  7274.1
20290237  50000.0  7274.1
20290238  50000.0  6721.0
20290239  75000.0  6721.0
20290240  75000.0  6135.8
20290241  100000.0  6135.8
20290242  100000.0  5362.9
20290243  200000.0  5362.9
20290244  200000.0  4534.1
20290245  300000.0  4534.1
20290246  300000.0  4053.0
20290247  400000.0  4053.0
20290248  400000.0  3727.4
20290249  500000.0  3727.4
20290250  500000.0  3369.0
20290251  750000.0  3369.0
20290252  750000.0  3002.8
20290253  1000000.0  3002.8
20290254  1000000.0  2552.4
20290255  2000000.0  2552.4
*
* power in heater 103
*
20290300  power  100  1.0  1.0
20290301  -1.0  220000.0
20290302  0.0  56700.0
```

```
20290303  30.0  56700.0
20290304  30.0  38200.0
20290305  75.0  38200.0
20290306  75.0  31900.0
20290307  200.0  31900.0
20290308  200.0  27881.8
20290309  300.0  27881.8
20290310  300.0  25956.5
20290311  400.0  25956.5
20290312  400.0  24504.4
20290313  500.0  24504.4
20290314  500.0  22703.2
20290315  750.0  22703.2
20290316  750.0  20708.8
20290317  1000.0  20708.8
20290318  1000.0  18039.7
20290319  2000.0  18039.7
20290320  2000.0  15304.5
20290321  3000.0  15304.5
20290322  3000.0  13863.9
20290323  4000.0  13863.9
20290324  4000.0  12932.5
20290325  5000.0  12932.5
20290326  5000.0  11921.7
20290327  7500.0  11921.7
20290328  7500.0  10906.8
20290329  10000.0  10906.8
20290330  10000.0  9696.9
20290331  20000.0  9696.9
20290332  20000.0  8453.4
20290333  30000.0  8453.4
20290334  30000.0  7754.1
20290335  40000.0  7754.1
20290336  40000.0  7274.1
20290337  50000.0  7274.1
20290338  50000.0  6721.0
20290339  75000.0  6721.0
20290340  75000.0  6135.8
20290341  100000.0  6135.8
20290342  100000.0  5362.9
20290343  200000.0  5362.9
20290344  200000.0  4534.1
20290345  300000.0  4534.1
20290346  300000.0  4053.0
20290347  400000.0  4053.0
20290348  400000.0  3727.4
20290349  500000.0  3727.4
20290350  500000.0  3369.0
20290351  750000.0  3369.0
20290352  750000.0  3002.8
20290353  1000000.0  3002.8
20290354  1000000.0  2552.4
20290355  2000000.0  2552.4
*
* power in heater 104
*
20290400  power  100  1.0  1.0
20290401  -1.0  220000.0
20290402  0.0  56700.0
20290403  30.0  56700.0
20290404  30.0  38200.0
20290405  75.0  38200.0
20290406  75.0  31900.0
```

```
20290407  200.0  31900.0
20290408  200.0  27881.8
20290409  300.0  27881.8
20290410  300.0  25956.5
20290411  400.0  25956.5
20290412  400.0  24504.4
20290413  500.0  24504.4
20290414  500.0  22703.2
20290415  750.0  22703.2
20290416  750.0  20708.8
20290417  1000.0  20708.8
20290418  1000.0  18039.7
20290419  2000.0  18039.7
20290420  2000.0  15304.5
20290421  3000.0  15304.5
20290422  3000.0  13863.9
20290423  4000.0  13863.9
20290424  4000.0  12932.5
20290425  5000.0  12932.5
20290426  5000.0  11921.7
20290427  7500.0  11921.7
20290428  7500.0  10906.8
20290429  10000.0  10906.8
20290430  10000.0  9696.9
20290431  20000.0  9696.9
20290432  20000.0  8453.4
20290433  30000.0  8453.4
20290434  30000.0  7754.1
20290435  40000.0  7754.1
20290436  40000.0  7274.1
20290437  50000.0  7274.1
20290438  50000.0  6721.0
20290439  75000.0  6721.0
20290440  75000.0  6135.8
20290441  100000.0  6135.8
20290442  100000.0  5362.9
20290443  200000.0  5362.9
20290444  200000.0  4534.1
20290445  300000.0  4534.1
20290446  300000.0  4053.0
20290447  400000.0  4053.0
20290448  400000.0  3727.4
20290449  500000.0  3727.4
20290450  500000.0  3369.0
20290451  750000.0  3369.0
20290452  750000.0  3002.8
20290453  1000000.0  3002.8
20290454  1000000.0  2552.4
20290455  2000000.0  2552.4
*
* power in heater 105
*
20290500  power  100  1.0  1.0
20290501  -1.0  220000.0
20290502  0.0  56700.0
20290503  30.0  56700.0
20290504  30.0  38200.0
20290505  75.0  38200.0
20290506  75.0  31900.0
20290507  200.0  31900.0
20290508  200.0  27881.8
20290509  300.0  27881.8
20290510  300.0  25956.5
```

```
20290511  400.0  25956.5
20290512  400.0  24504.4
20290513  500.0  24504.4
20290514  500.0  22703.2
20290515  750.0  22703.2
20290516  750.0  20708.8
20290517  1000.0  20708.8
20290518  1000.0  18039.7
20290519  2000.0  18039.7
20290520  2000.0  15304.5
20290521  3000.0  15304.5
20290522  3000.0  13863.9
20290523  4000.0  13863.9
20290524  4000.0  12932.5
20290525  5000.0  12932.5
20290526  5000.0  11921.7
20290527  7500.0  11921.7
20290528  7500.0  10906.8
20290529  10000.0  10906.8
20290530  10000.0  9696.9
20290531  20000.0  9696.9
20290532  20000.0  8453.4
20290533  30000.0  8453.4
20290534  30000.0  7754.1
20290535  40000.0  7754.1
20290536  40000.0  7274.1
20290537  50000.0  7274.1
20290538  50000.0  6721.0
20290539  75000.0  6721.0
20290540  75000.0  6135.8
20290541  100000.0  6135.8
20290542  100000.0  5362.9
20290543  200000.0  5362.9
20290544  200000.0  4534.1
20290545  300000.0  4534.1
20290546  300000.0  4053.0
20290547  400000.0  4053.0
20290548  400000.0  3727.4
20290549  500000.0  3727.4
20290550  500000.0  3369.0
20290551  750000.0  3369.0
20290552  750000.0  3002.8
20290553  1000000.0  3002.8
20290554  1000000.0  2552.4
20290555  2000000.0  2552.4
*
* power in heater 106
*
20290600  power  100  1.0  1.0
20290601  -1.0  220000.0
20290602  0.0  56700.0
20290603  30.0  56700.0
20290604  30.0  38200.0
20290605  75.0  38200.0
20290606  75.0  31900.0
20290607  200.0  31900.0
20290608  200.0  27881.8
20290609  300.0  27881.8
20290610  300.0  25956.5
20290611  400.0  25956.5
20290612  400.0  24504.4
20290613  500.0  24504.4
20290614  500.0  22703.2
```

```
20290615  750.0  22703.2
20290616  750.0  20708.8
20290617  1000.0  20708.8
20290618  1000.0  18039.7
20290619  2000.0  18039.7
20290620  2000.0  15304.5
20290621  3000.0  15304.5
20290622  3000.0  13863.9
20290623  4000.0  13863.9
20290624  4000.0  12932.5
20290625  5000.0  12932.5
20290626  5000.0  11921.7
20290627  7500.0  11921.7
20290628  7500.0  10906.8
20290629  10000.0  10906.8
20290630  10000.0  9696.9
20290631  20000.0  9696.9
20290632  20000.0  8453.4
20290633  30000.0  8453.4
20290634  30000.0  7754.1
20290635  40000.0  7754.1
20290636  40000.0  7274.1
20290637  50000.0  7274.1
20290638  50000.0  6721.0
20290639  75000.0  6721.0
20290640  75000.0  6135.8
20290641  100000.0  6135.8
20290642  100000.0  5362.9
20290643  200000.0  5362.9
20290644  200000.0  4534.1
20290645  300000.0  4534.1
20290646  300000.0  4053.0
20290647  400000.0  4053.0
20290648  400000.0  3727.4
20290649  500000.0  3727.4
20290650  500000.0  3369.0
20290651  750000.0  3369.0
20290652  750000.0  3002.8
20290653  1000000.0  3002.8
20290654  1000000.0  2552.4
20290655  2000000.0  2552.4
*
* power in heater 107
*
20290700  power  100  1.0  1.0
20290701  -1.0  220000.0
20290702  0.0  56700.0
20290703  30.0  56700.0
20290704  30.0  38200.0
20290705  75.0  38200.0
20290706  75.0  31900.0
20290707  200.0  31900.0
20290708  200.0  27881.8
20290709  300.0  27881.8
20290710  300.0  25956.5
20290711  400.0  25956.5
20290712  400.0  24504.4
20290713  500.0  24504.4
20290714  500.0  22703.2
20290715  750.0  22703.2
20290716  750.0  20708.8
20290717  1000.0  20708.8
20290718  1000.0  18039.7
```

```
20290719  2000.0  18039.7
20290720  2000.0  15304.5
20290721  3000.0  15304.5
20290722  3000.0  13863.9
20290723  4000.0  13863.9
20290724  4000.0  12932.5
20290725  5000.0  12932.5
20290726  5000.0  11921.7
20290727  7500.0  11921.7
20290728  7500.0  10906.8
20290729  10000.0  10906.8
20290730  10000.0  9696.9
20290731  20000.0  9696.9
20290732  20000.0  8453.4
20290733  30000.0  8453.4
20290734  30000.0  7754.1
20290735  40000.0  7754.1
20290736  40000.0  7274.1
20290737  50000.0  7274.1
20290738  50000.0  6721.0
20290739  75000.0  6721.0
20290740  75000.0  6135.8
20290741  100000.0  6135.8
20290742  100000.0  5362.9
20290743  200000.0  5362.9
20290744  200000.0  4534.1
20290745  300000.0  4534.1
20290746  300000.0  4053.0
20290747  400000.0  4053.0
20290748  400000.0  3727.4
20290749  500000.0  3727.4
20290750  500000.0  3369.0
20290751  750000.0  3369.0
20290752  750000.0  3002.8
20290753  1000000.0  3002.8
20290754  1000000.0  2552.4
20290755  2000000.0  2552.4
*
* power in heater 108
*
20290800  power  100  1.0  1.0
20290801  -1.0  220000.0
20290802  0.0  56700.0
20290803  30.0  56700.0
20290804  30.0  38200.0
20290805  75.0  38200.0
20290806  75.0  31900.0
20290807  200.0  31900.0
20290808  200.0  27881.8
20290809  300.0  27881.8
20290810  300.0  25956.5
20290811  400.0  25956.5
20290812  400.0  24504.4
20290813  500.0  24504.4
20290814  500.0  22703.2
20290815  750.0  22703.2
20290816  750.0  20708.8
20290817  1000.0  20708.8
20290818  1000.0  18039.7
20290819  2000.0  18039.7
20290820  2000.0  15304.5
20290821  3000.0  15304.5
20290822  3000.0  13863.9
```

```
20290823  4000.0  13863.9
20290824  4000.0  12932.5
20290825  5000.0  12932.5
20290826  5000.0  11921.7
20290827  7500.0  11921.7
20290828  7500.0  10906.8
20290829  10000.0  10906.8
20290830  10000.0  9696.9
20290831  20000.0  9696.9
20290832  20000.0  8453.4
20290833  30000.0  8453.4
20290834  30000.0  7754.1
20290835  40000.0  7754.1
20290836  40000.0  7274.1
20290837  50000.0  7274.1
20290838  50000.0  6721.0
20290839  75000.0  6721.0
20290840  75000.0  6135.8
20290841  100000.0  6135.8
20290842  100000.0  5362.9
20290843  200000.0  5362.9
20290844  200000.0  4534.1
20290845  300000.0  4534.1
20290846  300000.0  4053.0
20290847  400000.0  4053.0
20290848  400000.0  3727.4
20290849  500000.0  3727.4
20290850  500000.0  3369.0
20290851  750000.0  3369.0
20290852  750000.0  3002.8
20290853  1000000.0  3002.8
20290854  1000000.0  2552.4
20290855  2000000.0  2552.4
*
* power in heater 109
*
20290900  power  100  1.0  1.0
20290901  -1.0  220000.0
20290902  0.0  56700.0
20290903  30.0  56700.0
20290904  30.0  38200.0
20290905  75.0  38200.0
20290906  75.0  31900.0
20290907  200.0  31900.0
20290908  200.0  27881.8
20290909  300.0  27881.8
20290910  300.0  25956.5
20290911  400.0  25956.5
20290912  400.0  24504.4
20290913  500.0  24504.4
20290914  500.0  22703.2
20290915  750.0  22703.2
20290916  750.0  20708.8
20290917  1000.0  20708.8
20290918  1000.0  18039.7
20290919  2000.0  18039.7
20290920  2000.0  15304.5
20290921  3000.0  15304.5
20290922  3000.0  13863.9
20290923  4000.0  13863.9
20290924  4000.0  12932.5
20290925  5000.0  12932.5
20290926  5000.0  11921.7
```

```
20290927  7500.0  11921.7
20290928  7500.0  10906.8
20290929  10000.0  10906.8
20290930  10000.0  9696.9
20290931  20000.0  9696.9
20290932  20000.0  8453.4
20290933  30000.0  8453.4
20290934  30000.0  7754.1
20290935  40000.0  7754.1
20290936  40000.0  7274.1
20290937  50000.0  7274.1
20290938  50000.0  6721.0
20290939  75000.0  6721.0
20290940  75000.0  6135.8
20290941  100000.0  6135.8
20290942  100000.0  5362.9
20290943  200000.0  5362.9
20290944  200000.0  4534.1
20290945  300000.0  4534.1
20290946  300000.0  4053.0
20290947  400000.0  4053.0
20290948  400000.0  3727.4
20290949  500000.0  3727.4
20290950  500000.0  3369.0
20290951  750000.0  3369.0
20290952  750000.0  3002.8
20290953  1000000.0  3002.8
20290954  1000000.0  2552.4
20290955  2000000.0  2552.4
*
* power in heater 110
*
20291000  power  100  1.0  1.0
20291001  -1.0  220000.0
20291002  0.0  56700.0
20291003  30.0  56700.0
20291004  30.0  38200.0
20291005  75.0  38200.0
20291006  75.0  31900.0
20291007  200.0  31900.0
20291008  200.0  27881.8
20291009  300.0  27881.8
20291010  300.0  25956.5
20291011  400.0  25956.5
20291012  400.0  24504.4
20291013  500.0  24504.4
20291014  500.0  22703.2
20291015  750.0  22703.2
20291016  750.0  20708.8
20291017  1000.0  20708.8
20291018  1000.0  18039.7
20291019  2000.0  18039.7
20291020  2000.0  15304.5
20291021  3000.0  15304.5
20291022  3000.0  13863.9
20291023  4000.0  13863.9
20291024  4000.0  12932.5
20291025  5000.0  12932.5
20291026  5000.0  11921.7
20291027  7500.0  11921.7
20291028  7500.0  10906.8
20291029  10000.0  10906.8
20291030  10000.0  9696.9
```

```
20291031  20000.0  9696.9
20291032  20000.0  8453.4
20291033  30000.0  8453.4
20291034  30000.0  7754.1
20291035  40000.0  7754.1
20291036  40000.0  7274.1
20291037  50000.0  7274.1
20291038  50000.0  6721.0
20291039  75000.0  6721.0
20291040  75000.0  6135.8
20291041  100000.0  6135.8
20291042  100000.0  5362.9
20291043  200000.0  5362.9
20291044  200000.0  4534.1
20291045  300000.0  4534.1
20291046  300000.0  4053.0
20291047  400000.0  4053.0
20291048  400000.0  3727.4
20291049  500000.0  3727.4
20291050  500000.0  3369.0
20291051  750000.0  3369.0
20291052  750000.0  3002.8
20291053  1000000.0  3002.8
20291054  1000000.0  2552.4
20291055  2000000.0  2552.4
*
* building temperature boundary for RCCS and insulated structures
*
20295000  temp
20295001  0.0  300.0
*
* natural convection heat transfer coefficient for outside of RCCS rear panels and
insulated structures
*
20295100  htc-t
20295101  0.0  15.0
*
*******************************************************
*  control  variables
*******************************************************
*
20500000  9999
*
*******************************************************
* steady state control variables
*
* inlet flow controller
*
20502360  temperr  sum  1.0  0.0  0
20502361  -960.15  1.0  tempg  175010000
*
20502370  inflow  integral  0.001  1.0  0
20502371  cntrlvar  236
*
* outlet pressure controller
*
20502330  presserr  sum  1.0  0.0  0
20502331  700000.0  -1.0  p  100010000
*
20502340  inpress  integral  0.5  7.00E+05  0
20502341  cntrlvar  233
*
* feedwater flow control
```

```
*
20503190  SGtmperr  sum  1.0  0.0  0
20503191  -531.75  1.0  tempg  270040000  * temperature setpoint
*
20503200  SGFWflow  prop-int  1.00000  0.8  0
20503201  0.007  0.000007  cntrlvar  319
*
20503210  Fwfloint  integral  1.0  0.0  0
20503211  mflowj  320000000
*
* steam pressure control
*
20503690  SG-P-err  sum  1.0  0.0  0
20503691  -515000.0  1.0  p  355010000  * steam pressure
*
20503700  V370pos  integral  1.00E-09  1.0  0  3  0.0  1.0
20503701  cntrlvar  369
*
*******************************************************
* energy balance control variables
*
* core
*
20500010  core1pow  sum  1.0  0.0  1
20500011  0.0  1.0  q  140010000  1.0  q  140020000
20500012  1.0  q  140030000  1.0  q  140040000
20500013  1.0  q  140050000  1.0  q  140060000
20500014  1.0  q  140070000  1.0  q  140080000
20500015  1.0  q  140090000  1.0  q  140100000
20500016  1.0  q  140110000  1.0  q  140120000
20500017  1.0  q  140130000  1.0  q  140140000
*
20500020  core2pow  sum  1.0  0.0  1
20500021  0.0  1.0  q  145010000  1.0  q  145020000
20500022  1.0  q  145030000  1.0  q  145040000
20500023  1.0  q  145050000  1.0  q  145060000
20500024  1.0  q  145070000  1.0  q  145080000
20500025  1.0  q  145090000  1.0  q  145100000
20500026  1.0  q  145110000  1.0  q  145120000
20500027  1.0  q  145130000  1.0  q  145140000
*
20500030  core3pow  sum  1.0  0.0  1
20500031  0.0  1.0  q  150010000  1.0  q  150020000
20500032  1.0  q  150030000  1.0  q  150040000
20500033  1.0  q  150050000  1.0  q  150060000
20500034  1.0  q  150070000  1.0  q  150080000
20500035  1.0  q  150090000  1.0  q  150100000
20500036  1.0  q  150110000  1.0  q  150120000
20500037  1.0  q  150130000  1.0  q  150140000
*
20500040  bypirpow  sum  1.0  0.0  1
20500041  0.0  1.0  q  132010000  1.0  q  132020000
20500042  1.0  q  132030000  1.0  q  132040000
20500043  1.0  q  132050000  1.0  q  132060000
20500044  1.0  q  132070000  1.0  q  132080000
20500045  1.0  q  132090000  1.0  q  132100000
20500046  1.0  q  132110000  1.0  q  132120000
20500047  1.0  q  132130000  1.0  q  132140000
*
20500050  byporpow  sum  1.0  0.0  1
20500051  0.0  1.0  q  162010000  1.0  q  162020000
20500052  1.0  q  162030000  1.0  q  162040000
20500053  1.0  q  162050000  1.0  q  162060000
```

```
20500054  1.0  q  162070000  1.0  q  162080000
20500055  1.0  q  162090000  1.0  q  162100000
20500056  1.0  q  162110000  1.0  q  162120000
20500057  1.0  q  162130000  1.0  q  162140000
*
20500060  bypsppow  sum  1.0  0.0  1
20500061  0.0  1.0  q  164010000  1.0  q  164020000
20500062  1.0  q  164030000  1.0  q  164040000
20500063  1.0  q  164050000  1.0  q  164060000
20500064  1.0  q  164070000  1.0  q  164080000
20500065  1.0  q  164090000  1.0  q  164100000
20500066  1.0  q  164110000  1.0  q  164120000
20500067  1.0  q  164130000  1.0  q  164140000
*
20500070  byppbpow  sum  1.0  0.0  1
20500071  0.0  1.0  q  166010000  1.0  q  166020000
20500072  1.0  q  166030000  1.0  q  166040000
20500073  1.0  q  166050000  1.0  q  166060000
20500074  1.0  q  166070000  1.0  q  166080000
20500075  1.0  q  166090000  1.0  q  166100000
20500076  1.0  q  166110000  1.0  q  166120000
20500077  1.0  q  166130000  1.0  q  166140000
*
20500080  hr140gap  sum  1.0  0.0  1
20500081  0.0  1.0  q  141010000  1.0  q  141020000
20500082  1.0  q  141030000  1.0  q  141040000
20500083  1.0  q  141050000  1.0  q  141060000
20500084  1.0  q  141070000  1.0  q  141080000
20500085  1.0  q  141090000  1.0  q  141100000
*
20500090  hr145gap  sum  1.0  0.0  1
20500091  0.0  1.0  q  146010000  1.0  q  146020000
20500092  1.0  q  146030000  1.0  q  146040000
20500093  1.0  q  146050000  1.0  q  146060000
20500094  1.0  q  146070000  1.0  q  146080000
20500095  1.0  q  146090000  1.0  q  146100000
*
20500100  hr150gap  sum  1.0  0.0  1
20500101  0.0  1.0  q  151010000  1.0  q  151020000
20500102  1.0  q  151030000  1.0  q  151040000
20500103  1.0  q  151050000  1.0  q  151060000
20500104  1.0  q  151070000  1.0  q  151080000
20500105  1.0  q  151090000  1.0  q  151100000
*
20500110  corepow  sum  1.0  0.0  1
20500111  0.0  1.0  cntrlvar  1  1.0  cntrlvar  2
20500112  1.0  cntrlvar  3  1.0  cntrlvar  4
20500113  1.0  cntrlvar  5  1.0  cntrlvar  6
20500114  1.0  cntrlvar  7  1.0  cntrlvar  8
20500115  1.0  cntrlvar  9  1.0  cntrlvar  10
*
20500120  corenerg  integral  1.0  0.0  0
20500121  cntrlvar  11
*
* core power from flow enthalpy
*
20500130  corflowh  sum  1.0  0.0  1
20500131  0.0  1.0  flenth  175010000  -1.0  flenth  100010000
*
20500140  corflowE  integral  1.0  0.0  0
20500141  cntrlvar  13
*
* coolant riser heat input
```

```
*
20500160  ch115q  sum  1.0  0.0  1
20500161  0.0  1.0  q  115010000  1.0  q  115020000
20500162  1.0  q  115030000  1.0  q  115040000
20500163  1.0  q  115050000  1.0  q  115060000
20500164  1.0  q  115070000  1.0  q  115080000
20500165  1.0  q  115090000  1.0  q  115100000
20500166  1.0  q  115110000  1.0  q  115120000
20500167  1.0  q  115130000  1.0  q  115140000
20500168  1.0  q  115150000
*
* core flow distribution
*
20500200  corflowo  sum  1.0  0.001  1  1  0.001
20500201  0.0  1.0  mflowj  175010000
*
20500210  bypasscr  div  1.0  0.0  1
20500211  cntrlvar  20  mflowj  170010100
*
20500220  core140r  div  1.0  0.0  1
20500221  cntrlvar  20  mflowj  170010200
*
20500230  core145r  div  1.0  0.0  1
20500231  cntrlvar  20  mflowj  170010300
*
20500240  core150r  div  1.0  0.0  1
20500241  cntrlvar  20  mflowj  170010400
*
20500250  bypasssr  div  1.0  0.0  1
20500251  cntrlvar  20  mflowj  170010500
*
20500260  bypasssp  div  1.0  0.0  1
20500261  cntrlvar  20  mflowj  170010600
*
20500270  bypasspb  div  1.0  0.0  1
20500271  cntrlvar  20  mflowj  168000000
*
20500280  byprefl  sum  1.0  0.0  1
20500281  0.0  1.0  cntrlvar  21  1.0  cntrlvar  25
20500282  1.0  cntrlvar  26
*
20500290  bypastot  sum  1.0  0.0  1
20500291  0.0  1.0  cntrlvar  27  1.0  cntrlvar  28
*
* steam generator heat transfer
*
20500310  SGtubeq  sum  -1.0  0.0  1
20500311  0.0  1.0  q  225010000  1.0  q  225020000
20500312  1.0  q  225030000  1.0  q  225040000
20500313  1.0  q  225050000  1.0  q  225060000
20500314  1.0  q  225070000  1.0  q  225080000
20500315  1.0  q  225090000  1.0  q  225100000
20500316  1.0  q  225110000  1.0  q  225120000
20500317  1.0  q  225130000  1.0  q  225140000
20500318  1.0  q  225150000  1.0  q  225160000
+  1.0  q  225170000  1.0  q  225180000
+  1.0  q  225190000  1.0  q  225200000
+  1.0  q  225210000  1.0  q  225220000
*
20500320  Sgtubeht  sum  1.0  0.0  1
20500321  0.0  1.585  htrnr  225000101  1.585  htrnr  225000201
20500322  1.599  htrnr  225000301  1.599  htrnr  225000401
20500323  1.599  htrnr  225000501  1.599  htrnr  225000601
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20500324  1.599  htrnr  225000701  1.599  htrnr  225000801
20500325  1.599  htrnr  225000901  1.599  htrnr  225001001
20500326  2.044  htrnr  225001101  2.044  htrnr  225001201
20500327  1.599  htrnr  225001301  1.599  htrnr  225001401
20500328  1.599  htrnr  225001501  1.599  htrnr  225001601
+  1.599  htrnr  225001701  1.599  htrnr  225001801
+  1.599  htrnr  225001901  1.599  htrnr  225002001
+  1.585  htrnr  225002101  1.585  htrnr  225002201
*
20500330  Sgboilrq  sum  1.0  0.0  1
20500331  0.0  1.0  q  350010000  1.0  q  350020000
20500332  1.0  q  350030000  1.0  q  350040000
20500333  1.0  q  350050000  1.0  q  350060000
20500334  1.0  q  350070000  1.0  q  350080000
20500335  1.0  q  350090000  1.0  q  350100000
20500336  1.0  q  350110000
*
* steam generator flow enthalpy
*
20500350  SGflowh  sum  1.0  0.0  0
20500351  0.0  1.0  flenth  360020000  -1.0  flenth  330010000
*
20500360  SGflowE  integral  1.0  0.0  0
20500361  cntrlvar  35
*
* circulator flow enthalpy
*
20500450  cprflowh  sum  1.0  0.0  0
20500451  0.0  1.0  flenth  245000000  -1.0  flenth  235010000
*
20500460  cprflowE  integral  1.0  0.0  0
20500461  cntrlvar  45
*
* RCCS coolant net heat addition
*
20500950  RCCSpnlQ  sum  1.0  0.0  1
20500951  0.0  1.0  q  950010000  1.0  q  950020000
20500952  1.0  q  950030000  1.0  q  950040000
20500953  1.0  q  950050000  1.0  q  950060000
20500954  1.0  q  950070000  1.0  q  950080000
20500955  1.0  q  950090000  1.0  q  950100000
20500956  1.0  q  950110000  1.0  q  950120000
20500957  1.0  q  950130000  1.0  q  950140000
20500958  1.0  q  950150000  1.0  q  950160000
+  1.0  q  950170000  1.0  q  950180000
+  1.0  q  950190000
*
20500960  RCCSpnlE  integral  1.0  0.0  0
20500961  cntrlvar  95
*
* RCCS flow enthalpy
*
20500980  RCCSflwh  sum  1.0  0.0  0
20500981  0.0  1.0  flenth  955010000  -1.0  flenth  945020000
*
20500990  RCCSflwE  integral  1.0  0.0  0
20500991  cntrlvar  98
*
20501200  crefinpt  stdfnctn  1.0  0.0  1
20501201  max  htvat  1300003  htvat  1300004
20501202  htvat  1300005  htvat  1300006
20501203  htvat  1300007  htvat  1300008
20501204  htvat  1300009  htvat  1300010
```

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20501205  htvat  1300011  htvat  1300012
*
20501210  crefmdpt  stdfnctn  1.0  0.0  1
20501211  max  htvat  1320003  htvat  1320004
20501212  htvat  1320005  htvat  1320006
20501213  htvat  1320007  htvat  1320008
20501214  htvat  1320009  htvat  1320010
20501215  htvat  1320011  htvat  1320012
*
20501220  crefoupt  stdfnctn  1.0  0.0  1
20501221  max  htvat  1340003  htvat  1340004
20501222  htvat  1340005  htvat  1340006
20501223  htvat  1340007  htvat  1340008
20501224  htvat  1340009  htvat  1340010
20501225  htvat  1340011  htvat  1340012
*
20501230  corincpt  stdfnctn  1.0  0.0  1
20501231  max  htvat  1401001  htvat  1401002
20501232  htvat  1401003  htvat  1401004
20501233  htvat  1401005  htvat  1401006
20501234  htvat  1401007  htvat  1401008
20501235  htvat  1401009  htvat  1401010
*
20501240  cormdcpt  stdfnctn  1.0  0.0  1
20501241  max  htvat  1451001  htvat  1451002
20501242  htvat  1451003  htvat  1451004
20501243  htvat  1451005  htvat  1451006
20501244  htvat  1451007  htvat  1451008
20501245  htvat  1451009  htvat  1451010
*
20501250  coroucpt  stdfnctn  1.0  0.0  1
20501251  max  htvat  1501001  htvat  1501002
20501252  htvat  1501003  htvat  1501004
20501253  htvat  1501005  htvat  1501006
20501254  htvat  1501007  htvat  1501008
20501255  htvat  1501009  htvat  1501010
*
20501260  srefinpt  stdfnctn  1.0  0.0  1
20501261  max  htvat  1600003  htvat  1600004
20501262  htvat  1600005  htvat  1600006
20501263  htvat  1600007  htvat  1600008
20501264  htvat  1600009  htvat  1600010
20501265  htvat  1600011  htvat  1600012
*
20501270  srefmdpt  stdfnctn  1.0  0.0  1
20501271  max  htvat  1620003  htvat  1620004
20501272  htvat  1620005  htvat  1620006
20501273  htvat  1620007  htvat  1620008
20501274  htvat  1620009  htvat  1620010
20501275  htvat  1620011  htvat  1620012
*
20501280  srefoupt  stdfnctn  1.0  0.0  1
20501281  max  htvat  1640003  htvat  1640004
20501282  htvat  1640005  htvat  1640006
20501283  htvat  1640007  htvat  1640008
20501284  htvat  1640009  htvat  1640010
20501285  htvat  1640011  htvat  1640012
*
20501290  orefpt  stdfnctn  1.0  0.0  1
20501291  max  htvat  1660003  htvat  1660004
20501292  htvat  1660005  htvat  1660006
20501293  htvat  1660007  htvat  1660008
20501294  htvat  1660009  htvat  1660010
```

```
20501295  htvat  1660011  htvat  1660012
*
20501300  crinmaxt  stdfnctn  1.0  0.0  1
20501301  max  cntrlvar  120  cntrlvar  130
*
20501310  crmdmaxt  stdfnctn  1.0  0.0  1
20501311  max  cntrlvar  121  cntrlvar  131
*
20501320  croumaxt  stdfnctn  1.0  0.0  1
20501321  max  cntrlvar  122  cntrlvar  132
*
20501330  corinmxt  stdfnctn  1.0  0.0  1
20501331  max  cntrlvar  123  cntrlvar  133
*
20501340  cormdmxt  stdfnctn  1.0  0.0  1
20501341  max  cntrlvar  124  cntrlvar  134
*
20501350  coroumxt  stdfnctn  1.0  0.0  1
20501351  max  cntrlvar  125  cntrlvar  135
*
20501360  srinmaxt  stdfnctn  1.0  0.0  1
20501361  max  cntrlvar  126  cntrlvar  136
*
20501370  srmdmaxt  stdfnctn  1.0  0.0  1
20501371  max  cntrlvar  127  cntrlvar  137
*
20501380  sroumaxt  stdfnctn  1.0  0.0  1
20501381  max  cntrlvar  128  cntrlvar  138
*
20501390  orefmaxt  stdfnctn  1.0  0.0  1
20501391  max  cntrlvar  129  cntrlvar  139
*
* peak primary pressure vessel temperature
*
20501000  rvpeakt  stdfnctn  1.0  0.0  1
20501001  max  htvat  1000001  htvat  1000002
20501002  htvat  1000003  htvat  1000004
20501003  htvat  1000005  htvat  1000006
20501004  htvat  1000007  htvat  1000008
20501005  htvat  1000009  htvat  1000010
20501006  htvat  1000011  htvat  1000012
20501007  htvat  1000013  htvat  1000014
20501008  htvat  1000015  htvat  1000016
+  htvat  1000017
*
20501010  rvmaxt  stdfnctn  1.0  0.0  1
20501011  max  cntrlvar  100  cntrlvar  101
*
* peak core barrel temperature
*
20501030  cbpeakt  stdfnctn  1.0  0.0  1
20501031  max  htvat  1150001  htvat  1150002
20501032  htvat  1150003  htvat  1150004
20501033  htvat  1150005  htvat  1150006
20501034  htvat  1150007  htvat  1150008
20501035  htvat  1150009  htvat  1150010
20501036  htvat  1150011  htvat  1150012
20501037  htvat  1150013  htvat  1150014
20501038  htvat  1150015  htvat  1150016
*
20501040  cbmaxt  stdfnctn  1.0  0.0  1
20501041  max  cntrlvar  103  cntrlvar  104
*
```

```
* peak heater rod temperatures
*
20501400  corinmxt  stdfnctn  1.0  0.0  1
20501401  max  htvat  1403001  htvat  1403002
20501402  htvat  1403003  htvat  1403004
20501403  htvat  1403005  htvat  1403006
20501404  htvat  1403007  htvat  1403008
20501405  htvat  1403009  htvat  1403010
*
20501450  cormimxt  stdfnctn  1.0  0.0  1
20501451  max  htvat  1453001  htvat  1453002
20501452  htvat  1453003  htvat  1453004
20501453  htvat  1453005  htvat  1453006
20501454  htvat  1453007  htvat  1453008
20501455  htvat  1453009  htvat  1453010
*
20501500  coroumxt  stdfnctn  1.0  0.0  1
20501501  max  htvat  1503001  htvat  1503002
20501502  htvat  1503003  htvat  1503004
20501503  htvat  1503005  htvat  1503006
20501504  htvat  1503007  htvat  1503008
20501505  htvat  1503009  htvat  1503010
*
20501560  coremaxt  stdfnctn  1.0  0.0  1
20501561  max  cntrlvar  140  cntrlvar  145  cntrlvar  150
*
20501570  corpeakt  stdfnctn  1.0  0.0  1
20501571  max  cntrlvar  156  cntrlvar  157
*
* structure axial average temperatures over heated length
*
20501610  rvtave  sum  0.1  0.0  1
20501611  0.0  1.0  htvat  1000005  1.0  htvat  1000006
20501612  1.0  htvat  1000007  1.0  htvat  1000008
20501613  1.0  htvat  1000009  1.0  htvat  1000010
20501614  1.0  htvat  1000011  1.0  htvat  1000012
20501615  1.0  htvat  1000013  1.0  htvat  1000014
*
20501620  cbartave  sum  0.1  0.0  1
20501621  0.0  1.0  htvat  1150005  1.0  htvat  1150006
20501622  1.0  htvat  1150007  1.0  htvat  1150008
20501623  1.0  htvat  1150009  1.0  htvat  1150010
20501624  1.0  htvat  1150011  1.0  htvat  1150012
20501625  1.0  htvat  1150013  1.0  htvat  1150014
*
20501660  hs1300tv  sum  0.1  0.0  1
20501661  0.0  1.0  htvat  1300003  1.0  htvat  1300004
20501662  1.0  htvat  1300005  1.0  htvat  1300006
20501663  1.0  htvat  1300007  1.0  htvat  1300008
20501664  1.0  htvat  1300009  1.0  htvat  1300010
20501665  1.0  htvat  1300011  1.0  htvat  1300012
*
20501670  hs1320tv  sum  0.1  0.0  1
20501671  0.0  1.0  htvat  1320003  1.0  htvat  1320004
20501672  1.0  htvat  1320005  1.0  htvat  1320006
20501673  1.0  htvat  1320007  1.0  htvat  1320008
20501674  1.0  htvat  1320009  1.0  htvat  1320010
20501675  1.0  htvat  1320011  1.0  htvat  1320012
*
20501680  hs1340tv  sum  0.1  0.0  1
20501681  0.0  1.0  htvat  1340003  1.0  htvat  1340004
20501682  1.0  htvat  1340005  1.0  htvat  1340006
20501683  1.0  htvat  1340007  1.0  htvat  1340008
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20501684  1.0  htvat  1340009  1.0  htvat  1340010
20501685  1.0  htvat  1340011  1.0  htvat  1340012
*
20501690  hs1401tv  sum  0.1  0.0  1
20501691  0.0  1.0  htvat  1401001  1.0  htvat  1401002
20501692  1.0  htvat  1401003  1.0  htvat  1401004
20501693  1.0  htvat  1401005  1.0  htvat  1401006
20501694  1.0  htvat  1401007  1.0  htvat  1401008
20501695  1.0  htvat  1401009  1.0  htvat  1401010
*
20501700  hs1403tv  sum  0.1  0.0  1
20501701  0.0  1.0  htvat  1403001  1.0  htvat  1403002
20501702  1.0  htvat  1403003  1.0  htvat  1403004
20501703  1.0  htvat  1403005  1.0  htvat  1403006
20501704  1.0  htvat  1403007  1.0  htvat  1403008
20501705  1.0  htvat  1403009  1.0  htvat  1403010
*
20501710  hs1451tv  sum  0.1  0.0  1
20501711  0.0  1.0  htvat  1451001  1.0  htvat  1451002
20501712  1.0  htvat  1451003  1.0  htvat  1451004
20501713  1.0  htvat  1451005  1.0  htvat  1451006
20501714  1.0  htvat  1451007  1.0  htvat  1451008
20501715  1.0  htvat  1451009  1.0  htvat  1451010
*
20501720  hs1453tv  sum  0.1  0.0  1
20501721  0.0  1.0  htvat  1453001  1.0  htvat  1453002
20501722  1.0  htvat  1453003  1.0  htvat  1453004
20501723  1.0  htvat  1453005  1.0  htvat  1453006
20501724  1.0  htvat  1453007  1.0  htvat  1453008
20501725  1.0  htvat  1453009  1.0  htvat  1453010
*
20501730  hs1501tv  sum  0.1  0.0  1
20501731  0.0  1.0  htvat  1501001  1.0  htvat  1501002
20501732  1.0  htvat  1501003  1.0  htvat  1501004
20501733  1.0  htvat  1501005  1.0  htvat  1501006
20501734  1.0  htvat  1501007  1.0  htvat  1501008
20501735  1.0  htvat  1501009  1.0  htvat  1501010
*
20501740  hs1503tv  sum  0.1  0.0  1
20501741  0.0  1.0  htvat  1503001  1.0  htvat  1503002
20501742  1.0  htvat  1503003  1.0  htvat  1503004
20501743  1.0  htvat  1503005  1.0  htvat  1503006
20501744  1.0  htvat  1503007  1.0  htvat  1503008
20501745  1.0  htvat  1503009  1.0  htvat  1503010
*
20501750  hs1600tv  sum  0.1  0.0  1
20501751  0.0  1.0  htvat  1600003  1.0  htvat  1600004
20501752  1.0  htvat  1600005  1.0  htvat  1600006
20501753  1.0  htvat  1600007  1.0  htvat  1600008
20501754  1.0  htvat  1600009  1.0  htvat  1600010
20501755  1.0  htvat  1600011  1.0  htvat  1600012
*
20501760  hs1620tv  sum  0.1  0.0  1
20501761  0.0  1.0  htvat  1620003  1.0  htvat  1620004
20501762  1.0  htvat  1620005  1.0  htvat  1620006
20501763  1.0  htvat  1620007  1.0  htvat  1620008
20501764  1.0  htvat  1620009  1.0  htvat  1620010
20501765  1.0  htvat  1620011  1.0  htvat  1620012
*
20501770  hs1640tv  sum  0.1  0.0  1
20501771  0.0  1.0  htvat  1640003  1.0  htvat  1640004
20501772  1.0  htvat  1640005  1.0  htvat  1640006
20501773  1.0  htvat  1640007  1.0  htvat  1640008
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```
20501774  1.0  htvat  1640009  1.0  htvat  1640010
20501775  1.0  htvat  1640011  1.0  htvat  1640012
*
20501780  hs1660tv  sum  0.1  0.0  1
20501781  0.0  1.0  htvat  1660003  1.0  htvat  1660004
20501782  1.0  htvat  1660005  1.0  htvat  1660006
20501783  1.0  htvat  1660007  1.0  htvat  1660008
20501784  1.0  htvat  1660009  1.0  htvat  1660010
20501785  1.0  htvat  1660011  1.0  htvat  1660012
*
20501830  hs9500tv  sum  0.189487  0.0  1
20501831  0.0  1.0221  htvat  9500001  0.3273  htvat  9500002
20501832  0.2223  htvat  9500003  0.2515  htvat  9500004
20501833  0.2515  htvat  9500005  0.1981  htvat  9500006
20501834  0.1981  htvat  9500007  0.1981  htvat  9500008
20501835  0.1981  htvat  9500009  0.1981  htvat  9500010
20501836  0.1981  htvat  9500011  0.1981  htvat  9500012
20501837  0.1981  htvat  9500013  0.1981  htvat  9500014
20501838  0.1981  htvat  9500015  0.1905  htvat  9500016
+  0.2032  htvat  9500017  0.2732  htvat  9500018
+  0.748455  htvat  9500019
*
20501840  hs9501tv  sum  0.189487  0.0  1
20501841  0.0  1.0221  htvat  9501001  0.3273  htvat  9501002
20501842  0.2223  htvat  9501003  0.2515  htvat  9501004
20501843  0.2515  htvat  9501005  0.1981  htvat  9501006
20501844  0.1981  htvat  9501007  0.1981  htvat  9501008
20501845  0.1981  htvat  9501009  0.1981  htvat  9501010
20501846  0.1981  htvat  9501011  0.1981  htvat  9501012
20501847  0.1981  htvat  9501013  0.1981  htvat  9501014
20501848  0.1981  htvat  9501015  0.1905  htvat  9501016
+  0.2032  htvat  9501017  0.2732  htvat  9501018
+  0.748455  htvat  9501019
*
* differential pressures
*
20502750  coredp  sum  1.0  0.0  1
20502751  0.0  1.0  p  120010000  -1.0  p  175010000
*
20502760  rvessdp  sum  1.0  0.0  1
20502761  0.0  1.0  p  100010000  -1.0  p  200010000
*
* feedwater flow control (for transients with steam generator PCS isolation)
*
*20503190 SGleverr  sum  1.0  0.0  0
*20503191 2.0520  -1.0  cntrlvar  350
*
*20503200 SGFWflow  integral  0.01  0.0  0
*20503201 cntrlvar  319
*
* liquid level in steam generator boiler
*
20503500  SGlevel  sum  1.0  0.0  1
20503501  0.0  0.1409  voidf  350010000  0.1409  voidf  350020000
20503502  0.1421  voidf  350030000  0.1421  voidf  350040000
20503503  0.1421  voidf  350050000  0.1421  voidf  350060000
20503504  0.1421  voidf  350070000  0.1421  voidf  350080000
20503505  0.1421  voidf  350090000  0.1421  voidf  350100000
20503506  0.6336  voidf  350110000  0.6336  voidf  350120000
*
* facility steam generator liquid level (% of span)
*
20503550  LDP-601  sum  44.58116  50.0  1
```

```
20503551  -0.03815  1.0  cntrlvar  350
*
* potable water supply valve controls
*
* determine flow setpoint
*
20504030  flowdmnd  sum  1.0  0.0  1
20504031  0.0  1.0  mflowj  320000000
* if the alternate RCCS source volume is being used and flow is not being discharged
to the storage tank, delete the card below
20504032  1.0  mflowj  945010000  -1.0000  mflowj  955010000
* if the normal RCCS water source is being used but flow is not recirculated to the
storage tank, use the card below
*20504032  1.0  mflowj  945010000
* if the alternate RCCS source volume is being used but flow is being discharged to
the storage tank, use the card below
*20504032  -1.0  mflowj  955010000
*
20504040  lowlevel  tripunit  1.0  0.0  0
20504041  1410
*
20504050  hilevel  tripunit  -1.0  0.0  0
20504051  1412
*
20504060  leveloor  sum  1.0  0.0  0
20504061  0.0  1.0  cntrlvar  404  1.0  cntrlvar  405
*
20504070  levelctb  mult  0.25  0.0  0
20504071  cntrlvar  403  cntrlvar  406
*
20504080  flosetpt  sum  1.0  0.0  1
20504081  0.0  1.0  cntrlvar  403  1.0  cntrlvar  407
*
* flow demand error and valve controller
*
20504090  flowerr  sum  1.0  0.0  0
20504091  0.0  1.0  cntrlvar  408  -1.0  mflowj  410000000
*
20504100  V410pos  integral  0.01  0.06  0  3  1.00E-05  1.0
20504101  cntrlvar  409
*
* liquid level in tank T-010
*
20504500  level450  sum  1.0  0.0  1
20504501  0.0  0.0349  voidf  450010000  0.0826  voidf  450020000
20504502  0.0349  voidf  450030000  0.0349  voidf  450040000
20504503  0.0826  voidf  450050000  0.0349  voidf  450060000
*
* tank level setpoints
*
20504510  lev450lo  constant  0.1  * low level setpoint (m)
20504520  lev450hi  constant  0.24  * high level setpoint (m)
* mid-range level
20504530  lev450md  sum  1.0  0.25  0
20504531  0  0.5  cntrlvar  451  0.5  cntrlvar  452
*
* facility measurements
*
20505010  "DP-1001"  sum  0.001  0.0  1
20505011  0.0  1.0  p  145010000  -1.0  p  145130000
*
20505020  "DP-4001"  sum  0.001  0.0  1
20505021  0.0  1.0  p  270040000  -1.0  p  200010000
```

```
*
20505030  "DP-7001"  sum  0.001  0.0  1
20505031  0.0  1.0  p  270040000  -1.0  p  120010000
*
20505040  "DP-8001"  sum  0.001  0.0  1
20505041  0.0  1.0  p  270040000  -1.0  p  175010000
*
20505050  "DP-8002"  sum  0.001  0.0  1
20505051  0.0  1.0  p  270040000  -1.0  p  105010000
*
20505060  "DP-9001"  sum  0.001  0.0  1
20505061  0.0  1.0  p  270040000  -1.0  p  115150000
*
20505070  "DP-801"  sum  0.001  0.0  1
20505071  0.0  1.0  p  945010000  -1.0  p  955010000
*
* core power input
*
* heater powers
*
20509010  power101  function  1.0  2.20E+05  1
20509011  time  0  901
*
20509020  power102  function  1.0  2.20E+05  1
20509021  time  0  902
*
20509030  power103  function  1.0  2.20E+05  1
20509031  time  0  903
*
20509040  power104  function  1.0  2.20E+05  1
20509041  time  0  904
*
20509050  power105  function  1.0  2.20E+05  1
20509051  time  0  905
*
20509060  power106  function  1.0  2.20E+05  1
20509061  time  0  906
*
20509070  power107  function  1.0  2.20E+05  1
20509071  time  0  907
*
20509080  power108  function  1.0  2.20E+05  1
20509081  time  0  908
*
20509090  power109  function  1.0  2.20E+05  1
20509091  time  0  909
*
20509100  power110  function  1.0  2.20E+05  1
20509101  time  0  910
*
* core power in W
*
20509110  corepow  sum  1.0  2.20E+06  1
20509111  0.0  1.0  cntrlvar  901  1.0  cntrlvar  902
20509112  1.0  cntrlvar  903  1.0  cntrlvar  904
20509113  1.0  cntrlvar  905  1.0  cntrlvar  906
20509114  1.0  cntrlvar  907  1.0  cntrlvar  908
20509115  1.0  cntrlvar  909  1.0  cntrlvar  910
*
* core power in MW
*
20509120  coreheat  sum  1.00E-06  2.2  1
20509121  0.0  1.0  cntrlvar  911
```

```
*
* integrated core heat generation in MJ
*
20509130  corehtin  integral  1.0  0.0  0
20509131  cntrlvar  912
*
* heater rod power input
*
20509400  powin140  sum  1.0  586666.7  1
20509401  0.0  0.904762  cntrlvar  901  0.428571  cntrlvar  910
20509402  0.904762  cntrlvar  906  0.428571  cntrlvar  907
*
20509450  powin145  sum  1.0  754285.7  1
20509451  0.0  0.095238  cntrlvar  901  0.523810  cntrlvar  910
20509452  0.857143  cntrlvar  903  0.142857  cntrlvar  908
20509453  0.095238  cntrlvar  905  0.095238  cntrlvar  906
20509454  0.523810  cntrlvar  907  0.857143  cntrlvar  904
20509455  0.142857  cntrlvar  909  0.095238  cntrlvar  902
*
20509500  powin150  sum  1.0  859047.6  1
20509501  0.0  0.047619  cntrlvar  910  0.142857  cntrlvar  903
20509502  0.857143  cntrlvar  908  0.904762  cntrlvar  905
20509503  0.047619  cntrlvar  907  0.142857  cntrlvar  904
20509504  0.857143  cntrlvar  909  0.904762  cntrlvar  902
*
* RCCS flow control
*
20509180  RCCStout  constant  305.0  * RCCS desired outlet temperature
*
20509190  RCCSterr  sum  1.0  0.0  0
20509191  0.0  1.0  tempf  955010000  -1.0  cntrlvar  918
*
20509200  RCCSflo  prop-int  1.0  1.0  0  1  0.0
20509201  0.07  0.0001  cntrlvar  919
*
* heat structure convection/radiation/conduction
*
20510000  qcv1000l  sum  1.0  0.0  1
20510001  0.0  1.684  htrnr  100000100  1.144  htrnr  100000200
20510002  1.294  htrnr  100000300  1.294  htrnr  100000400
20510003  1.020  htrnr  100000500  1.020  htrnr  100000600
20510004  1.020  htrnr  100000700  1.020  htrnr  100000800
20510005  1.020  htrnr  100000900  1.020  htrnr  100001000
20510006  1.020  htrnr  100001100  1.020  htrnr  100001200
20510007  1.020  htrnr  100001300  1.020  htrnr  100001400
20510008  0.980  htrnr  100001500  1.046  htrnr  100001600
+  1.406  htrnr  100001700
*
20510010  qrc1000l  sum  1.0  0.0  1
20510011  0.0  1.684  qrad  1902  1.144  qrad  1906
20510012  1.294  qrad  1908  1.294  qrad  1910
20510013  1.020  qrad  1912  1.020  qrad  1914
20510014  1.020  qrad  1916  1.020  qrad  1918
20510015  1.020  qrad  1920  1.020  qrad  1922
20510016  1.020  qrad  1924  1.020  qrad  1926
20510017  1.020  qrad  1928  1.020  qrad  1930
20510018  0.980  qrad  1932  1.046  qrad  1934
+  1.406  qrad  1936
*
20510020  qt1000l  sum  1.0  0.0  1
20510021  0.0  1.0  cntrlvar  1000  1.0  cntrlvar  1001
*
20510030  qi1000l  integral  1.0  0.0  0
```

```
20510031  cntrlvar  1002
*
20510040  qcv1000r  sum  1.0  0.0  1
20510041  0.0  1.711  htrnr  100000101  1.162  htrnr  100000201
20510042  1.314  htrnr  100000301  1.314  htrnr  100000401
20510043  1.036  htrnr  100000501  1.036  htrnr  100000601
20510044  1.036  htrnr  100000701  1.036  htrnr  100000801
20510045  1.036  htrnr  100000901  1.036  htrnr  100001001
20510046  1.036  htrnr  100001101  1.036  htrnr  100001201
20510047  1.036  htrnr  100001301  1.036  htrnr  100001401
20510048  0.996  htrnr  100001501  1.062  htrnr  100001601
+  1.428  htrnr  100001701
*
20510050  qrc1000r  sum  1.0  0.0  1
20510051  0.0  1.711  qrad  2103  1.162  qrad  2105
20510052  1.314  qrad  2107  1.314  qrad  2109
20510053  1.036  qrad  2111  1.036  qrad  2113
20510054  1.036  qrad  2115  1.036  qrad  2117
20510055  1.036  qrad  2119  1.036  qrad  2121
20510056  1.036  qrad  2123  1.036  qrad  2125
20510057  1.036  qrad  2127  1.036  qrad  2129
20510058  0.996  qrad  2131  1.062  qrad  2133
+  1.428  qrad  2135
*
20510060  qt1000r  sum  1.0  0.0  1
20510061  0.0  1.0  cntrlvar  1004  1.0  cntrlvar  1005
*
20510070  qi1000r  integral  1.0  0.0  0
20510071  cntrlvar  1006
*
20510080  qt1000  sum  1.0  0.0  0
20510081  0.0  1.0  cntrlvar  1002  1.0  cntrlvar  1006
*
20510090  qi1000  sum  1.0  0.0  0
20510091  0.0  1.0  cntrlvar  1003  1.0  cntrlvar  1007
*
20510100  qcv1001l  mult  3.664  0.0  1
20510101  htrnr  100100100
*
20510110  qrc1001l  mult  3.664  0.0  1
20510111  qrad  1603
*
20510120  qt1001l  sum  1.0  0.0  1
20510121  0.0  1.0  cntrlvar  1010  1.0  cntrlvar  1011
*
20510130  qi1001l  integral  1.0  0.0  0
20510131  cntrlvar  1012
*
20510140  qcv1001r  mult  4.348  0.0  1
20510141  htrnr  100100101
*
20510150  qrc1001r  mult  4.348  0.0  1
20510151  qrad  2137
*
20510160  qt1001r  sum  1.0  0.0  1
20510161  0.0  1.0  cntrlvar  1014  1.0  cntrlvar  1015
*
20510170  qi1001r  integral  1.0  0.0  0
20510171  cntrlvar  1016
*
20510180  qt1001  sum  1.0  0.0  0
20510181  0.0  1.0  cntrlvar  1012  1.0  cntrlvar  1016
*
```

```
20510190  qi1001  sum  1.0  0.0  0
20510191  0.0  1.0  cntrlvar  1013  1.0  cntrlvar  1017
*
20510200  qcv1150l  sum  1.0  0.0  1
20510201  0.0  1.557  htrnr  115000100  1.057  htrnr  115000200
20510202  1.196  htrnr  115000300  1.196  htrnr  115000400
20510203  0.943  htrnr  115000500  0.943  htrnr  115000600
20510204  0.943  htrnr  115000700  0.943  htrnr  115000800
20510205  0.943  htrnr  115000900  0.943  htrnr  115001000
20510206  0.943  htrnr  115001100  0.943  htrnr  115001200
20510207  0.943  htrnr  115001300  0.943  htrnr  115001400
20510208  0.906  htrnr  115001500  0.967  htrnr  115001600
*
20510210  qrc1150l  sum  1.0  0.0  1
20510211  0.0  1.057  qrad  1806  1.196  qrad  1528
20510212  1.196  qrad  1526  0.943  qrad  1524
20510213  0.943  qrad  1522  0.943  qrad  1520
20510214  0.943  qrad  1518  0.943  qrad  1516
20510215  0.943  qrad  1514  0.943  qrad  1512
20510216  0.943  qrad  1510  0.943  qrad  1508
20510217  0.943  qrad  1506  0.906  qrad  1504
20510218  0.967  qrad  1502
*
20510220  qt1150l  sum  1.0  0.0  1
20510221  0.0  1.0  cntrlvar  1020  1.0  cntrlvar  1021
*
20510230  qi1150l  integral  1.0  0.0  0
20510231  cntrlvar  1022
*
20510240  qcv1150r  sum  1.0  0.0  1
20510241  0.0  1.567  htrnr  115000101  1.064  htrnr  115000201
20510242  1.204  htrnr  115000301  1.204  htrnr  115000401
20510243  0.949  htrnr  115000501  0.949  htrnr  115000601
20510244  0.949  htrnr  115000701  0.949  htrnr  115000801
20510245  0.949  htrnr  115000901  0.949  htrnr  115001001
20510246  0.949  htrnr  115001101  0.949  htrnr  115001201
20510247  0.949  htrnr  115001301  0.949  htrnr  115001401
20510248  0.912  htrnr  115001501  0.973  htrnr  115001601
*
20510250  qrc1150r  sum  1.0  0.0  1
20510251  0.0  1.567  qrad  1901  1.064  qrad  1903
20510252  1.204  qrad  1907  1.204  qrad  1909
20510253  0.949  qrad  1911  0.949  qrad  1913
20510254  0.949  qrad  1915  0.949  qrad  1917
20510255  0.949  qrad  1919  0.949  qrad  1921
20510256  0.949  qrad  1923  0.949  qrad  1925
20510257  0.949  qrad  1927  0.949  qrad  1929
20510258  0.912  qrad  1931  0.973  qrad  1933
*
20510260  qt1150r  sum  1.0  0.0  1
20510261  0.0  1.0  cntrlvar  1024  1.0  cntrlvar  1025
*
20510270  qi1150r  integral  1.0  0.0  0
20510271  cntrlvar  1026
*
20510280  qt1150  sum  1.0  0.0  0
20510281  0.0  1.0  cntrlvar  1022  1.0  cntrlvar  1026
*
20510290  qi1150  sum  1.0  0.0  0
20510291  0.0  1.0  cntrlvar  1023  1.0  cntrlvar  1027
*
20510300  qcv1200l  mult  1.311  0.0  1
20510301  htrnr  120000100
```

```
*
20510310  qrc1200l  mult  1.311  0.0  1
20510311  qrad  1604
*
20510320  qt1200l  sum  1.0  0.0  1
20510321  0.0  1.0  cntrlvar  1030  1.0  cntrlvar  1031
*
20510330  qi1200l  integral  1.0  0.0  0
20510331  cntrlvar  1032
*
20510340  qcv1200r  mult  1.316  0.0  1
20510341  htrnr  120000101
*
20510350  qrc1200r  mult  1.316  0.0  1
20510351  qrad  1935
*
20510360  qt1200r  sum  1.0  0.0  1
20510361  0.0  1.0  cntrlvar  1034  1.0  cntrlvar  1035
*
20510370  qi1200r  integral  1.0  0.0  0
20510371  cntrlvar  1036
*
20510380  qt1200  sum  1.0  0.0  0
20510381  0.0  1.0  cntrlvar  1032  1.0  cntrlvar  1036
*
20510390  qi1200  sum  1.0  0.0  0
20510391  0.0  1.0  cntrlvar  1033  1.0  cntrlvar  1037
*
20510410  qrc1201l  mult  1.673  0.0  1
20510411  qrad  271
*
20510420  qt1201l  sum  1.0  0.0  1
20510421  0.0  1.0  cntrlvar  1041
*
20510430  qi1201l  integral  1.0  0.0  0
20510431  cntrlvar  1042
*
20510440  qcv1201r  mult  1.673  0.0  1
20510441  htrnr  120100101
*
20510450  qrc1201r  mult  1.673  0.0  1
20510451  qrad  1601
*
20510460  qt1201r  sum  1.0  0.0  1
20510461  0.0  1.0  cntrlvar  1044  1.0  cntrlvar  1045
*
20510470  qi1201r  integral  1.0  0.0  0
20510471  cntrlvar  1046
*
20510480  qt1201  sum  1.0  0.0  0
20510481  0.0  1.0  cntrlvar  1042  1.0  cntrlvar  1046
*
20510490  qi1201  sum  1.0  0.0  0
20510491  0.0  1.0  cntrlvar  1043  1.0  cntrlvar  1047
*
20510540  qcv1202r  mult  2.864  0.0  1
20510541  htrnr  120200101
*
20510550  qrc1202r  mult  2.864  0.0  1
20510551  qrad  1602
*
20510560  qt1202r  sum  1.0  0.0  1
20510561  0.0  1.0  cntrlvar  1054  1.0  cntrlvar  1055
```

```
*
20510570  qi1202r  integral  1.0  0.0  0
20510571  cntrlvar  1056
*
20510580  qt1202r  sum  1.0  0.0  0
20510581  0.0  1.0  cntrlvar  1056  *1.0  cntrlvar  1056
*
20510590  qi1202r  sum  1.0  0.0  0
20510591  0.0  1.0  cntrlvar  1057  *1.0  cntrlvar  1057
*
20510650  qrc1300r  sum  1.0  0.0  1
20510651  0.0  0.090  qrad  101  0.090  qrad  104
20510652  0.094  qrad  107  0.094  qrad  110
20510653  0.094  qrad  113  0.094  qrad  116
20510654  0.094  qrad  119  0.094  qrad  122
20510655  0.094  qrad  125  0.094  qrad  128
20510656  0.094  qrad  131  0.094  qrad  134
20510657  0.119  qrad  137  0.119  qrad  140
*
20510660  qt1300r  sum  1.0  0.0  1
20510661  0.0  1.0  cntrlvar  1065
*
20510670  qi1300r  integral  1.0  0.0  0
20510671  cntrlvar  1066
*
20510680  qt1300  sum  1.0  0.0  0
20510681  0.0  1.0  cntrlvar  1066
*
20510690  qi1300  sum  1.0  0.0  0
20510691  0.0  1.0  cntrlvar  1067
*
20510700  qcv1320l  sum  1.0  0.0  1
20510701  0.0  0.068  htrnr  132000100  0.068  htrnr  132000200
20510702  0.071  htrnr  132000300  0.071  htrnr  132000400
20510703  0.071  htrnr  132000500  0.071  htrnr  132000600
20510704  0.071  htrnr  132000700  0.071  htrnr  132000800
20510705  0.071  htrnr  132000900  0.071  htrnr  132001000
20510706  0.071  htrnr  132001100  0.071  htrnr  132001200
20510707  0.090  htrnr  132001300  0.090  htrnr  132001400
*
20510710  qrc1320l  sum  1.0  0.0  1
20510711  0.0  0.090  qrad  1801
*
20510720  qt1320l  sum  1.0  0.0  1
20510721  0.0  1.0  cntrlvar  1070  1.0  cntrlvar  1071
*
20510730  qi1320l  integral  1.0  0.0  0
20510731  cntrlvar  1072
*
20510750  qrc1320r  sum  1.0  0.0  1
20510751  0.0  0.432  qrad  102  0.432  qrad  105
20510752  0.449  qrad  108  0.449  qrad  111
20510753  0.449  qrad  114  0.449  qrad  117
20510754  0.449  qrad  120  0.449  qrad  123
20510755  0.449  qrad  126  0.449  qrad  129
20510756  0.449  qrad  132  0.449  qrad  135
20510757  0.570  qrad  138  0.570  qrad  141
*
20510760  qt1320r  sum  1.0  0.0  1
20510761  0.0  1.0  cntrlvar  1075
*
20510770  qi1320r  integral  1.0  0.0  0
20510771  cntrlvar  1076
```

```
*
20510780  qt1320  sum  1.0  0.0  0
20510781  0.0  1.0  cntrlvar  1072  1.0  cntrlvar  1076
*
20510790  qi1320  sum  1.0  0.0  0
20510791  0.0  1.0  cntrlvar  1073  1.0  cntrlvar  1077
*
20510810  qrc1340l  sum  1.0  0.0  1
20510811  0.0  0.198  qrad  103  0.198  qrad  106
20510812  0.206  qrad  109  0.206  qrad  112
20510813  0.206  qrad  115  0.206  qrad  118
20510814  0.206  qrad  121  0.206  qrad  124
20510815  0.206  qrad  127  0.206  qrad  130
20510816  0.206  qrad  133  0.206  qrad  136
20510817  0.261  qrad  139  0.261  qrad  142
*
20510820  qt1340l  sum  1.0  0.0  1
20510821  0.0  1.0  cntrlvar  1081
*
20510830  qi1340l  integral  1.0  0.0  0
20510831  cntrlvar  1082
*
20510850  qrc1340r  sum  1.0  0.0  1
20510851  0.0  0.212  qrad  201  0.212  qrad  206
20510852  0.221  qrad  211  0.221  qrad  216
20510853  0.221  qrad  221  0.221  qrad  226
20510854  0.221  qrad  231  0.221  qrad  236
20510855  0.221  qrad  241  0.221  qrad  246
20510856  0.221  qrad  251  0.221  qrad  256
20510857  0.280  qrad  261  0.280  qrad  266
*
20510860  qt1340r  sum  1.0  0.0  1
20510861  0.0  1.0  cntrlvar  1085
*
20510870  qi1340r  integral  1.0  0.0  0
20510871  cntrlvar  1086
*
20510880  qt1340  sum  1.0  0.0  0
20510881  0.0  1.0  cntrlvar  1082  1.0  cntrlvar  1086
*
20510890  qi1340  sum  1.0  0.0  0
20510891  0.0  1.0  cntrlvar  1083  1.0  cntrlvar  1087
*
20510900  qcv1401l  sum  1.0  0.0  1
20510901  0.0  1.163  htrnr  140000100  1.163  htrnr  140000200
20510902  1.209  htrnr  140100100  1.209  htrnr  140100200
20510903  1.209  htrnr  140100300  1.209  htrnr  140100400
20510904  1.209  htrnr  140100500  1.209  htrnr  140100600
20510905  1.209  htrnr  140100700  1.209  htrnr  140100800
20510906  1.209  htrnr  140100900  1.209  htrnr  140101000
20510907  1.535  htrnr  140200100  1.535  htrnr  140200200
*
20510910  qrc1401l  sum  1.0  0.0  1
20510911  0.0  1.163  qrad  202  1.163  qrad  207
20510912  1.209  qrad  212  1.209  qrad  217
20510913  1.209  qrad  222  1.209  qrad  227
20510914  1.209  qrad  232  1.209  qrad  237
20510915  1.209  qrad  242  1.209  qrad  247
20510916  1.209  qrad  252  1.209  qrad  257
20510917  1.535  qrad  262  1.535  qrad  267
*
20510920  qt1401l  sum  1.0  0.0  1
20510921  0.0  1.0  cntrlvar  1090  1.0  cntrlvar  1091
```

```
*
20510930  qi1401l  integral  1.0  0.0  0
20510931  cntrlvar  1092
*
20510940  qcv1401r  sum  1.0  0.0  1
20510941  0.0  2.862  htrnr  140100101  2.862  htrnr  140100201
20510942  2.862  htrnr  140100301  2.862  htrnr  140100401
20510943  2.862  htrnr  140100501  2.862  htrnr  140100601
20510944  2.862  htrnr  140100701  2.862  htrnr  140100801
20510945  2.862  htrnr  140100901  2.862  htrnr  140101001
*
20510950  qrc1401r  sum  1.0  0.0  1
20510951  0.0  2.862  qrad  1102  2.862  qrad  1104
20510952  2.862  qrad  1106  2.862  qrad  1108
20510953  2.862  qrad  1110  2.862  qrad  1112
20510954  2.862  qrad  1114  2.862  qrad  1116
20510955  2.862  qrad  1118  2.862  qrad  1120
20510956  3.632  qrad  1802
*
20510960  qt1401r  sum  1.0  0.0  1
20510961  0.0  1.0  cntrlvar  1095  1.0  cntrlvar  1094
*
20510970  qi1401r  integral  1.0  0.0  0
20510971  cntrlvar  1096
*
20510980  qt1401  sum  1.0  0.0  0
20510981  0.0  1.0  cntrlvar  1092  1.0  cntrlvar  1096
*
20510990  qi1401  sum  1.0  0.0  0
20510991  0.0  1.0  cntrlvar  1093  1.0  cntrlvar  1097
*
20511000  qcv1451l  sum  1.0  0.0  1
20511001  0.0  1.368  htrnr  145000100  1.368  htrnr  145000200
20511002  1.423  htrnr  145100100  1.423  htrnr  145100200
20511003  1.423  htrnr  145100300  1.423  htrnr  145100400
20511004  1.423  htrnr  145100500  1.423  htrnr  145100600
20511005  1.423  htrnr  145100700  1.423  htrnr  145100800
20511006  1.423  htrnr  145100900  1.423  htrnr  145101000
20511007  1.806  htrnr  145200100  1.806  htrnr  145200200
*
20511010  qrc1451l  sum  1.0  0.0  1
20511011  0.0  1.368  qrad  203  1.368  qrad  208
20511012  1.423  qrad  213  1.423  qrad  218
20511013  1.423  qrad  223  1.423  qrad  228
20511014  1.423  qrad  233  1.423  qrad  238
20511015  1.423  qrad  243  1.423  qrad  248
20511016  1.423  qrad  253  1.423  qrad  258
20511017  1.806  qrad  263  1.806  qrad  268
*
20511020  qt1451l  sum  1.0  0.0  1
20511021  0.0  1.0  cntrlvar  1100  1.0  cntrlvar  1101
*
20511030  qi1451l  integral  1.0  0.0  0
20511031  cntrlvar  1102
*
20511040  qcv1451r  sum  1.0  0.0  1
20511041  0.0  3.068  htrnr  145100101  3.068  htrnr  145100201
20511042  3.068  htrnr  145100301  3.068  htrnr  145100401
20511043  3.068  htrnr  145100501  3.068  htrnr  145100601
20511044  3.068  htrnr  145100701  3.068  htrnr  145100801
20511045  3.068  htrnr  145100901  3.068  htrnr  145101001
*
20511050  qrc1451r  sum  1.0  0.0  1
```

```
20511051  0.0  3.068  qrad  1202  3.068  qrad  1204
20511052  3.068  qrad  1206  3.068  qrad  1208
20511053  3.068  qrad  1210  3.068  qrad  1212
20511054  3.068  qrad  1214  3.068  qrad  1216
20511055  3.068  qrad  1218  3.068  qrad  1220
20511056  3.894  qrad  1803
*
20511060  qt1451r  sum  1.0  0.0  1
20511061  0.0  1.0  cntrlvar  1105  1.0  cntrlvar  1104
*
20511070  qi1451r  integral  1.0  0.0  0
20511071  cntrlvar  1106
*
20511080  qt1451  sum  1.0  0.0  0
20511081  0.0  1.0  cntrlvar  1102  1.0  cntrlvar  1106
*
20511090  qi1451  sum  1.0  0.0  0
20511091  0.0  1.0  cntrlvar  1103  1.0  cntrlvar  1107
*
20511100  qcv1501l  sum  1.0  0.0  1
20511101  0.0  1.824  htrnr  150000100  1.824  htrnr  150000200
20511102  1.897  htrnr  150100100  1.897  htrnr  150100200
20511103  1.897  htrnr  150100300  1.897  htrnr  150100400
20511104  1.897  htrnr  150100500  1.897  htrnr  150100600
20511105  1.897  htrnr  150100700  1.897  htrnr  150100800
20511106  1.897  htrnr  150100900  1.897  htrnr  150101000
20511107  2.408  htrnr  150200100  2.408  htrnr  150200200
*
20511110  qrc1501l  sum  1.0  0.0  1
20511111  0.0  1.824  qrad  204  1.824  qrad  209
20511112  1.897  qrad  214  1.897  qrad  219
20511113  1.897  qrad  224  1.897  qrad  229
20511114  1.897  qrad  234  1.897  qrad  239
20511115  1.897  qrad  244  1.897  qrad  249
20511116  1.897  qrad  254  1.897  qrad  259
20511117  2.408  qrad  264  2.408  qrad  269
*
20511120  qt1501l  sum  1.0  0.0  1
20511121  0.0  1.0  cntrlvar  1110  1.0  cntrlvar  1111
*
20511130  qi1501l  integral  1.0  0.0  0
20511131  cntrlvar  1112
*
20511140  qcv1501r  sum  1.0  0.0  1
20511141  0.0  4.753  htrnr  150100101  4.753  htrnr  150100201
20511142  4.753  htrnr  150100301  4.753  htrnr  150100401
20511143  4.753  htrnr  150100501  4.753  htrnr  150100601
20511144  4.753  htrnr  150100701  4.753  htrnr  150100801
20511145  4.753  htrnr  150100901  4.753  htrnr  150101001
*
20511150  qrc1501r  sum  1.0  0.0  1
20511151  0.0  4.753  qrad  1302  4.753  qrad  1304
20511152  4.753  qrad  1306  4.753  qrad  1308
20511153  4.753  qrad  1310  4.753  qrad  1312
20511154  4.753  qrad  1314  4.753  qrad  1316
20511155  4.753  qrad  1318  4.753  qrad  1320
20511156  6.033  qrad  1804
*
20511160  qt1501r  sum  1.0  0.0  1
20511161  0.0  1.0  cntrlvar  1115  1.0  cntrlvar  1114
*
20511170  qi1501r  integral  1.0  0.0  0
20511171  cntrlvar  1116
```

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*
20511180  qt1501  sum  1.0  0.0  0
20511181  0.0  1.0  cntrlvar  1112  1.0  cntrlvar  1116
*
20511190  qi1501  sum  1.0  0.0  0
20511191  0.0  1.0  cntrlvar  1113  1.0  cntrlvar  1117
*
20511210  qrc1600l  sum  1.0  0.0  1
20511211  0.0  0.567  qrad  205  0.567  qrad  210
20511212  0.589  qrad  215  0.589  qrad  220
20511213  0.589  qrad  225  0.589  qrad  230
20511214  0.589  qrad  235  0.589  qrad  240
20511215  0.589  qrad  245  0.589  qrad  250
20511216  0.589  qrad  255  0.589  qrad  260
20511217  0.748  qrad  265  0.748  qrad  270
*
20511220  qt1600l  sum  1.0  0.0  1
20511221  0.0  1.0  cntrlvar  1121
*
20511230  qi1600l  integral  1.0  0.0  0
20511231  cntrlvar  1122
*
20511250  qrc1600r  sum  1.0  0.0  1
20511251  0.0  0.608  qrad  301  0.608  qrad  304
20511252  0.633  qrad  307  0.633  qrad  310
20511253  0.633  qrad  313  0.633  qrad  316
20511254  0.633  qrad  319  0.633  qrad  322
20511255  0.633  qrad  325  0.633  qrad  328
20511256  0.633  qrad  331  0.633  qrad  334
20511257  0.803  qrad  337  0.803  qrad  340
*
20511260  qt1600r  sum  1.0  0.0  1
20511261  0.0  1.0  cntrlvar  1125
*
20511270  qi1600r  integral  1.0  0.0  0
20511271  cntrlvar  1126
*
20511280  qt1600  sum  1.0  0.0  0
20511281  0.0  1.0  cntrlvar  1122  1.0  cntrlvar  1126
*
20511290  qi1600  sum  1.0  0.0  0
20511291  0.0  1.0  cntrlvar  1123  1.0  cntrlvar  1127
*
20511300  qcv1620l  sum  1.0  0.0  1
20511301  0.0  0.342  htrnr  162000100  0.342  htrnr  162000200
20511302  0.356  htrnr  162000300  0.356  htrnr  162000400
20511303  0.356  htrnr  162000500  0.356  htrnr  162000600
20511304  0.356  htrnr  162000700  0.356  htrnr  162000800
20511305  0.356  htrnr  162000900  0.356  htrnr  162001000
20511306  0.356  htrnr  162001100  0.356  htrnr  162001200
20511307  0.451  htrnr  162001300  0.451  htrnr  162001400
*
20511310  qrc1620l  sum  1.0  0.0  1
20511311  0.0  0.451  qrad  1805
*
20511320  qt1620l  sum  1.0  0.0  1
20511321  0.0  1.0  cntrlvar  1130  1.0  cntrlvar  1131
*
20511330  qi1620l  integral  1.0  0.0  0
20511331  cntrlvar  1132
*
20511350  qrc1620r  sum  1.0  0.0  1
20511351  0.0  1.943  qrad  302  1.943  qrad  305
```

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20511352  2.020  qrad  308  2.020  qrad  311
20511353  2.020  qrad  314  2.020  qrad  317
20511354  2.020  qrad  320  2.020  qrad  323
20511355  2.020  qrad  326  2.020  qrad  329
20511356  2.020  qrad  332  2.020  qrad  335
20511357  2.564  qrad  338  2.564  qrad  341
*
20511360  qt1620r  sum  1.0  0.0  1
20511361  0.0  1.0  cntrlvar  1135
*
20511370  qi1620r  integral  1.0  0.0  0
20511371  cntrlvar  1136
*
20511380  qt1620  sum  1.0  0.0  0
20511381  0.0  1.0  cntrlvar  1132  1.0  cntrlvar  1136
*
20511390  qi1620  sum  1.0  0.0  0
20511391  0.0  1.0  cntrlvar  1133  1.0  cntrlvar  1137
*
20511410  qrc1640l  sum  1.0  0.0  1
20511411  0.0  0.689  qrad  303  0.689  qrad  306
20511412  0.717  qrad  309  0.717  qrad  312
20511413  0.717  qrad  315  0.717  qrad  318
20511414  0.717  qrad  321  0.717  qrad  324
20511415  0.717  qrad  327  0.717  qrad  330
20511416  0.717  qrad  333  0.717  qrad  336
20511417  0.910  qrad  339  0.910  qrad  342
*
20511420  qt1640l  sum  1.0  0.0  1
20511421  0.0  1.0  cntrlvar  1141
*
20511430  qi1640l  integral  1.0  0.0  0
20511431  cntrlvar  1142
*
20511440  qcv1640r  sum  1.0  0.0  1
20511441  0.0  0.723  htrnr  164000101  0.723  htrnr  164000201
20511442  0.752  htrnr  164000301  0.752  htrnr  164000401
20511443  0.752  htrnr  164000501  0.752  htrnr  164000601
20511444  0.752  htrnr  164000701  0.752  htrnr  164000801
20511445  0.752  htrnr  164000901  0.752  htrnr  164001001
20511446  0.752  htrnr  164001101  0.752  htrnr  164001201
20511447  0.955  htrnr  164001301  0.955  htrnr  164001401
*
20511450  qrc1640r  sum  1.0  0.0  1
20511451  0.0  0.723  qrad  1401  0.723  qrad  1403
20511452  0.752  qrad  1405  0.752  qrad  1407
20511453  0.752  qrad  1409  0.752  qrad  1411
20511454  0.752  qrad  1413  0.752  qrad  1415
20511455  0.752  qrad  1417  0.752  qrad  1419
20511456  0.752  qrad  1421  0.752  qrad  1423
20511457  0.955  qrad  1425  0.955  qrad  1427
*
20511460  qt1640r  sum  1.0  0.0  1
20511461  0.0  1.0  cntrlvar  1144  1.0  cntrlvar  1145
*
20511470  qi1640r  integral  1.0  0.0  0
20511471  cntrlvar  1146
*
20511480  qt1640  sum  1.0  0.0  0
20511481  0.0  1.0  cntrlvar  1142  1.0  cntrlvar  1146
*
20511490  qi1640  sum  1.0  0.0  0
20511491  0.0  1.0  cntrlvar  1143  1.0  cntrlvar  1147
```

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*
20511500  qcv1660l  sum  1.0  0.0  1
20511501  0.0  0.734  htrnr  166000100  0.734  htrnr  166000200
20511502  0.764  htrnr  166000300  0.764  htrnr  166000400
20511503  0.764  htrnr  166000500  0.764  htrnr  166000600
20511504  0.764  htrnr  166000700  0.764  htrnr  166000800
20511505  0.764  htrnr  166000900  0.764  htrnr  166001000
20511506  0.764  htrnr  166001100  0.764  htrnr  166001200
20511507  0.969  htrnr  166001300  0.969  htrnr  166001400
*
20511510  qrc1660l  sum  1.0  0.0  1
20511511  0.0  0.734  qrad  1402  0.734  qrad  1404
20511512  0.764  qrad  1406  0.764  qrad  1408
20511513  0.764  qrad  1410  0.764  qrad  1412
20511514  0.764  qrad  1414  0.764  qrad  1416
20511515  0.764  qrad  1418  0.764  qrad  1420
20511516  0.764  qrad  1420  0.764  qrad  1424
20511517  0.969  qrad  1426  0.969  qrad  1428
*
20511520  qt1660l  sum  1.0  0.0  1
20511521  0.0  1.0  cntrlvar  1150  1.0  cntrlvar  1151
*
20511530  qi1660l  integral  1.0  0.0  0
20511531  cntrlvar  1152
*
20511540  qcv1660r  sum  1.0  0.0  1
20511541  0.0  0.899  htrnr  166000101  0.899  htrnr  166000201
20511542  0.935  htrnr  166000301  0.935  htrnr  166000401
20511543  0.935  htrnr  166000501  0.935  htrnr  166000601
20511544  0.935  htrnr  166000701  0.935  htrnr  166000801
20511545  0.935  htrnr  166000901  0.935  htrnr  166001001
20511546  0.935  htrnr  166001101  0.935  htrnr  166001201
20511547  1.186  htrnr  166001301  1.186  htrnr  166001401
*
20511550  qrc1660r  sum  1.0  0.0  1
20511551  0.0  0.899  qrad  1501  0.899  qrad  1503
20511552  0.935  qrad  1505  0.935  qrad  1507
20511553  0.935  qrad  1509  0.935  qrad  1511
20511554  0.935  qrad  1513  0.935  qrad  1515
20511555  0.935  qrad  1517  0.935  qrad  1519
20511556  0.935  qrad  1521  0.935  qrad  1523
20511557  1.186  qrad  1525  1.186  qrad  1527
*
20511560  qt1660r  sum  1.0  0.0  1
20511561  0.0  1.0  cntrlvar  1154  1.0  cntrlvar  1155
*
20511570  qi1660r  integral  1.0  0.0  0
20511571  cntrlvar  1156
*
20511580  qt1660  sum  1.0  0.0  0
20511581  0.0  1.0  cntrlvar  1152  1.0  cntrlvar  1156
*
20511590  qi1660  sum  1.0  0.0  0
20511591  0.0  1.0  cntrlvar  1153  1.0  cntrlvar  1157
*
20511600  qcv1750l  sum  1.0  0.0  1
20511601  0.0  1.771  htrnr  175000100
*
20511610  qrc1750l  sum  1.0  0.0  1
20511611  0.0  1.771  qrad  1808
*
20511620  qt1750l  sum  1.0  0.0  1
20511621  0.0  1.0  cntrlvar  1160  1.0  cntrlvar  1161
```

```
*
20511630  qi1750l  integral  1.0  0.0  0
20511631  cntrlvar  1162
*
20511640  qcv1750r  sum  1.0  0.0  1
20511641  0.0  1.771  htrnr  175000101
*
20511660  qt1750r  sum  1.0  0.0  1
20511661  0.0  1.0  cntrlvar  1164
*
20511670  qi1750r  integral  1.0  0.0  0
20511671  cntrlvar  1166
*
20511680  qt1750  sum  1.0  0.0  0
20511681  0.0  1.0  cntrlvar  1162  1.0  cntrlvar  1166
*
20511690  qi1750  sum  1.0  0.0  0
20511691  0.0  1.0  cntrlvar  1163  1.0  cntrlvar  1167
*
20511740  qcv1751r  mult  6.668  0.0  1
20511741  htrnr  175100101
*
20511750  qrc1751r  sum  1.0  0.0  1
20511751  0  6.668  qrad  1806
*
20511760  qt1751r  sum  1.0  0.0  1
20511761  0.0  1.0  cntrlvar  1174  1.0  cntrlvar  1175
*
20511770  qi1751r  integral  1.0  0.0  0
20511771  cntrlvar  1176
*
20511780  qt1751r  sum  1.0  0.0  0
20511781  0.0  1.0  cntrlvar  1176
*
20511790  qi1751r  sum  1.0  0.0  0
20511791  0.0  1.0  cntrlvar  1177
*
20511800  qcv9500l  sum  1.0  0.0  1
20511801  0.0  9.969  htrnr  950000100  3.192  htrnr  950000200
20511802  2.168  htrnr  950000300  2.453  htrnr  950000400
20511803  2.453  htrnr  950000500  2.453  htrnr  950000600
20511804  2.453  htrnr  950000700  2.453  htrnr  950000800
20511805  2.453  htrnr  950000900  2.453  htrnr  950001000
20511806  2.453  htrnr  950001100  2.453  htrnr  950001200
20511807  2.453  htrnr  950001300  2.453  htrnr  950001400
20511808  1.932  htrnr  950001500  1.858  htrnr  950001600
+  1.982  htrnr  950001700  2.665  htrnr  950001800
+  7.300  htrnr  950001900
*
20511810  qrc9500l  sum  1.0  0.0  1
20511811  0.0  9.969  qrad  2102  3.192  qrad  2104
20511812  2.168  qrad  2106  2.453  qrad  2108
20511813  2.453  qrad  2110  2.453  qrad  2112
20511814  2.453  qrad  2114  2.453  qrad  2116
20511815  2.453  qrad  2118  2.453  qrad  2120
20511816  2.453  qrad  2122  2.453  qrad  2124
20511817  2.453  qrad  2126  2.453  qrad  2128
20511818  1.932  qrad  2130  1.858  qrad  2132
+  1.982  qrad  2134  2.665  qrad  2136
+  7.300  qrad  2138
*
20511820  qt9500l  sum  1.0  0.0  1
20511821  0.0  1.0  cntrlvar  1180  1.0  cntrlvar  1181
```

```
*
20511830  qi9500l  integral  1.0  0.0  0
20511831  cntrlvar  1182
*
20511840  qcv9500r  sum  1.0  0.0  1
20511841  0.0  9.969  htrnr  950000101  3.192  htrnr  950000201
20511842  2.168  htrnr  950000301  2.453  htrnr  950000401
20511843  2.453  htrnr  950000501  2.453  htrnr  950000601
20511844  2.453  htrnr  950000701  2.453  htrnr  950000801
20511845  2.453  htrnr  950000901  2.453  htrnr  950001001
20511846  2.453  htrnr  950001101  2.453  htrnr  950001201
20511847  2.453  htrnr  950001301  2.453  htrnr  950001401
20511848  1.932  htrnr  950001501  1.858  htrnr  950001601
+  1.982  htrnr  950001701  2.665  htrnr  950001801
+  7.300  htrnr  950001901
*
20511860  qt9500r  sum  1.0  0.0  1
20511861  0.0  1.0  cntrlvar  1184  * 1.0  cntrlvar  1185
*
20511870  qi9500r  integral  1.0  0.0  0
20511871  cntrlvar  1186
*
20511880  qt9500  sum  1.0  0.0  0
20511881  0.0  1.0  cntrlvar  1182  1.0  cntrlvar  1186
*
20511890  qi9500  sum  1.0  0.0  0
20511891  0.0  1.0  cntrlvar  1183  1.0  cntrlvar  1187
*
20511900  qcv9501l  sum  1.0  0.0  1
20511901  0.0  9.969  htrnr  950100100  3.192  htrnr  950100200
20511902  2.168  htrnr  950100300  2.453  htrnr  950100400
20511903  2.453  htrnr  950100500  2.453  htrnr  950100600
20511904  2.453  htrnr  950100700  2.453  htrnr  950100800
20511905  2.453  htrnr  950100900  2.453  htrnr  950101000
20511906  2.453  htrnr  950101100  2.453  htrnr  950101200
20511907  2.453  htrnr  950101300  2.453  htrnr  950101400
20511908  1.932  htrnr  950101500  1.858  htrnr  950101600
+  1.982  htrnr  950101700  2.665  htrnr  950101800
+  7.300  htrnr  950101900
*
20511920  qt9501l  sum  1.0  0.0  1
20511921  0.0  1.0  cntrlvar  1190
*
20511930  qi9501l  integral  1.0  0.0  0
20511931  cntrlvar  1192
*
20511940  qcv9501r  sum  1.0  0.0  1
20511941  0.0  9.969  htrnr  950100101  3.192  htrnr  950100201
20511942  2.168  htrnr  950100301  2.453  htrnr  950100401
20511943  2.453  htrnr  950100501  2.453  htrnr  950100601
20511944  2.453  htrnr  950100701  2.453  htrnr  950100801
20511945  2.453  htrnr  950100901  2.453  htrnr  950101001
20511946  2.453  htrnr  950101101  2.453  htrnr  950101201
20511947  2.453  htrnr  950101301  2.453  htrnr  950101401
20511948  1.932  htrnr  950101501  1.858  htrnr  950101601
+  1.982  htrnr  950101701  2.665  htrnr  950101801
+  7.300  htrnr  950101901
*
20511960  qt9501r  sum  1.0  0.0  1
20511961  0.0  1.0  cntrlvar  1194
*
20511970  qi9501r  integral  1.0  0.0  0
20511971  cntrlvar  1196
```

```
*
20511980  qt9501  sum  1.0  0.0  0
20511981  0.0  1.0  cntrlvar  1192  1.0  cntrlvar  1196
*
20511990  qi9501  sum  1.0  0.0  0
20511991  0.0  1.0  cntrlvar  1193  1.0  cntrlvar  1197
*
20512000  qcv1002l  sum  1.0  0.0  1
20512001  0.0  4.216  htrnr  100200100
*
20512020  qt1002l  sum  1.0  0.0  1
20512021  0.0  1.0  cntrlvar  1200
*
20512030  qi1002l  integral  1.0  0.0  0
20512031  cntrlvar  1202
*
20512040  qcv1002r  sum  1.0  0.0  1
20512041  0.0  4.348  htrnr  100200101
*
20512050  qrc1002r  sum  1.0  0.0  1
20512051  0.0  4.348  qrad  2101
*
20512060  qt1002r  sum  1.0  0.0  1
20512061  0.0  1.0  cntrlvar  1204  1.0  cntrlvar  1205
*
20512070  qi1002r  integral  1.0  0.0  0
20512071  cntrlvar  1206
*
20512080  qt1002  sum  1.0  0.0  1
20512081  0.0  1.0  cntrlvar  1202  1.0  cntrlvar  1206
*
20512090  qi1002  sum  1.0  0.0  1
20512091  0.0  1.0  cntrlvar  1203  1.0  cntrlvar  1207
*
20512150  qrc1403r  sum  1.0  0.0  1
20512151  0.0  0.506  qrad  1101  0.506  qrad  1103
20512152  0.506  qrad  1105  0.506  qrad  1107
20512153  0.506  qrad  1109  0.506  qrad  1111
20512154  0.506  qrad  1113  0.506  qrad  1115
20512155  0.506  qrad  1117  0.506  qrad  1119
*
20512160  qt1403r  sum  1.0  0.0  1
20512161  0.0  1.0  cntrlvar  1215
*
20512170  qi1403r  integral  1.0  0.0  0
20512171  cntrlvar  1216
*
20512250  qrc1453r  sum  1.0  0.0  1
20512251  0.0  0.650  qrad  1201  0.650  qrad  1203
20512252  0.650  qrad  1205  0.650  qrad  1207
20512253  0.650  qrad  1209  0.650  qrad  1211
20512254  0.650  qrad  1213  0.650  qrad  1215
20512255  0.650  qrad  1217  0.650  qrad  1219
*
20512260  qt1453r  sum  1.0  0.0  1
20512261  0.0  1.0  cntrlvar  1225
*
20512270  qi1453r  integral  1.0  0.0  0
20512271  cntrlvar  1226
*
20512350  qrc1503r  sum  1.0  0.0  1
20512351  0.0  0.741  qrad  1301  0.741  qrad  1303
20512352  0.741  qrad  1305  0.741  qrad  1307
```

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20512353  0.741  qrad  1309  0.741  qrad  1311
20512354  0.741  qrad  1313  0.741  qrad  1315
20512355  0.741  qrad  1317  0.741  qrad  1319
*
20512360  qt1503r  sum  1.0  0.0  1
20512361  0.0  1.0  cntrlvar  1235
*
20512370  qi1503r  integral  1.0  0.0  0
20512371  cntrlvar  1236
*
* net heat out of heater rods
*
20513010  qhtrsout  sum  1.0  0.0  0
20513011  0.0  -1.0  cntrlvar  907  1.0  cntrlvar  1216
20513012  1.0  cntrlvar  1226  1.0  cntrlvar  1236
*
* net heat out of core heater region ceramic
*
20513020  qcoreout  sum  1.0  0.0  0
20513021  0.0  1.0  cntrlvar  1301  1.0  cntrlvar  1098
20513022  1.0  cntrlvar  1108  1.0  cntrlvar  1118
*
* net heat out of core block
*
20513030  qcblkout  sum  1.0  0.0  0
20513031  0.0  1.0  cntrlvar  1302  1.0  cntrlvar  1068
20513032  1.0  cntrlvar  1078  1.0  cntrlvar  1088
20513033  1.0  cntrlvar  1128  1.0  cntrlvar  1138
20513034  1.0  cntrlvar  1148
*
* net heat out of core and reflectors
*
20513040  qcortout  sum  1.0  0.0  0
20513041  0.0  1.0  cntrlvar  1303  1.0  cntrlvar  1158
20513042  1.0  cntrlvar  1048
*
* net heat out of core, reflectors, and core barrel
*
20513050  qbarout  sum  1.0  0.0  0
20513051  0.0  1.0  cntrlvar  1304  1.0  cntrlvar  1028
20513052  1.0  cntrlvar  1038
*
* net heat out of entire primary pressure vessel
*
20513060  qrvout  sum  1.0  0.0  0
20513061  0.0  1.0  cntrlvar  1305  1.0  cntrlvar  1008
20513062  1.0  cntrlvar  1018  1.0  cntrlvar  1058
20513063  1.0  cntrlvar  1168  1.0  cntrlvar  1178
20513064  1.0  cntrlvar  2008
*
* environmental heat losses
*
20514010  hs200ehl  sum  1.0  0.0  1
20514011  0.0  0.656  htrnr  200100101  0.656  htrnr  200100201
*
20514030  hs215ehl  sum  1.0  0.0  1
20514031  0.0  0.723  htrnr  215000101
*
20514040  hs220ehl  sum  1.0  0.0  1
20514041  0.0  0.889  htrnr  220000101
*
20514050  hs228ehl  sum  1.0  0.0  1
20514051  0.0  0.756  htrnr  228000101
```

```
*
20514060  hs230ehl  sum  1.0  0.0  1
20514061  0.0  2.303  htrnr  230000101
*
20514070  hs235ehl  sum  1.0  0.0  1
20514071  0.0  2.045  htrnr  235000101
*
20514080  hs240ehl  sum  1.0  0.0  1
20514081  0.0  1.305  htrnr  240000101
*
20514090  hs250ehl  sum  1.0  0.0  1
20514091  0.0  1.101  htrnr  250000101  0.364  htrnr  250000201
20514092  0.628  htrnr  250000301
*
20514110  hs260ehl  sum  1.0  0.0  1
20514111  0.0  0.369  htrnr  260000101
*
20514120  hs270ehl  sum  1.0  0.0  1
20514121  0.0  0.725  htrnr  270000101  0.725  htrnr  270000201
20514122  1.144  htrnr  270000301  0.759  htrnr  270000401
*
20514130  hs280ehl  sum  1.0  0.0  1
20514131  0.0  8.969  htrnr  280000101  29.852  htrnr  280000201
* replace the card above with the one below when using the single-volume RCST
*20514131 0.0  38.821  htrnr  280000101
*
20514140  hs340ehl  sum  1.0  0.0  1
20514141  0.0  0.315  htrnr  340000101  0.315  htrnr  340000201
20514142  0.318  htrnr  340000301  0.318  htrnr  340000401
20514143  0.318  htrnr  340000501  0.318  htrnr  340000601
20514144  0.318  htrnr  340000701  0.318  htrnr  340000801
20514145  0.318  htrnr  340000901  0.318  htrnr  340001001
20514146  1.416  htrnr  340001101  1.275  htrnr  340001201
20514147  1.249  htrnr  340001301
*
20514150  hs355ehl  sum  1.0  0.0  1
20514151  0.0  0.689  htrnr  355000101
*
* use the cards below for a CRD line break
*
*20514160 hl0100  sum  1.0  0.0  1
*20514161 0.0  0.0149  htrnr  10000101  0.0149  htrnr  10000201
*20514162  0.0149  htrnr  10000301  0.0149  htrnr  10000401
*20514163  0.0149  htrnr  10000501  0.0149  htrnr  10000601
*20514164  0.0149  htrnr  10000701  0.0149  htrnr  10000801
*20514165  0.0149  htrnr  10000901  0.0149  htrnr  10001001
*20514166  0.0149  htrnr  10001101  0.0149  htrnr  10001201
*20514167  0.0149  htrnr  10001301  0.0149  htrnr  10001401
*20514168  0.0149  htrnr  10001501  0.0149  htrnr  10001601
*+  0.0149  htrnr  10001701  0.0149  htrnr  10001801
*+  0.0149  htrnr  10001901  0.0149  htrnr  10002001
*+  0.0149  htrnr  10002101  0.0149  htrnr  10002201
*+  0.0149  htrnr  10002301  0.0149  htrnr  10002401
*+  0.0149  htrnr  10002501
*
*20514170 hl020-1  sum  1.0  0.0  1
*20514171 0.0  0.0139  htrnr  20000101  0.0139  htrnr  20000201
*20514172  0.0139  htrnr  20000301  0.0139  htrnr  20000401
*20514173  0.0139  htrnr  20000501  0.0139  htrnr  20000601
*20514174  0.0139  htrnr  20000701  0.0139  htrnr  20000801
*20514175  0.0139  htrnr  20000901  0.0139  htrnr  20001001
*20514176  0.0139  htrnr  20001101  0.0139  htrnr  20001201
*20514177  0.0139  htrnr  20001301  0.0139  htrnr  20001401
```

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*20514178  0.0139  htrnr  20001501  0.0139  htrnr  20001601
*+  0.0139  htrnr  20001701  0.0139  htrnr  20001801
*+  0.0139  htrnr  20001901  0.0139  htrnr  20002001
*+  0.0139  htrnr  20002101  0.0139  htrnr  20002201
*+  0.0139  htrnr  20002301  0.0139  htrnr  20002401
*+  0.0139  htrnr  20002501  0.0139  htrnr  20002601
*+  0.0139  htrnr  20002701  0.0139  htrnr  20002801
*+  0.0139  htrnr  20002901  0.0139  htrnr  20003001
*+  0.0139  htrnr  20003101  0.0139  htrnr  20003201
*+  0.0139  htrnr  20003301  0.0139  htrnr  20003401
*+  0.0139  htrnr  20003501
*
*20514180 hl030-1  sum  1.0  0.0  1
*20514181 0.0  0.0136  htrnr  30000101  0.0136  htrnr  30000201
*20514182  0.0136  htrnr  30000301  0.0136  htrnr  30000401
*20514183  0.0136  htrnr  30000501  0.0136  htrnr  30000601
*20514184  0.0136  htrnr  30000701  0.0136  htrnr  30000801
*20514185  0.0136  htrnr  30000901  0.0136  htrnr  30001001
*20514186  0.0136  htrnr  30001101  0.0136  htrnr  30001201
*20514187  0.0136  htrnr  30001301  0.0136  htrnr  30001401
*20514188  0.0136  htrnr  30001501  0.0136  htrnr  30001601
*+  0.0136  htrnr  30001701  0.0136  htrnr  30001801
*+  0.0136  htrnr  30001901  0.0136  htrnr  30002001
*+  0.0136  htrnr  30002101  0.0136  htrnr  30002201
*+  0.0136  htrnr  30002301  0.0136  htrnr  30002401
*+  0.0136  htrnr  30002501  0.0136  htrnr  30002601
*+  0.0136  htrnr  30002701  0.0136  htrnr  30002801
*+  0.0136  htrnr  30002901  0.0136  htrnr  30003001
*+  0.0136  htrnr  30003101  0.0136  htrnr  30003201
*+  0.0136  htrnr  30003301  0.0136  htrnr  30003401
*+  0.0136  htrnr  30003501  0.0136  htrnr  30003601
*+  0.0136  htrnr  30003701  0.0136  htrnr  30003801
*+  0.0136  htrnr  30003901  0.0136  htrnr  30004001
*
*20514190 hl030-2  sum  1.0  0.0  1
*20514191 0.0  0.0136  htrnr  30004101  0.0136  htrnr  30004201
*20514192  0.0136  htrnr  30004301  0.0136  htrnr  30004401
*20514193  0.0136  htrnr  30004501  0.0136  htrnr  30004601
*20514194  0.0136  htrnr  30004701  0.0136  htrnr  30004801
*20514195  0.0136  htrnr  30004901  0.0136  htrnr  30005001
*20514196  0.0136  htrnr  30005101  0.0136  htrnr  30005201
*20514197  0.0136  htrnr  30005301  0.0136  htrnr  30005401
*20514198  0.0136  htrnr  30005501  0.0136  htrnr  30005601
*+  0.0136  htrnr  30005701  0.0136  htrnr  30005801
*+  0.0136  htrnr  30005901  0.0136  htrnr  30006001
*+  0.0136  htrnr  30006101  0.0136  htrnr  30006201
*+  0.0136  htrnr  30006301  0.0136  htrnr  30006401
*+  0.0136  htrnr  30006501  0.0136  htrnr  30006601
*+  0.0136  htrnr  30006701  0.0136  htrnr  30006801
*+  0.0136  htrnr  30006901  0.0136  htrnr  30007001
*+  0.0136  htrnr  30007101  0.0136  htrnr  30007201
*+  0.0136  htrnr  30007301  0.0136  htrnr  30007401
*+  0.0136  htrnr  30007501  0.0136  htrnr  30007601
*+  0.0136  htrnr  30007701  0.0136  htrnr  30007801
*+  0.0136  htrnr  30007901  0.0136  htrnr  30008001
*
*20514200 hl030-3  sum  1.0  0.0  1
*20514201 0.0  0.0136  htrnr  30008101  0.0136  htrnr  30008201
*20514202  0.0136  htrnr  30008301  0.0136  htrnr  30008401
*20514203  0.0136  htrnr  30008501  0.0136  htrnr  30008601
*20514204  0.0136  htrnr  30008701  0.0136  htrnr  30008801
*20514205  0.0136  htrnr  30008901  0.0136  htrnr  30009001
*20514206  0.0136  htrnr  30009101  0.0136  htrnr  30009201
```

```
*
*20514210 hs030ehl  sum  1.0  0.0  1
*20514211 0.0  1.0  cntrlvar  1418  1.0  cntrlvar  1419
*20514212  1.0  cntrlvar  1420
*
*20514220 hl032-1  sum  1.0  0.0  1
*20514221 0.0  0.0136  htrnr  32000101  0.0136  htrnr  32000201
*20514222  0.0136  htrnr  32000301  0.0136  htrnr  32000401
*20514223  0.0136  htrnr  32000501  0.0136  htrnr  32000601
*20514224  0.0136  htrnr  32000701  0.0136  htrnr  32000801
*20514225  0.0136  htrnr  32000901  0.0136  htrnr  32001001
*20514226  0.0136  htrnr  32001101  0.0136  htrnr  32001201
*20514227  0.0136  htrnr  32001301  0.0136  htrnr  32001401
*20514228  0.0136  htrnr  32001501  0.0136  htrnr  32001601
*+  0.0136  htrnr  32001701  0.0136  htrnr  32001801
*+  0.0136  htrnr  32001901  0.0136  htrnr  32002001
*+  0.0136  htrnr  32002101  0.0136  htrnr  32002201
*+  0.0136  htrnr  32002301  0.0136  htrnr  32002401
*+  0.0136  htrnr  32002501  0.0136  htrnr  32002601
*+  0.0136  htrnr  32002701  0.0136  htrnr  32002801
*+  0.0136  htrnr  32002901  0.0136  htrnr  32003001
*+  0.0136  htrnr  32003101  0.0136  htrnr  32003201
*+  0.0136  htrnr  32003301  0.0136  htrnr  32003401
*+  0.0136  htrnr  32003501  0.0136  htrnr  32003601
*+  0.0136  htrnr  32003701  0.0136  htrnr  32003801
*+  0.0136  htrnr  32003901  0.0136  htrnr  32004001
*
*20514230 hl032-2  sum  1.0  0.0  1
*20514231 0.0  0.0136  htrnr  32004101  0.0136  htrnr  32004201
*20514232  0.0136  htrnr  32004301  0.0136  htrnr  32004401
*20514233  0.0136  htrnr  32004501  0.0136  htrnr  32004601
*20514234  0.0136  htrnr  32004701  0.0136  htrnr  32004801
*20514235  0.0136  htrnr  32004901  0.0136  htrnr  32005001
*20514236  0.0136  htrnr  32005101  0.0136  htrnr  32005201
*20514237  0.0136  htrnr  32005301  0.0136  htrnr  32005401
*20514238  0.0136  htrnr  32005501  0.0136  htrnr  32005601
*+  0.0136  htrnr  32005701  0.0136  htrnr  32005801
*+  0.0136  htrnr  32005901  0.0136  htrnr  32006001
*+  0.0136  htrnr  32006101  0.0136  htrnr  32006201
*+  0.0136  htrnr  32006301  0.0136  htrnr  32006401
*+  0.0136  htrnr  32006501  0.0136  htrnr  32006601
*+  0.0136  htrnr  32006701  0.0136  htrnr  32006801
*+  0.0136  htrnr  32006901  0.0136  htrnr  32007001
*+  0.0136  htrnr  32007101  0.0136  htrnr  32007201
*+  0.0136  htrnr  32007301  0.0136  htrnr  32007401
*+  0.0136  htrnr  32007501  0.0136  htrnr  32007601
*+  0.0136  htrnr  32007701  0.0136  htrnr  32007801
*+  0.0136  htrnr  32007901  0.0136  htrnr  32008001
*
*20514240 hl032-3  sum  1.0  0.0  1
*20514241 0.0  0.0136  htrnr  32008101  0.0136  htrnr  32008201
*20514242  0.0136  htrnr  32008301  0.0136  htrnr  32008401
*20514243  0.0136  htrnr  32008501  0.0136  htrnr  32008601
*20514244  0.0136  htrnr  32008701  0.0136  htrnr  32008801
*20514245  0.0136  htrnr  32008901  0.0136  htrnr  32009001
*20514246  0.0136  htrnr  32009101  0.0136  htrnr  32009201
*
*20514250 hs032ehl  sum  1.0  0.0  1
*20514251 0.0  1.0  cntrlvar  1422  1.0  cntrlvar  1423
*20514252  1.0  cntrlvar  1424
*
*20514260 hl034-1  sum  1.0  0.0  1
*20514261 0.0  0.0136  htrnr  34000101  0.0136  htrnr  34000201
```

```
*20514262  0.0136  htrnr  34000301  0.0136  htrnr  34000401
*20514263  0.0136  htrnr  34000501  0.0136  htrnr  34000601
*20514264  0.0136  htrnr  34000701  0.0136  htrnr  34000801
*20514265  0.0136  htrnr  34000901  0.0136  htrnr  34001001
*20514266  0.0136  htrnr  34001101  0.0136  htrnr  34001201
*20514267  0.0136  htrnr  34001301  0.0136  htrnr  34001401
*20514268  0.0136  htrnr  34001501  0.0136  htrnr  34001601
*+  0.0136  htrnr  34001701  0.0136  htrnr  34001801
*+  0.0136  htrnr  34001901  0.0136  htrnr  34002001
*+  0.0136  htrnr  34002101  0.0136  htrnr  34002201
*+  0.0136  htrnr  34002301  0.0136  htrnr  34002401
*+  0.0136  htrnr  34002501  0.0136  htrnr  34002601
*+  0.0136  htrnr  34002701  0.0136  htrnr  34002801
*+  0.0136  htrnr  34002901  0.0136  htrnr  34003001
*+  0.0136  htrnr  34003101  0.0136  htrnr  34003201
*+  0.0136  htrnr  34003301  0.0136  htrnr  34003401
*+  0.0136  htrnr  34003501  0.0136  htrnr  34003601
*+  0.0136  htrnr  34003701  0.0136  htrnr  34003801
*+  0.0136  htrnr  34003901  0.0136  htrnr  34004001
*
*20514270 hl034-2  sum  1.0  0.0  1
*20514271 0.0  0.0136  htrnr  34004101  0.0136  htrnr  34004201
*20514272  0.0136  htrnr  34004301  0.0136  htrnr  34004401
*20514273  0.0136  htrnr  34004501  0.0136  htrnr  34004601
*20514274  0.0136  htrnr  34004701  0.0136  htrnr  34004801
*20514275  0.0136  htrnr  34004901  0.0136  htrnr  34005001
*20514276  0.0136  htrnr  34005101  0.0136  htrnr  34005201
*20514277  0.0136  htrnr  34005301  0.0136  htrnr  34005401
*20514278  0.0136  htrnr  34005501  0.0136  htrnr  34005601
*+  0.0136  htrnr  34005701  0.0136  htrnr  34005801
*+  0.0136  htrnr  34005901  0.0136  htrnr  34006001
*+  0.0136  htrnr  34006101  0.0136  htrnr  34006201
*+  0.0136  htrnr  34006301  0.0136  htrnr  34006401
*+  0.0136  htrnr  34006501  0.0136  htrnr  34006601
*+  0.0136  htrnr  34006701  0.0136  htrnr  34006801
*+  0.0136  htrnr  34006901  0.0136  htrnr  34007001
*+  0.0136  htrnr  34007101  0.0136  htrnr  34007201
*+  0.0136  htrnr  34007301  0.0136  htrnr  34007401
*+  0.0136  htrnr  34007501  0.0136  htrnr  34007601
*+  0.0136  htrnr  34007701  0.0136  htrnr  34007801
*+  0.0136  htrnr  34007901  0.0136  htrnr  34008001
*
*20514280 hl034-3  sum  1.0  0.0  1
*20514281 0.0  0.0136  htrnr  34008101  0.0136  htrnr  34008201
*20514282  0.0136  htrnr  34008301  0.0136  htrnr  34008401
*20514283  0.0136  htrnr  34008501  0.0136  htrnr  34008601
*20514284  0.0136  htrnr  34008701  0.0136  htrnr  34008801
*20514285  0.0136  htrnr  34008901  0.0136  htrnr  34009001
*20514286  0.0136  htrnr  34009101  0.0136  htrnr  34009201
*
*20514290 hs034ehl  sum  1.0  0.0  1
*20514291 0.0  1.0  cntrlvar  1426  1.0  cntrlvar  1427
*20514292  1.0  cntrlvar  1428
*
*20514300 CRDbkehl  sum  1.0  0.0  1
*20514301 0.0  1.0  cntrlvar  1416  1.0  cntrlvar  1417
*20514302  1.0  cntrlvar  1421  1.0  cntrlvar  1425
*20514303  1.0  cntrlvar  1429
*
* use the cards below for a vessel bottom break
*20514310 hl070-1  sum  1.0  0.0  1
*20514311 0.0  0.0137  htrnr  70000101  0.0137  htrnr  70000201
*20514312  0.0137  htrnr  70000301  0.0137  htrnr  70000401
```

```
*20514313  0.0137  htrnr  70000501  0.0137  htrnr  70000601
*20514314  0.0137  htrnr  70000701  0.0137  htrnr  70000801
*20514315  0.0137  htrnr  70000901  0.0137  htrnr  70001001
*20514316  0.0137  htrnr  70001101  0.0137  htrnr  70001201
*20514317  0.0137  htrnr  70001301  0.0137  htrnr  70001401
*20514318  0.0137  htrnr  70001501  0.0137  htrnr  70001601
*+  0.0137  htrnr  70001701  0.0137  htrnr  70001801
*+  0.0137  htrnr  70001901  0.0137  htrnr  70002001
*+  0.0137  htrnr  70002101  0.0137  htrnr  70002201
*+  0.0137  htrnr  70002301  0.0137  htrnr  70002401
*+  0.0137  htrnr  70002501  0.0137  htrnr  70002601
*+  0.0137  htrnr  70002701  0.0137  htrnr  70002801
*+  0.0137  htrnr  70002901  0.0137  htrnr  70003001
*+  0.0137  htrnr  70003101  0.0137  htrnr  70003201
*+  0.0137  htrnr  70003301  0.0137  htrnr  70003401
*+  0.0137  htrnr  70003501  0.0137  htrnr  70003601
*+  0.0137  htrnr  70003701  0.0137  htrnr  70003801
*+  0.0137  htrnr  70003901  0.0137  htrnr  70004001
*
*20514320 hl070-2  sum  1.0  0.0  1
*20514321 0.0  0.0137  htrnr  70004101  0.0137  htrnr  70004201
*20514322  0.0137  htrnr  70004301  0.0137  htrnr  70004401
*20514323  0.0137  htrnr  70004501  0.0137  htrnr  70004601
*20514324  0.0137  htrnr  70004701  0.0137  htrnr  70004801
*20514325  0.0137  htrnr  70004901  0.0137  htrnr  70005001
*20514326  0.0137  htrnr  70005101  0.0137  htrnr  70005201
*20514327  0.0137  htrnr  70005301  0.0137  htrnr  70005401
*20514328  0.0137  htrnr  70005501  0.0137  htrnr  70005601
*+  0.0137  htrnr  70005701  0.0137  htrnr  70005801
*+  0.0137  htrnr  70005901  0.0137  htrnr  70006001
*+  0.0137  htrnr  70006101  0.0137  htrnr  70006201
*+  0.0137  htrnr  70006301  0.0137  htrnr  70006401
*+  0.0137  htrnr  70006501  0.0137  htrnr  70006601
*+  0.0137  htrnr  70006701  0.0137  htrnr  70006801
*+  0.0137  htrnr  70006901  0.0137  htrnr  70007001
*+  0.0137  htrnr  70007101  0.0137  htrnr  70007201
*+  0.0137  htrnr  70007301
*
*20514330 hs070ehl  sum  1.0  0.0  1
*20514331 0.0  1.0  cntrlvar  1431  1.0  cntrlvar  1432
*
*20514340 hl072-1  sum  1.0  0.0  1
*20514341 0.0  0.0137  htrnr  72000101  0.0137  htrnr  72000201
*20514342  0.0137  htrnr  72000301  0.0137  htrnr  72000401
*20514343  0.0137  htrnr  72000501  0.0137  htrnr  72000601
*20514344  0.0137  htrnr  72000701  0.0137  htrnr  72000801
*20514345  0.0137  htrnr  72000901  0.0137  htrnr  72001001
*20514346  0.0137  htrnr  72001101  0.0137  htrnr  72001201
*20514347  0.0137  htrnr  72001301  0.0137  htrnr  72001401
*20514348  0.0137  htrnr  72001501  0.0137  htrnr  72001601
*+  0.0137  htrnr  72001701  0.0137  htrnr  72001801
*+  0.0137  htrnr  72001901  0.0137  htrnr  72002001
*+  0.0137  htrnr  72002101  0.0137  htrnr  72002201
*+  0.0137  htrnr  72002301  0.0137  htrnr  72002401
*+  0.0137  htrnr  72002501  0.0137  htrnr  72002601
*+  0.0137  htrnr  72002701  0.0137  htrnr  72002801
*+  0.0137  htrnr  72002901  0.0137  htrnr  72003001
*+  0.0137  htrnr  72003101  0.0137  htrnr  72003201
*+  0.0137  htrnr  72003301  0.0137  htrnr  72003401
*+  0.0137  htrnr  72003501  0.0137  htrnr  72003601
*+  0.0137  htrnr  72003701  0.0137  htrnr  72003801
*+  0.0137  htrnr  72003901  0.0137  htrnr  72004001
*
```

```
*20514350 hl072-2  sum  1.0  0.0  1
*20514351 0.0  0.0137  htrnr  72004101  0.0137  htrnr  72004201
*20514352  0.0137  htrnr  72004301  0.0137  htrnr  72004401
*20514353  0.0137  htrnr  72004501  0.0137  htrnr  72004601
*20514354  0.0137  htrnr  72004701  0.0137  htrnr  72004801
*20514355  0.0137  htrnr  72004901  0.0137  htrnr  72005001
*20514356  0.0137  htrnr  72005101  0.0137  htrnr  72005201
*20514357  0.0137  htrnr  72005301  0.0137  htrnr  72005401
*20514358  0.0137  htrnr  72005501  0.0137  htrnr  72005601
*+  0.0137  htrnr  72005701  0.0137  htrnr  72005801
*+  0.0137  htrnr  72005901  0.0137  htrnr  72006001
*+  0.0137  htrnr  72006101  0.0137  htrnr  72006201
*+  0.0137  htrnr  72006301  0.0137  htrnr  72006401
*+  0.0137  htrnr  72006501  0.0137  htrnr  72006601
*+  0.0137  htrnr  72006701  0.0137  htrnr  72006801
*+  0.0137  htrnr  72006901  0.0137  htrnr  72007001
*+  0.0137  htrnr  72007101  0.0137  htrnr  72007201
*+  0.0137  htrnr  72007301
*
*20514360 hs072ehl  sum  1.0  0.0  1
*20514361 0.0  1.0  cntrlvar  1434  1.0  cntrlvar  1435
*
*20514370 hl080-1  sum  1.0  0.0  1
*20514371 0.0  0.0136  htrnr  80000101  0.0136  htrnr  80000201
*20514372  0.0136  htrnr  80000301  0.0136  htrnr  80000401
*20514373  0.0136  htrnr  80000501  0.0136  htrnr  80000601
*20514374  0.0136  htrnr  80000701  0.0136  htrnr  80000801
*20514375  0.0136  htrnr  80000901  0.0136  htrnr  80001001
*20514376  0.0136  htrnr  80001101  0.0136  htrnr  80001201
*20514377  0.0136  htrnr  80001301  0.0136  htrnr  80001401
*20514378  0.0136  htrnr  80001501  0.0136  htrnr  80001601
*+  0.0136  htrnr  80001701  0.0136  htrnr  80001801
*+  0.0136  htrnr  80001901  0.0136  htrnr  80002001
*+  0.0136  htrnr  80002101  0.0136  htrnr  80002201
*+  0.0136  htrnr  80002301  0.0136  htrnr  80002401
*+  0.0136  htrnr  80002501  0.0136  htrnr  80002601
*+  0.0136  htrnr  80002701  0.0136  htrnr  80002801
*+  0.0136  htrnr  80002901  0.0136  htrnr  80003001
*+  0.0136  htrnr  80003101  0.0136  htrnr  80003201
*+  0.0136  htrnr  80003301  0.0136  htrnr  80003401
*+  0.0136  htrnr  80003501  0.0136  htrnr  80003601
*+  0.0136  htrnr  80003701  0.0136  htrnr  80003801
*+  0.0136  htrnr  80003901  0.0136  htrnr  80004001
*
*20514380 hl080-2  sum  1.0  0.0  1
*20514381 0.0  0.0136  htrnr  80004101  0.0136  htrnr  80004201
*20514382  0.0136  htrnr  80004301  0.0136  htrnr  80004401
*20514383  0.0136  htrnr  80004501  0.0136  htrnr  80004601
*20514384  0.0136  htrnr  80004701  0.0136  htrnr  80004801
*20514385  0.0136  htrnr  80004901  0.0136  htrnr  80005001
*20514386  0.0136  htrnr  80005101  0.0136  htrnr  80005201
*20514387  0.0136  htrnr  80005301  0.0136  htrnr  80005401
*20514388  0.0136  htrnr  80005501  0.0136  htrnr  80005601
*+  0.0136  htrnr  80005701  0.0136  htrnr  80005801
*+  0.0136  htrnr  80005901  0.0136  htrnr  80006001
*+  0.0136  htrnr  80006101  0.0136  htrnr  80006201
*+  0.0136  htrnr  80006301  0.0136  htrnr  80006401
*+  0.0136  htrnr  80006501  0.0136  htrnr  80006601
*+  0.0136  htrnr  80006701  0.0136  htrnr  80006801
*+  0.0136  htrnr  80006901  0.0136  htrnr  80007001
*+  0.0136  htrnr  80007101  0.0136  htrnr  80007201
*+  0.0136  htrnr  80007301  0.0136  htrnr  80007401
*+  0.0136  htrnr  80007501  0.0136  htrnr  80007601
```

```
*+  0.0136  htrnr  80007701  0.0136  htrnr  80007801
*+  0.0136  htrnr  80007901  0.0136  htrnr  80008001
*
*20514390 hl080-3  sum  1.0  0.0  1
*20514391 0.0  0.0136  htrnr  80008101  0.0136  htrnr  80008201
*20514392  0.0136  htrnr  80008301  0.0136  htrnr  80008401
*20514393  0.0136  htrnr  80008501  0.0136  htrnr  80008601
*20514394  0.0136  htrnr  80008701  0.0136  htrnr  80008801
*20514395  0.0136  htrnr  80008901  0.0136  htrnr  80009001
*20514396  0.0136  htrnr  80009101  0.0136  htrnr  80009201
*20514397  0.0136  htrnr  80009301  0.0136  htrnr  80009401
*20514398  0.0136  htrnr  80009501  0.0136  htrnr  80009601
*
*20514400 hs080ehl  sum  1.0  0.0  1
*20514401 0.0  1.0  cntrlvar  1437  1.0  cntrlvar  1438
*20514402  1.0  cntrlvar  1439
*
*20514410 vbtbkehl  sum  1.0  0.0  1
*20514411 0.0  1.0  cntrlvar  1436  1.0  cntrlvar  1440
*
20514440  pipeehl  sum  1.0  0.0  1
20514441  0.0  1.0  cntrlvar  1401  1.0  cntrlvar  1403
20514442  1.0  cntrlvar  1406  1.0  cntrlvar  1407
20514443  1.0  cntrlvar  1408  1.0  cntrlvar  1409
20514444  1.0  cntrlvar  1411  1.0  cntrlvar  1412
*
20514450  SGehl  sum  1.0  0.0  1
20514451  0.0  1.0  cntrlvar  1404  1.0  cntrlvar  1405
20514452  1.0  cntrlvar  1414  1.0  cntrlvar  1415
*
20514460  PCSehl  sum  1.0  0.0  1
20514461  0.0  1.0  cntrlvar  1444  1.0  cntrlvar  1404
20514462  1.0  cntrlvar  1405  1.0  cntrlvar  1413
* add the card below if the vessel CRD break line is included in the model
*20514463  1.0  cntrlvar  1430
* add the card below if the vessel bottom break line is included in the model
*20514463  1.0  cntrlvar  1441
* add the card below if both vessel break lines are included in the model
*20514463  1.0  cntrlvar  1430  1.0  cntrlvar  1441
*
20514470  SCSehl  sum  1.0  0.0  1
20514471  0.0  1.0  cntrlvar  1414  1.0  cntrlvar  1415
*
20514490  totalehl  sum  1.0  0.0  1
20514491  0.0  1.0  cntrlvar  1446  1.0  cntrlvar  1447
*
20514500  toflehlq  integral  1.0  0.0  0
20514501  cntrlvar  1449
*
* system mass variables
*
20516010  mass140  sum  1.0  0.0  1
20516011  0.0  1.0  tmassv  140010000  1.0  tmassv  140020000
20516012  1.0  tmassv  140030000  1.0  tmassv  140040000
20516013  1.0  tmassv  140050000  1.0  tmassv  140060000
20516014  1.0  tmassv  140070000  1.0  tmassv  140080000
20516015  1.0  tmassv  140090000  1.0  tmassv  140100000
20516016  1.0  tmassv  140110000  1.0  tmassv  140120000
20516017  1.0  tmassv  140130000  1.0  tmassv  140140000
*
20516020  mass145  sum  1.0  0.0  1
20516021  0.0  1.0  tmassv  145010000  1.0  tmassv  145020000
20516022  1.0  tmassv  145030000  1.0  tmassv  145040000
```

```
20516023  1.0  tmassv  145050000  1.0  tmassv  145060000
20516024  1.0  tmassv  145070000  1.0  tmassv  145080000
20516025  1.0  tmassv  145090000  1.0  tmassv  145100000
20516026  1.0  tmassv  145110000  1.0  tmassv  145120000
20516027  1.0  tmassv  145130000  1.0  tmassv  145140000
*
20516030  mass150  sum  1.0  0.0  1
20516031  0.0  1.0  tmassv  150010000  1.0  tmassv  150020000
20516032  1.0  tmassv  150030000  1.0  tmassv  150040000
20516033  1.0  tmassv  150050000  1.0  tmassv  150060000
20516034  1.0  tmassv  150070000  1.0  tmassv  150080000
20516035  1.0  tmassv  150090000  1.0  tmassv  150100000
20516036  1.0  tmassv  150110000  1.0  tmassv  150120000
20516037  1.0  tmassv  150130000  1.0  tmassv  150140000
*
20516040  mass132  sum  1.0  0.0  1
20516041  0.0  1.0  tmassv  132010000  1.0  tmassv  132020000
20516042  1.0  tmassv  132030000  1.0  tmassv  132040000
20516043  1.0  tmassv  132050000  1.0  tmassv  132060000
20516044  1.0  tmassv  132070000  1.0  tmassv  132080000
20516045  1.0  tmassv  132090000  1.0  tmassv  132100000
20516046  1.0  tmassv  132110000  1.0  tmassv  132120000
20516047  1.0  tmassv  132130000  1.0  tmassv  132140000
*
20516050  mass162  sum  1.0  0.0  1
20516051  0.0  1.0  tmassv  162010000  1.0  tmassv  162020000
20516052  1.0  tmassv  162030000  1.0  tmassv  162040000
20516053  1.0  tmassv  162050000  1.0  tmassv  162060000
20516054  1.0  tmassv  162070000  1.0  tmassv  162080000
20516055  1.0  tmassv  162090000  1.0  tmassv  162100000
20516056  1.0  tmassv  162110000  1.0  tmassv  162120000
20516057  1.0  tmassv  162130000  1.0  tmassv  162140000
*
20516060  mass164  sum  1.0  0.0  1
20516061  0.0  1.0  tmassv  164010000  1.0  tmassv  164020000
20516062  1.0  tmassv  164030000  1.0  tmassv  164040000
20516063  1.0  tmassv  164050000  1.0  tmassv  164060000
20516064  1.0  tmassv  164070000  1.0  tmassv  164080000
20516065  1.0  tmassv  164090000  1.0  tmassv  164100000
20516066  1.0  tmassv  164110000  1.0  tmassv  164120000
20516067  1.0  tmassv  164130000  1.0  tmassv  164140000
*
20516070  mass166  sum  1.0  0.0  1
20516071  0.0  1.0  tmassv  166010000  1.0  tmassv  166020000
20516072  1.0  tmassv  166030000  1.0  tmassv  166040000
20516073  1.0  tmassv  166050000  1.0  tmassv  166060000
20516074  1.0  tmassv  166070000  1.0  tmassv  166080000
20516075  1.0  tmassv  166090000  1.0  tmassv  166100000
20516076  1.0  tmassv  166110000  1.0  tmassv  166120000
20516077  1.0  tmassv  166130000  1.0  tmassv  166140000
*
20516080  masscore  sum  1.0  0.0  1
20516081  0.0  1.0  cntrlvar  1601  1.0  cntrlvar  1602
20516082  1.0  cntrlvar  1603  1.0  cntrlvar  1604
20516083  1.0  cntrlvar  1605  1.0  cntrlvar  1606
20516084  1.0  cntrlvar  1607
*
20516090  mass115  sum  1.0  0.0  1
20516091  0.0  1.0  tmassv  115010000  1.0  tmassv  115020000
20516092  1.0  tmassv  115030000  1.0  tmassv  115040000
20516093  1.0  tmassv  115050000  1.0  tmassv  115060000
20516094  1.0  tmassv  115070000  1.0  tmassv  115080000
20516095  1.0  tmassv  115090000  1.0  tmassv  115100000
```

```
20516096  1.0  tmassv  115110000  1.0  tmassv  115120000
20516097  1.0  tmassv  115130000  1.0  tmassv  115140000
20516098  1.0  tmassv  115150000
*
20516100  massrv1  sum  1.0  0.0  1
20516101  0.0  1.0  tmassv  100010000  1.0  tmassv  105010000
20516102  1.0  tmassv  105020000  1.0  tmassv  110010000
20516103  1.0  tmassv  120010000  1.0  tmassv  175010000
*
20516110  massRV  sum  1.0  0.0  1
20516111  0.0  1.0  cntrlvar  1608  1.0  cntrlvar  1609
20516112  1.0  cntrlvar  1610
*
20516150  masshleg  sum  1.0  0.0  1
20516151  0.0  1.0  tmassv  200010000  1.0  tmassv  200020000
20516152  1.0  tmassv  200030000  1.0  tmassv  200040000
20516153  1.0  tmassv  200050000  1.0  tmassv  200060000
20516154  1.0  tmassv  215010000
*
20516160  massSGp  sum  1.0  0.0  1
20516161  0.0  1.0  tmassv  220010000  1.0  tmassv  228010000
20516162  1.0  tmassv  225010000  1.0  tmassv  225020000
20516163  1.0  tmassv  225030000  1.0  tmassv  225040000
20516164  1.0  tmassv  225050000  1.0  tmassv  225060000
20516165  1.0  tmassv  225070000  1.0  tmassv  225080000
20516166  1.0  tmassv  225090000  1.0  tmassv  225100000
20516167  1.0  tmassv  225110000  1.0  tmassv  225120000
20516168  1.0  tmassv  225130000  1.0  tmassv  225140000
+  1.0  tmassv  225150000  1.0  tmassv  225160000
+  1.0  tmassv  225170000  1.0  tmassv  225180000
+  1.0  tmassv  225190000  1.0  tmassv  225200000
+  1.0  tmassv  225210000  1.0  tmassv  225220000
*
20516170  masscleg  sum  1.0  0.0  1
20516171  0.0  1.0  tmassv  230010000  1.0  tmassv  235010000
20516172  1.0  tmassv  240010000  1.0  tmassv  250010000
20516173  1.0  tmassv  250020000  1.0  tmassv  250030000
20516174  1.0  tmassv  260010000  1.0  tmassv  270010000
20516175  1.0  tmassv  270020000  1.0  tmassv  270030000
20516176  1.0  tmassv  270040000  1.0  tmassv  293010000
*
20516180  massloop  sum  1.0  0.0  1
20516181  0.0  1.0  cntrlvar  1615  1.0  cntrlvar  1616
20516182  1.0  cntrlvar  1617
*
20516190  massPCS  sum  1.0  0.0  1
20516191  0.0  1.0  cntrlvar  1611  1.0  cntrlvar  1618
*
20516210  massRCST  sum  1.0  0.0  1
20516211  0.0  1.0  tmassv  210010000  1.0  tmassv  258010000
20516212  1.0  tmassv  280010000  1.0  tmassv  280020000
* replace the card above with the one below when using the single-volume RCST
*20516212  1.0  tmassv  280010000
*
20516260  massSGs  sum  1.0  0.0  1
20516261  0.0  1.0  tmassv  340010000  1.0  tmassv  340020000
20516262  1.0  tmassv  340030000  1.0  tmassv  340040000
20516263  1.0  tmassv  340050000  1.0  tmassv  340060000
20516264  1.0  tmassv  340070000  1.0  tmassv  340080000
20516265  1.0  tmassv  340090000  1.0  tmassv  340100000
20516266  1.0  tmassv  340110000  1.0  tmassv  350010000
20516267  1.0  tmassv  350020000  1.0  tmassv  350030000
20516268  1.0  tmassv  350040000  1.0  tmassv  350050000
```

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+  1.0  tmassv  350060000  1.0  tmassv  350070000
+  1.0  tmassv  350080000  1.0  tmassv  350090000
+  1.0  tmassv  350100000  1.0  tmassv  350110000
+  1.0  tmassv  350120000  1.0  tmassv  350130000
+  1.0  tmassv  355010000  1.0  tmassv  360010000
*
20516270  massSCS  sum  1.0  0.0  1
20516271  0.0  1.0  cntrlvar  1626  1.0  tmassv  330010000
20516272  1.0  tmassv  365010000  1.0  tmassv  390010000
*
20516310  mass950  sum  1.0  0.0  1
20516311  0.0  1.0  tmassv  950010000  1.0  tmassv  950020000
20516312  1.0  tmassv  950030000  1.0  tmassv  950040000
20516313  1.0  tmassv  950050000  1.0  tmassv  950060000
20516314  1.0  tmassv  950070000  1.0  tmassv  950080000
20516315  1.0  tmassv  950090000  1.0  tmassv  950100000
20516316  1.0  tmassv  950110000  1.0  tmassv  950120000
20516317  1.0  tmassv  950130000  1.0  tmassv  950140000
20516318  1.0  tmassv  950150000  1.0  tmassv  950160000
+  1.0  tmassv  950170000  1.0  tmassv  950180000
+  1.0  tmassv  950190000
*
20516320  massRCCS  sum  1.0  0.0  1
20516321  0.0  1.0  cntrlvar  1631  1.0  tmassv  930010000
20516322  1.0  tmassv  940010000  1.0  tmassv  945010000
20516323  1.0  tmassv  955010000  1.0  tmassv  960010000
*
20516360  mass450  sum  1.0  0.0  1
20516361  0.0  1.0  tmassv  450010000  1.0  tmassv  450020000
20516362  1.0  tmassv  450030000  1.0  tmassv  450040000
20516363  1.0  tmassv  450050000  1.0  tmassv  450060000
*
20516370  massPWS  sum  1.0  0.0  1
20516371  0.0  1.0  cntrlvar  1636  1.0  tmassv  420010000
20516372  1.0  tmassv  460010000  1.0  tmassv  490010000
*
20516400  massWS  sum  1.0  0.0  1
20516401  0.0  1.0  cntrlvar  1627  1.0  cntrlvar  1632
20516402  1.0  cntrlvar  1637
*
* variables for scaling assessments
*
20520010  ch115dp  sum  1.0  0.0  1
20520011  0.0  1.0  p  115010000  -1.0  p  115140000
*
20520020  ch115pav  sum  1.0  0.0  1
20520021  0.0  0.5  p  115010000  0.5  p  115140000
*
20520030  ch115dt  sum  1.0  0.0  1
20520031  0.0  1.0  tempg  115140000  -1.0  tempg  115010000
*
20520040  ch115tav  sum  1.0  0.0  1
20520041  0.0  0.5  tempg  115140000  0.5  tempg  115010000
*
20520050  ch115rhv  sum  1.0  0.0  1
20520051  0.0  0.5  rhog  115140000  0.5  rhog  115010000
*
20520060  ch115Cpt  mult  1.0  0.0  1
20520061  csubpg  115010000
*
20520070  ch115Cpb  mult  1.0  0.0  1
20520071  csubpg  115140000
*
```

```
20520080  ch115Cpa  sum  1.0  0.0  1
20520081  0.0  0.5  csubpg  115140000  0.5  csubpg  115010000
*
20520090  ch115vsm  mult  1.0  1.0E-05  1
20520091  viscg  115080000
*
20520100  ch115ivs  div  1.0  1.0E+05  1
20520101  viscg  115080000
*
20520110  ch115Bm  mult  1.0  0.0  1
20520111  betagg  115080000
*
20520120  ch115Cpm  mult  1.0  0.0  1
20520121  csubpg  115080000
*
20520130  ch115tcm  mult  1.0  0.0  1
20520131  thcong  115080000
*
20520140  ch115itc  div  1.0  0.0  1
20520141  thcong  115080000
*
20520150  ch115dTw  sum  1.0  0.0  1
20520151  0.0  1.0  httemp  115001005  -1.0  tempg  115100000
*
20520160  ch115Gm  mult  1.0  0.0  1
20520161  rhog  115080000  velg  115080000
*
20520170  ch115Re  mult  0.11430  0.0  1
20520171  cntrlvar  2016  cntrlvar  2010
*
20520180  ch115Nu  mult  0.11430  0.0  1
20520181  hthtc  115001001  cntrlvar  2014
*
20520190  ch115Pr  mult  1.0  0.0  1
20520191  csubpg  115080000  viscg  115080000  cntrlvar  2014
*
20520200  ch115Gr  mult  394.55  0.0  1
20520201  betagg  115080000  cntrlvar  2015  rhog  115080000
20520202  rhog  115080000  cntrlvar  2010  cntrlvar  2010
*
20520210  ch115Fr  poweri  0.8927  0.0  1
20520211  velg  115080000  2
*
20520220  ch115q-1  mult  1.0  0.0  1
20520221  betagg  115080000  htrnr  115001001
*
20520230  ch115q-2  mult  1.0  0.0  1
20520231  cntrlvar  2016  csubpg  115080000
*
20520240  ch115q+  div  1.0  0.0  1
20520241  cntrlvar  2023  cntrlvar  2022
*
20520250  ch115Kv  div  4.0  0.0  1
20520251  cntrlvar  2017  cntrlvar  2024
*
20520260  ch115Re2  poweri  1.0  0.0  1
20520261  cntrlvar  2017  2
*
20520270  ch115Ri  div  1.0  0.0  1
20520271  cntrlvar  2026  cntrlvar  2020
*
20520280  ch115B01  powerr  1.0  0.0  1
20520281  cntrlvar  2026  1.7125
```

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*
20520290  ch115B02  powerr  1.0  0.0  1
20520291  cntrlvar  2019  0.8
*
20520300  ch115B03  mult  1.0  0.0  1
20520301  cntrlvar  2028  cntrlvar  2029
*
20520310  ch115Bo  div  1.0  0.0  1
20520311  cntrlvar  2030  cntrlvar  2020
*
20520510  ch132dp  sum  1.0  0.0  1
20520511  0.0  1.0  p  132020000  -1.0  p  132130000
*
20520520  ch132pav  sum  1.0  0.0  1
20520521  0.0  0.5  p  132020000  0.5  p  132130000
*
20520530  ch132dt  sum  1.0  0.0  1
20520531  0.0  1.0  tempg  132130000  -1.0  tempg  132020000
*
20520540  ch132tav  sum  1.0  0.0  1
20520541  0.0  0.5  tempg  132130000  0.5  tempg  132020000
*
20520550  ch132rhv  sum  1.0  0.0  1
20520551  0.0  0.5  rhog  132130000  0.5  rhog  132020000
*
20520560  ch132Cpt  mult  1.0  0.0  1
20520561  csubpg  132020000
*
20520570  ch132Cpb  mult  1.0  0.0  1
20520571  csubpg  132130000
*
20520580  ch132Cpa  sum  1.0  0.0  1
20520581  0.0  0.5  csubpg  132130000  0.5  csubpg  132020000
*
20520590  ch132vsm  mult  1.0  1.0E-05  1
20520591  viscg  132080000
*
20520600  ch132ivs  div  1.0  1.0E+05  1
20520601  viscg  132080000
*
20520610  ch132Bm  mult  1.0  0.0  1
20520611  betagg  132080000
*
20520620  ch132Cpm  mult  1.0  0.0  1
20520621  csubpg  132080000
*
20520630  ch132tcm  mult  1.0  0.0  1
20520631  thcong  132080000
*
20520640  ch132itc  div  1.0  0.0  1
20520641  thcong  132080000
*
20520650  ch132dTw  sum  1.0  0.0  1
20520651  0.0  1.0  httemp  132000801  -1.0  tempg  132080000
*
20520660  ch132Gm  mult  1.0  0.0  1
20520661  rhog  132080000  velg  132080000
*
20520670  ch132Re  mult  0.0191  0.0  1
20520671  cntrlvar  2066  cntrlvar  2060
*
20520680  ch132Nu  mult  0.0191  0.0  1
20520681  hthtc  132000800  cntrlvar  2064
```

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*
20520690  ch132Pr  mult  1.0  0.0  1
20520691  csubpg  132080000  viscg  132080000  cntrlvar  2064
*
20520700  ch132Gr  mult  76.21  0.0  1
20520701  betagg  132080000  cntrlvar  2065  rhog  132080000
20520702  rhog  132080000  cntrlvar  2060  cntrlvar  2060
*
20520710  ch132Fr  poweri  5.3565  0.0  1
20520711  velg  132080000  2
*
20520720  ch132q-1  mult  1.0  0.0  1
20520721  betagg  132080000  htrnr  132000800
*
20520730  ch132q-2  mult  1.0  0.0  1
20520731  cntrlvar  2066  csubpg  132080000
*
20520740  ch132q+  div  1.0  0.0  1
20520741  cntrlvar  2073  cntrlvar  2072
*
20520750  ch132Kv  div  4.0  0.0  1
20520751  cntrlvar  2067  cntrlvar  2074
*
20520760  ch132Re2  poweri  1.0  0.0  1
20520761  cntrlvar  2067  2
*
20520770  ch132Ri  div  1.0  0.0  1
20520771  cntrlvar  2076  cntrlvar  2070
*
20520780  ch132B01  powerr  1.0  0.0  1
20520781  cntrlvar  2076  1.7125
*
20520790  ch132B02  powerr  1.0  0.0  1
20520791  cntrlvar  2069  0.8
*
20520800  ch132B03  mult  1.0  0.0  1
20520801  cntrlvar  2078  cntrlvar  2079
*
20520810  ch132Bo  div  1.0  0.0  1
20520811  cntrlvar  2080  cntrlvar  2070
*
20521010  ch140dp  sum  1.0  0.0  1
20521011  0.0  1.0  p  140020000  -1.0  p  140130000
*
20521020  ch140pav  sum  1.0  0.0  1
20521021  0.0  0.5  p  140020000  0.5  p  140130000
*
20521030  ch140dt  sum  1.0  0.0  1
20521031  0.0  1.0  tempg  140130000  -1.0  tempg  140020000
*
20521040  ch140tav  sum  1.0  0.0  1
20521041  0.0  0.5  tempg  140130000  0.5  tempg  140020000
*
20521050  ch140rhv  sum  1.0  0.0  1
20521051  0.0  0.5  rhog  140130000  0.5  rhog  140020000
*
20521060  ch140Cpt  mult  1.0  0.0  1
20521061  csubpg  140020000
*
20521070  ch140Cpb  mult  1.0  0.0  1
20521071  csubpg  140130000
*
20521080  ch140Cpa  sum  1.0  0.0  1
```

```
20521081  0.0  0.5  csubpg  140130000  0.5  csubpg  140020000
*
20521090  ch140vsm  mult  1.0  1.0E-05  1
20521091  viscg  140080000
*
20521100  ch140ivs  div  1.0  1.0E+05  1
20521101  viscg  140080000
*
20521110  ch140Bm  mult  1.0  0.0  1
20521111  betagg  140080000
*
20521120  ch140Cpm  mult  1.0  0.0  1
20521121  csubpg  140080000
*
20521130  ch140tcm  mult  1.0  0.0  1
20521131  thcong  140080000
*
20521140  ch140itc  div  1.0  0.0  1
20521141  thcong  140080000
*
20521150  ch140dTw  sum  1.0  0.0  1
20521151  0.0  1.0  httemp  140100601  -1.0  tempg  140080000
*
20521160  ch140Gm  mult  1.0  0.0  1
20521161  rhog  140080000  velg  140080000
*
20521170  ch140Re  mult  0.015  0.0  1
20521171  cntrlvar  2116  cntrlvar  2110
*
20521180  ch140Nu  mult  0.015  0.0  1
20521181  hthtc  140100600  cntrlvar  2114
*
20521190  ch140Pr  mult  1.0  0.0  1
20521191  csubpg  140080000  viscg  140080000  cntrlvar  2114
*
20521200  ch140Gr  mult  76.21  0.0  1
20521201  betagg  140080000  cntrlvar  2115  rhog  140080000
20521202  rhog  140080000  cntrlvar  2110  cntrlvar  2110
*
20521210  ch140Fr  poweri  6.8027  0.0  1
20521211  velg  140080000  2
*
20521220  ch140q-1  mult  1.0  0.0  1
20521221  betagg  140080000  htrnr  140100600
*
20521230  ch140q-2  mult  1.0  0.0  1
20521231  cntrlvar  2116  csubpg  140080000
*
20521240  ch140q+  div  1.0  0.0  1
20521241  cntrlvar  2123  cntrlvar  2122
*
20521250  ch140Kv  div  4.0  0.0  1
20521251  cntrlvar  2117  cntrlvar  2124
*
20521260  ch140Re2  poweri  1.0  0.0  1
20521261  cntrlvar  2117  2
*
20521270  ch140Ri  div  1.0  0.0  1
20521271  cntrlvar  2126  cntrlvar  2120
*
20521280  ch140B01  powerr  1.0  0.0  1
20521281  cntrlvar  2126  1.7125
*
```

```
20521290  ch140B02  powerr  1.0  0.0  1
20521291  cntrlvar  2119  0.8
*
20521300  ch140B03  mult  1.0  0.0  1
20521301  cntrlvar  2128  cntrlvar  2129
*
20521310  ch140Bo  div  1.0  0.0  1
20521311  cntrlvar  2130  cntrlvar  2120
*
20521510  ch145dp  sum  1.0  0.0  1
20521511  0.0  1.0  p  145020000  -1.0  p  145130000
*
20521520  ch145pav  sum  1.0  0.0  1
20521521  0.0  0.5  p  145020000  0.5  p  145130000
*
20521530  ch145dt  sum  1.0  0.0  1
20521531  0.0  1.0  tempg  145130000  -1.0  tempg  145020000
*
20521540  ch145tav  sum  1.0  0.0  1
20521541  0.0  0.5  tempg  145130000  0.5  tempg  145020000
*
20521550  ch145rhv  sum  1.0  0.0  1
20521551  0.0  0.5  rhog  145130000  0.5  rhog  145020000
*
20521560  ch145Cpt  mult  1.0  0.0  1
20521561  csubpg  145020000
*
20521570  ch145Cpb  mult  1.0  0.0  1
20521571  csubpg  145130000
*
20521580  ch145Cpa  sum  1.0  0.0  1
20521581  0.0  0.5  csubpg  145130000  0.5  csubpg  145020000
*
20521590  ch145vsm  mult  1.0  1.0E-05  1
20521591  viscg  145080000
*
20521600  ch145ivs  div  1.0  1.0E+05  1
20521601  viscg  145080000
*
20521610  ch145Bm  mult  1.0  0.0  1
20521611  betagg  145080000
*
20521620  ch145Cpm  mult  1.0  0.0  1
20521621  csubpg  145080000
*
20521630  ch145tcm  mult  1.0  0.0  1
20521631  thcong  145080000
*
20521640  ch145itc  div  1.0  0.0  1
20521641  thcong  145080000
*
20521650  ch145dTw  sum  1.0  0.0  1
20521651  0.0  1.0  httemp  145100601  -1.0  tempg  145080000
*
20521660  ch145Gm  mult  1.0  0.0  1
20521661  rhog  145080000  velg  145080000
*
20521670  ch145Re  mult  0.016  0.0  1
20521671  cntrlvar  2166  cntrlvar  2160
*
20521680  ch145Nu  mult  0.016  0.0  1
20521681  hthtc  145100600  cntrlvar  2164
*
```

```
20521690  ch145Pr  mult  1.0  0.0  1
20521691  csubpg  145080000  viscg  145080000  cntrlvar  2164
*
20521700  ch145Gr  mult  76.21  0.0  1
20521701  betagg  145080000  cntrlvar  2165  rhog  145080000
20521702  rhog  145080000  cntrlvar  2160  cntrlvar  2160
*
20521710  ch145Fr  poweri  6.4278  0.0  1
20521711  velg  145080000  2
*
20521720  ch145q-1  mult  1.0  0.0  1
20521721  betagg  145080000  htrnr  145100600
*
20521730  ch145q-2  mult  1.0  0.0  1
20521731  cntrlvar  2166  csubpg  145080000
*
20521740  ch145q+  div  1.0  0.0  1
20521741  cntrlvar  2173  cntrlvar  2172
*
20521750  ch145Kv  div  4.0  0.0  1
20521751  cntrlvar  2167  cntrlvar  2174
*
20521760  ch145Re2  poweri  1.0  0.0  1
20521761  cntrlvar  2167  2
*
20521770  ch145Ri  div  1.0  0.0  1
20521771  cntrlvar  2176  cntrlvar  2170
*
20521780  ch145B01  powerr  1.0  0.0  1
20521781  cntrlvar  2176  1.7125
*
20521790  ch145B02  powerr  1.0  0.0  1
20521791  cntrlvar  2169  0.8
*
20521800  ch145B03  mult  1.0  0.0  1
20521801  cntrlvar  2178  cntrlvar  2179
*
20521810  ch145Bo  div  1.0  0.0  1
20521811  cntrlvar  2180  cntrlvar  2170
*
20522010  ch150dp  sum  1.0  0.0  1
20522011  0.0  1.0  p  150020000  -1.0  p  150130000
*
20522020  ch150pav  sum  1.0  0.0  1
20522021  0.0  0.5  p  150020000  0.5  p  150130000
*
20522030  ch150dt  sum  1.0  0.0  1
20522031  0.0  1.0  tempg  150130000  -1.0  tempg  150020000
*
20522040  ch150tav  sum  1.0  0.0  1
20522041  0.0  0.5  tempg  150130000  0.5  tempg  150020000
*
20522050  ch150rhv  sum  1.0  0.0  1
20522051  0.0  0.5  rhog  150130000  0.5  rhog  150020000
*
20522060  ch150Cpt  mult  1.0  0.0  1
20522061  csubpg  150020000
*
20522070  ch150Cpb  mult  1.0  0.0  1
20522071  csubpg  150130000
*
20522080  ch150Cpa  sum  1.0  0.0  1
20522081  0.0  0.5  csubpg  150130000  0.5  csubpg  150020000
```

```
*
20522090  ch150vsm  mult  1.0  1.0E-05  1
20522091  viscg  150080000
*
20522100  ch150ivs  div  1.0  1.0E+05  1
20522101  viscg  150080000
*
20522110  ch150Bm  mult  1.0  0.0  1
20522111  betagg  150080000
*
20522120  ch150Cpm  mult  1.0  0.0  1
20522121  csubpg  150080000
*
20522130  ch150tcm  mult  1.0  0.0  1
20522131  thcong  150080000
*
20522140  ch150itc  div  1.0  0.0  1
20522141  thcong  150080000
*
20522150  ch150dTw  sum  1.0  0.0  1
20522151  0.0  1.0  httemp  150100601  -1.0  tempg  150080000
*
20522160  ch150Gm  mult  1.0  0.0  1
20522161  rhog  150080000  velg  150080000
*
20522170  ch150Re  mult  0.0144  0.0  1
20522171  cntrlvar  2216  cntrlvar  2210
*
20522180  ch150Nu  mult  0.0144  0.0  1
20522181  hthtc  150100600  cntrlvar  2214
*
20522190  ch150Pr  mult  1.0  0.0  1
20522191  csubpg  150080000  viscg  150080000  cntrlvar  2214
*
20522200  ch150Gr  mult  76.21  0.0  1
20522201  betagg  150080000  cntrlvar  2215  rhog  150080000
20522202  rhog  150080000  cntrlvar  2210  cntrlvar  2210
*
20522210  ch150Fr  poweri  7.0862  0.0  1
20522211  velg  150080000  2
*
20522220  ch150q-1  mult  1.0  0.0  1
20522221  betagg  150080000  htrnr  150100600
*
20522230  ch150q-2  mult  1.0  0.0  1
20522231  cntrlvar  2216  csubpg  150080000
*
20522240  ch150q+  div  1.0  0.0  1
20522241  cntrlvar  2223  cntrlvar  2222
*
20522250  ch150Kv  div  4.0  0.0  1
20522251  cntrlvar  2217  cntrlvar  2224
*
20522260  ch150Re2  poweri  1.0  0.0  1
20522261  cntrlvar  2217  2
*
20522270  ch150Ri  div  1.0  0.0  1
20522271  cntrlvar  2226  cntrlvar  2220
*
20522280  ch150B01  powerr  1.0  0.0  1
20522281  cntrlvar  2226  1.7125
*
20522290  ch150B02  powerr  1.0  0.0  1
```

```
20522291  cntrlvar  2219  0.8
*
20522300  ch150B03  mult  1.0  0.0  1
20522301  cntrlvar  2228  cntrlvar  2229
*
20522310  ch150Bo  div  1.0  0.0  1
20522311  cntrlvar  2230  cntrlvar  2220
*
20522510  ch162dp  sum  1.0  0.0  1
20522511  0.0  1.0  p  162020000  -1.0  p  162130000
*
20522520  ch162pav  sum  1.0  0.0  1
20522521  0.0  0.5  p  162020000  0.5  p  162130000
*
20522530  ch162dt  sum  1.0  0.0  1
20522531  0.0  1.0  tempg  162130000  -1.0  tempg  162020000
*
20522540  ch162tav  sum  1.0  0.0  1
20522541  0.0  0.5  tempg  162130000  0.5  tempg  162020000
*
20522550  ch162rhv  sum  1.0  0.0  1
20522551  0.0  0.5  rhog  162130000  0.5  rhog  162020000
*
20522560  ch162Cpt  mult  1.0  0.0  1
20522561  csubpg  162020000
*
20522570  ch162Cpb  mult  1.0  0.0  1
20522571  csubpg  162130000
*
20522580  ch162Cpa  sum  1.0  0.0  1
20522581  0.0  0.5  csubpg  162130000  0.5  csubpg  162020000
*
20522590  ch162vsm  mult  1.0  1.0E-05  1
20522591  viscg  162080000
*
20522600  ch162ivs  div  1.0  1.0E+05  1
20522601  viscg  162080000
*
20522610  ch162Bm  mult  1.0  0.0  1
20522611  betagg  162080000
*
20522620  ch162Cpm  mult  1.0  0.0  1
20522621  csubpg  162080000
*
20522630  ch162tcm  mult  1.0  0.0  1
20522631  thcong  162080000
*
20522640  ch162itc  div  1.0  0.0  1
20522641  thcong  162080000
*
20522650  ch162dTw  sum  1.0  0.0  1
20522651  0.0  1.0  httemp  162000801  -1.0  tempg  162080000
*
20522660  ch162Gm  mult  1.0  0.0  1
20522661  rhog  162080000  velg  162080000
*
20522670  ch162Re  mult  0.015875  0.0  1
20522671  cntrlvar  2266  cntrlvar  2260
*
20522680  ch162Nu  mult  0.015875  0.0  1
20522681  hthtc  162000800  cntrlvar  2264
*
20522690  ch162Pr  mult  1.0  0.0  1
```

```
20522691  csubpg  162080000  viscg  162080000  cntrlvar  2264
*
20522700  ch162Gr  mult  76.21  0.0  1
20522701  betagg  162080000  cntrlvar  2265  rhog  162080000
20522702  rhog  162080000  cntrlvar  2260  cntrlvar  2260
*
20522710  ch162Fr  poweri  6.4278  0.0  1
20522711  velg  162080000  2
*
20522720  ch162q-1  mult  1.0  0.0  1
20522721  betagg  162080000  htrnr  162000800
*
20522730  ch162q-2  mult  1.0  0.0  1
20522731  cntrlvar  2266  csubpg  162080000
*
20522740  ch162q+  div  1.0  0.0  1
20522741  cntrlvar  2273  cntrlvar  2272
*
20522750  ch162Kv  div  4.0  0.0  1
20522751  cntrlvar  2267  cntrlvar  2274
*
20522760  ch162Re2  poweri  1.0  0.0  1
20522761  cntrlvar  2267  2
*
20522770  ch162Ri  div  1.0  0.0  1
20522771  cntrlvar  2276  cntrlvar  2270
*
20522780  ch162B01  powerr  1.0  0.0  1
20522781  cntrlvar  2276  1.7125
*
20522790  ch162B02  powerr  1.0  0.0  1
20522791  cntrlvar  2269  0.8
*
20522800  ch162B03  mult  1.0  0.0  1
20522801  cntrlvar  2278  cntrlvar  2279
*
20522810  ch162Bo  div  1.0  0.0  1
20522811  cntrlvar  2280  cntrlvar  2270
*
20523010  ch164dp  sum  1.0  0.0  1
20523011  0.0  1.0  p  164020000  -1.0  p  164130000
*
20523020  ch164pav  sum  1.0  0.0  1
20523021  0.0  0.5  p  164020000  0.5  p  164130000
*
20523030  ch164dt  sum  1.0  0.0  1
20523031  0.0  1.0  tempg  164130000  -1.0  tempg  164020000
*
20523040  ch164tav  sum  1.0  0.0  1
20523041  0.0  0.5  tempg  164130000  0.5  tempg  164020000
*
20523050  ch164rhv  sum  1.0  0.0  1
20523051  0.0  0.5  rhog  164130000  0.5  rhog  164020000
*
20523060  ch164Cpt  mult  1.0  0.0  1
20523061  csubpg  164020000
*
20523070  ch164Cpb  mult  1.0  0.0  1
20523071  csubpg  164130000
*
20523080  ch164Cpa  sum  1.0  0.0  1
20523081  0.0  0.5  csubpg  164130000  0.5  csubpg  164020000
*
```

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20523090  ch164vsm  mult  1.0  1.0E-05  1
20523091  viscg  164080000
*
20523100  ch164ivs  div  1.0  1.0E+05  1
20523101  viscg  164080000
*
20523110  ch164Bm  mult  1.0  0.0  1
20523111  betagg  164080000
*
20523120  ch164Cpm  mult  1.0  0.0  1
20523121  csubpg  164080000
*
20523130  ch164tcm  mult  1.0  0.0  1
20523131  thcong  164080000
*
20523140  ch164itc  div  1.0  0.0  1
20523141  thcong  164080000
*
20523150  ch164dTw  sum  1.0  0.0  1
20523151  0.0  1.0  httemp  164000807  -1.0  tempg  164080000
*
20523160  ch164Gm  mult  1.0  0.0  1
20523161  rhog  164080000  velg  164080000
*
20523170  ch164Re  mult  0.0146304  0.0  1
20523171  cntrlvar  2316  cntrlvar  2310
*
20523180  ch164Nu  mult  0.0146304  0.0  1
20523181  hthtc  164000801  cntrlvar  2314
*
20523190  ch164Pr  mult  1.0  0.0  1
20523191  csubpg  164080000  viscg  164080000  cntrlvar  2314
*
20523200  ch164Gr  mult  76.21  0.0  1
20523201  betagg  164080000  cntrlvar  2315  rhog  164080000
20523202  rhog  164080000  cntrlvar  2310  cntrlvar  2310
*
20523210  ch164Fr  poweri  6.9746  0.0  1
20523211  velg  164080000  2
*
20523220  ch164q-1  mult  1.0  0.0  1
20523221  betagg  164080000  htrnr  164000801
*
20523230  ch164q-2  mult  1.0  0.0  1
20523231  cntrlvar  2316  csubpg  164080000
*
20523240  ch164q+  div  1.0  0.0  1
20523241  cntrlvar  2323  cntrlvar  2322
*
20523250  ch164Kv  div  4.0  0.0  1
20523251  cntrlvar  2317  cntrlvar  2324
*
20523260  ch164Re2  poweri  1.0  0.0  1
20523261  cntrlvar  2317  2
*
20523270  ch164Ri  div  1.0  0.0  1
20523271  cntrlvar  2326  cntrlvar  2320
*
20523280  ch164B01  powerr  1.0  0.0  1
20523281  cntrlvar  2326  1.7125
*
20523290  ch164B02  powerr  1.0  0.0  1
20523291  cntrlvar  2319  0.8
```

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*
20523300  ch164B03  mult  1.0  0.0  1
20523301  cntrlvar  2328  cntrlvar  2329
*
20523310  ch164Bo  div  1.0  0.0  1
20523311  cntrlvar  2330  cntrlvar  2320
*
20523510  ch166dp  sum  1.0  0.0  1
20523511  0.0  1.0  p  166020000  -1.0  p  166130000
*
20523520  ch166pav  sum  1.0  0.0  1
20523521  0.0  0.5  p  166020000  0.5  p  166130000
*
20523530  ch166dt  sum  1.0  0.0  1
20523531  0.0  1.0  tempg  166130000  -1.0  tempg  166020000
*
20523540  ch166tav  sum  1.0  0.0  1
20523541  0.0  0.5  tempg  166130000  0.5  tempg  166020000
*
20523550  ch166rhv  sum  1.0  0.0  1
20523551  0.0  0.5  rhog  166130000  0.5  rhog  166020000
*
20523560  ch166Cpt  mult  1.0  0.0  1
20523561  csubpg  166020000
*
20523570  ch166Cpb  mult  1.0  0.0  1
20523571  csubpg  166130000
*
20523580  ch166Cpa  sum  1.0  0.0  1
20523581  0.0  0.5  csubpg  166130000  0.5  csubpg  166020000
*
20523590  ch166vsm  mult  1.0  1.0E-05  1
20523591  viscg  166080000
*
20523600  ch166ivs  div  1.0  1.0E+05  1
20523601  viscg  166080000
*
20523610  ch166Bm  mult  1.0  0.0  1
20523611  betagg  166080000
*
20523620  ch166Cpm  mult  1.0  0.0  1
20523621  csubpg  166080000
*
20523630  ch166tcm  mult  1.0  0.0  1
20523631  thcong  166080000
*
20523640  ch166itc  div  1.0  0.0  1
20523641  thcong  166080000
*
20523650  ch166dTw  sum  1.0  0.0  1
20523651  0.0  1.0  httemp  166000807  -1.0  tempg  166080000
*
20523660  ch166Gm  mult  1.0  0.0  1
20523661  rhog  166080000  velg  166080000
*
20523670  ch166Re  mult  0.013  0.0  1
20523671  cntrlvar  2366  cntrlvar  2360
*
20523680  ch166Nu  mult  0.013  0.0  1
20523681  hthtc  166000801  cntrlvar  2364
*
20523690  ch166Pr  mult  1.0  0.0  1
20523691  csubpg  166080000  viscg  166080000  cntrlvar  2364
```

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*
20523700  ch166Gr  mult  76.21  0.0  1
20523701  betagg  166080000  cntrlvar  2365  rhog  166080000
20523702  rhog  166080000  cntrlvar  2360  cntrlvar  2360
*
20523710  ch166Fr  poweri  8.0187  0.0  1
20523711  velg  166080000  2
*
20523720  ch166q-1  mult  1.0  0.0  1
20523721  betagg  166080000  htrnr  166000801
*
20523730  ch166q-2  mult  1.0  0.0  1
20523731  cntrlvar  2366  csubpg  166080000
*
20523740  ch166q+  div  1.0  0.0  1
20523741  cntrlvar  2373  cntrlvar  2372
*
20523750  ch166Kv  div  4.0  0.0  1
20523751  cntrlvar  2367  cntrlvar  2374
*
20523760  ch166Re2  poweri  1.0  0.0  1
20523761  cntrlvar  2367  2
*
20523770  ch166Ri  div  1.0  0.0  1
20523771  cntrlvar  2376  cntrlvar  2370
*
20523780  ch166B01  powerr  1.0  0.0  1
20523781  cntrlvar  2376  1.7125
*
20523790  ch166B02  powerr  1.0  0.0  1
20523791  cntrlvar  2369  0.8
*
20523800  ch166B03  mult  1.0  0.0  1
20523801  cntrlvar  2378  cntrlvar  2379
*
20523810  ch166Bo  div  1.0  0.0  1
20523811  cntrlvar  2380  cntrlvar  2370
*
20524010  ch950dp  sum  1.0  0.0  1
20524011  0.0  1.0  p  950010000  -1.0  p  950190000
*
20524020  ch950pav  sum  1.0  0.0  1
20524021  0.0  0.5  p  950010000  0.5  p  950190000
*
20524030  ch950dt  sum  1.0  0.0  1
20524031  0.0  1.0  tempg  950190000  -1.0  tempg  950010000
*
20524040  ch950tav  sum  1.0  0.0  1
20524041  0.0  0.5  tempg  950190000  0.5  tempg  950010000
*
20524050  ch950rhv  sum  1.0  0.0  1
20524051  0.0  0.5  rhog  950190000  0.5  rhog  950010000
*
20524060  ch950Cpt  mult  1.0  0.0  1
20524061  csubpg  950010000
*
20524070  ch950Cpb  mult  1.0  0.0  1
20524071  csubpg  950190000
*
20524080  ch950Cpa  sum  1.0  0.0  1
20524081  0.0  0.5  csubpg  950190000  0.5  csubpg  950010000
*
20524090  ch950vsm  mult  1.0  1.0E-05  1
```

```
20524091  viscg  950100000
*
20524100  ch950ivs  div  1.0  1.0E+05  1
20524101  viscg  950100000
*
20524110  ch950Bm  mult  1.0  0.0  1
20524111  betagg  950100000
*
20524120  ch950Cpm  mult  1.0  0.0  1
20524121  csubpg  950100000
*
20524130  ch950tcm  mult  1.0  0.0  1
20524131  thcong  950100000
*
20524140  ch950itc  div  1.0  0.0  1
20524141  thcong  950100000
*
20524150  ch950dTw  sum  1.0  0.0  1
20524151  0.0  1.0  httemp  950001004  -1.0  tempg  950100000
*
20524160  ch950Gm  mult  1.0  0.0  1
20524161  rhog  950100000  velg  950100000
*
20524170  ch950Re  mult  0.0508  0.0  1
20524171  cntrlvar  2416  cntrlvar  2410
*
20524180  ch950Nu  mult  0.0508  0.0  1
20524181  hthtc  950001001  cntrlvar  2414
*
20524190  ch950Pr  mult  1.0  0.0  1
20524191  csubpg  950100000  viscg  950100000  cntrlvar  2414
*
20524200  ch950Gr  mult  1440.41  0.0  1
20524201  betagg  950100000  cntrlvar  2415  rhog  950100000
20524202  rhog  950100000  cntrlvar  2410  cntrlvar  2410
*
20524210  ch950Fr  poweri  2.0087  0.0  1
20524211  velg  950100000  2
*
20524220  ch950q-1  mult  1.0  0.0  1
20524221  betagg  950100000  htrnr  950001001
*
20524230  ch950q-2  mult  1.0  0.0  1
20524231  cntrlvar  2416  csubpg  950100000
*
20524240  ch950q+  div  1.0  0.0  1
20524241  cntrlvar  2423  cntrlvar  2422
*
20524250  ch950Kv  div  4.0  0.0  1
20524251  cntrlvar  2417  cntrlvar  2424
*
20524260  ch950Re2  poweri  1.0  0.0  1
20524261  cntrlvar  2417  2
*
20524270  ch950Ri  div  1.0  0.0  1
20524271  cntrlvar  2426  cntrlvar  2420
*
20524280  ch950B01  powerr  1.0  0.0  1
20524281  cntrlvar  2426  1.7125
*
20524290  ch950B02  powerr  1.0  0.0  1
20524291  cntrlvar  2419  0.8
*
```

```
20524300  ch950B03  mult  1.0  0.0  1
20524301  cntrlvar  2428  cntrlvar  2429
*
20524310  ch950Bo  div  1.0  0.0  1
20524311  cntrlvar  2430  cntrlvar  2420
*
* structure energy storage
*
20530010  hc100001  function  1.0E-06  0.0  1
20530011  htvat  1000001  3
*
20530020  es100001  mult  0.02156  0.0  1
20530021  htvat  1000001  cntrlvar  3001
*
20530030  hc100002  function  1.0E-06  0.0  1
20530031  htvat  1000002  3
*
20530040  es100002  mult  0.01464  0.0  1
20530041  htvat  1000002  cntrlvar  3003
*
20530050  hc100003  function  1.0E-06  0.0  1
20530051  htvat  1000003  3
*
20530060  es100003  mult  0.01656  0.0  1
20530061  htvat  1000003  cntrlvar  3005
*
20530070  hc100004  function  1.0E-06  0.0  1
20530071  htvat  1000004  3
*
20530080  es100004  mult  0.01656  0.0  1
20530081  htvat  1000004  cntrlvar  3007
*
20530090  hc100005  function  1.0E-06  0.0  1
20530091  htvat  1000005  3
*
20530100  es100005  mult  0.01305  0.0  1
20530101  htvat  1000005  cntrlvar  3009
*
20530110  hc100006  function  1.0E-06  0.0  1
20530111  htvat  1000006  3
*
20530120  es100006  mult  0.01305  0.0  1
20530121  htvat  1000006  cntrlvar  3011
*
20530130  hc100007  function  1.0E-06  0.0  1
20530131  htvat  1000007  3
*
20530140  es100007  mult  0.01305  0.0  1
20530141  htvat  1000007  cntrlvar  3013
*
20530150  hc100008  function  1.0E-06  0.0  1
20530151  htvat  1000008  3
*
20530160  es100008  mult  0.01305  0.0  1
20530161  htvat  1000008  cntrlvar  3015
*
20530170  hc100009  function  1.0E-06  0.0  1
20530171  htvat  1000009  3
*
20530180  es100009  mult  0.01305  0.0  1
20530181  htvat  1000009  cntrlvar  3017
*
20530190  hc100010  function  1.0E-06  0.0  1
```

```
20530191  htvat  1000010  3
*
20530200  es100010  mult  0.01305  0.0  1
20530201  htvat  1000010  cntrlvar  3019
*
20530210  hc100011  function  1.0E-06  0.0  1
20530211  htvat  1000011  3
*
20530220  es100011  mult  0.01305  0.0  1
20530221  htvat  1000011  cntrlvar  3021
*
20530230  hc100012  function  1.0E-06  0.0  1
20530231  htvat  1000012  3
*
20530240  es100012  mult  0.01305  0.0  1
20530241  htvat  1000012  cntrlvar  3023
*
20530250  hc100013  function  1.0E-06  0.0  1
20530251  htvat  1000013  3
*
20530260  es100013  mult  0.01305  0.0  1
20530261  htvat  1000013  cntrlvar  3025
*
20530270  hc100014  function  1.0E-06  0.0  1
20530271  htvat  1000014  3
*
20530280  es100014  mult  0.01305  0.0  1
20530281  htvat  1000014  cntrlvar  3027
*
20530290  hc100015  function  1.0E-06  0.0  1
20530291  htvat  1000015  3
*
20530300  es100015  mult  0.01255  0.0  1
20530301  htvat  1000015  cntrlvar  3029
*
20530310  hc100016  function  1.0E-06  0.0  1
20530311  htvat  1000016  3
*
20530320  es100016  mult  0.01339  0.0  1
20530321  htvat  1000016  cntrlvar  3031
*
20530330  hc100017  function  1.0E-06  0.0  1
20530331  htvat  1000017  3
*
20530340  es100017  mult  0.01800  0.0  1
20530341  htvat  1000017  cntrlvar  3033
*
20530350  hc100101  function  1.0E-06  0.0  1
20530351  htvat  1001001  3
*
20530360  es100101  mult  0.05438  0.0  1
20530361  htvat  1001001  cntrlvar  3035
*
20530380  es-pv  sum  1.0  0.0  1
20530381  0.0  1.0  cntrlvar  3002  1.0  cntrlvar  3004
20530382  1.0  cntrlvar  3006  1.0  cntrlvar  3008
20530383  1.0  cntrlvar  3010  1.0  cntrlvar  3012
20530384  1.0  cntrlvar  3014  1.0  cntrlvar  3016
20530385  1.0  cntrlvar  3018  1.0  cntrlvar  3020
20530386  1.0  cntrlvar  3022  1.0  cntrlvar  3024
20530387  1.0  cntrlvar  3026  1.0  cntrlvar  3028
20530388  1.0  cntrlvar  3030  1.0  cntrlvar  3032
+  1.0  cntrlvar  3034  1.0  cntrlvar  3036
```

```
*
20530410  hc105001  function  1.0E-06  0.0  1
20530411  htvat  1050001  3
*
20530420  es105001  mult  0.02046  0.0  1
20530421  htvat  1050001  cntrlvar  3041
*
20530430  hc110001  function  1.0E-06  0.0  1
20530431  htvat  1100001  3
*
20530440  es110001  mult  0.00946  0.0  1
20530441  htvat  1100001  cntrlvar  3043
*
20530490  hc115001  function  1.0E-06  0.0  1
20530491  htvat  1150001  3
*
20530500  es115001  mult  0.00744  0.0  1
20530501  htvat  1150001  cntrlvar  3049
*
20530510  hc115002  function  1.0E-06  0.0  1
20530511  htvat  1150002  3
*
20530520  es115002  mult  0.00505  0.0  1
20530521  htvat  1150002  cntrlvar  3051
*
20530530  hc115003  function  1.0E-06  0.0  1
20530531  htvat  1150003  3
*
20530540  es115003  mult  0.00572  0.0  1
20530541  htvat  1150003  cntrlvar  3053
*
20530550  hc115004  function  1.0E-06  0.0  1
20530551  htvat  1150004  3
*
20530560  es115004  mult  0.00572  0.0  1
20530561  htvat  1150004  cntrlvar  3055
*
20530570  hc115005  function  1.0E-06  0.0  1
20530571  htvat  1150005  3
*
20530580  es115005  mult  0.00450  0.0  1
20530581  htvat  1150005  cntrlvar  3057
*
20530590  hc115006  function  1.0E-06  0.0  1
20530591  htvat  1150006  3
*
20530600  es115006  mult  0.00450  0.0  1
20530601  htvat  1150006  cntrlvar  3059
*
20530610  hc115007  function  1.0E-06  0.0  1
20530611  htvat  1150007  3
*
20530620  es115007  mult  0.00450  0.0  1
20530621  htvat  1150007  cntrlvar  3061
*
20530630  hc115008  function  1.0E-06  0.0  1
20530631  htvat  1150008  3
*
20530640  es115008  mult  0.00450  0.0  1
20530641  htvat  1150008  cntrlvar  3063
*
20530650  hc115009  function  1.0E-06  0.0  1
20530651  htvat  1150009  3
```

```
*
20530660  es115009  mult  0.00450  0.0  1
20530661  htvat  1150009  cntrlvar  3065
*
20530670  hc115010  function  1.0E-06  0.0  1
20530671  htvat  1150010  3
*
20530680  es115010  mult  0.00450  0.0  1
20530681  htvat  1150010  cntrlvar  3067
*
20530690  hc115011  function  1.0E-06  0.0  1
20530691  htvat  1150011  3
*
20530700  es115011  mult  0.00450  0.0  1
20530701  htvat  1150011  cntrlvar  3069
*
20530710  hc115012  function  1.0E-06  0.0  1
20530711  htvat  1150012  3
*
20530720  es115012  mult  0.00450  0.0  1
20530721  htvat  1150012  cntrlvar  3071
*
20530730  hc115013  function  1.0E-06  0.0  1
20530731  htvat  1150013  3
*
20530740  es115013  mult  0.00450  0.0  1
20530741  htvat  1150013  cntrlvar  3073
*
20530750  hc115014  function  1.0E-06  0.0  1
20530751  htvat  1150014  3
*
20530760  es115014  mult  0.00529  0.0  1
20530761  htvat  1150014  cntrlvar  3075
*
20530770  hc115015  function  1.0E-06  0.0  1
20530771  htvat  1150015  3
*
20530780  es115015  mult  0.00433  0.0  1
20530781  htvat  1150015  cntrlvar  3077
*
20530790  hc115016  function  1.0E-06  0.0  1
20530791  htvat  1150016  3
*
20530800  es115016  mult  0.00433  0.0  1
20530801  htvat  1150016  cntrlvar  3079
*
20530810  es-cbarl  sum  1.0  0.0  1
20530811  0.0  1.0  cntrlvar  3050  1.0  cntrlvar  3052
20530812  1.0  cntrlvar  3054  1.0  cntrlvar  3056
20530813  1.0  cntrlvar  3058  1.0  cntrlvar  3060
20530814  1.0  cntrlvar  3062  1.0  cntrlvar  3064
20530815  1.0  cntrlvar  3066  1.0  cntrlvar  3068
20530816  1.0  cntrlvar  3070  1.0  cntrlvar  3072
20530817  1.0  cntrlvar  3074  1.0  cntrlvar  3076
20530818  1.0  cntrlvar  3078  1.0  cntrlvar  3080
*
20530830  hc120001  function  1.0E-06  0.0  1
20530831  htvat  1200001  4
*
20530840  es120001  mult  0.00399  0.0  1
20530841  htvat  1200001  cntrlvar  3083
*
20530850  hc120101  function  1.0E-06  0.0  1
```

```
20530851  htvat  1201001  2
*
20530860  es120101  mult  0.02125  0.0  1
20530861  htvat  1201001  cntrlvar  3085
*
20530870  hc120201  function  1.0E-06  0.0  1
20530871  htvat  1202001  3
*
20530880  es120201  mult  0.00529  0.0  1
20530881  htvat  1202001  cntrlvar  3087
*
20530910  hc130001  function  1.0E-06  0.0  1
20530911  htvat  1300001  1
*
20530920  es130001  mult  0.00338  0.0  1
20530921  htvat  1300001  cntrlvar  3091
*
20530930  hc130002  function  1.0E-06  0.0  1
20530931  htvat  1300002  1
*
20530940  es130002  mult  0.00338  0.0  1
20530941  htvat  1300002  cntrlvar  3093
*
20530950  hc130003  function  1.0E-06  0.0  1
20530951  htvat  1300003  1
*
20530960  es130003  mult  0.00351  0.0  1
20530961  htvat  1300003  cntrlvar  3095
*
20530970  hc130004  function  1.0E-06  0.0  1
20530971  htvat  1300004  1
*
20530980  es130004  mult  0.00351  0.0  1
20530981  htvat  1300004  cntrlvar  3097
*
20530990  hc130005  function  1.0E-06  0.0  1
20530991  htvat  1300005  1
*
20531000  es130005  mult  0.00351  0.0  1
20531001  htvat  1300005  cntrlvar  3099
*
20531010  hc130006  function  1.0E-06  0.0  1
20531011  htvat  1300006  1
*
20531020  es130006  mult  0.00351  0.0  1
20531021  htvat  1300006  cntrlvar  3101
*
20531030  hc130007  function  1.0E-06  0.0  1
20531031  htvat  1300007  1
*
20531040  es130007  mult  0.00351  0.0  1
20531041  htvat  1300007  cntrlvar  3103
*
20531050  hc130008  function  1.0E-06  0.0  1
20531051  htvat  1300008  1
*
20531060  es130008  mult  0.00351  0.0  1
20531061  htvat  1300008  cntrlvar  3105
*
20531070  hc130009  function  1.0E-06  0.0  1
20531071  htvat  1300009  1
*
20531080  es130009  mult  0.00351  0.0  1
```

```
20531081  htvat  1300009  cntrlvar  3107
*
20531090  hc130010  function  1.0E-06  0.0  1
20531091  htvat  1300010  1
*
20531100  es130010  mult  0.00351  0.0  1
20531101  htvat  1300010  cntrlvar  3109
*
20531110  hc130011  function  1.0E-06  0.0  1
20531111  htvat  1300011  1
*
20531120  es130011  mult  0.00351  0.0  1
20531121  htvat  1300011  cntrlvar  3111
*
20531130  hc130012  function  1.0E-06  0.0  1
20531131  htvat  1300012  1
*
20531140  es130012  mult  0.00351  0.0  1
20531141  htvat  1300012  cntrlvar  3113
*
20531150  hc130013  function  1.0E-06  0.0  1
20531151  htvat  1300013  1
*
20531160  es130013  mult  0.00446  0.0  1
20531161  htvat  1300013  cntrlvar  3115
*
20531170  hc130014  function  1.0E-06  0.0  1
20531171  htvat  1300014  1
*
20531180  es130014  mult  0.00446  0.0  1
20531181  htvat  1300014  cntrlvar  3117
*
20531210  hc132001  function  1.0E-06  0.0  1
20531211  htvat  1320001  1
*
20531220  es132001  mult  0.01265  0.0  1
20531221  htvat  1320001  cntrlvar  3121
*
20531230  hc132002  function  1.0E-06  0.0  1
20531231  htvat  1320002  1
*
20531240  es132002  mult  0.01265  0.0  1
20531241  htvat  1320002  cntrlvar  3123
*
20531250  hc132003  function  1.0E-06  0.0  1
20531251  htvat  1320003  1
*
20531260  es132003  mult  0.01315  0.0  1
20531261  htvat  1320003  cntrlvar  3125
*
20531270  hc132004  function  1.0E-06  0.0  1
20531271  htvat  1320004  1
*
20531280  es132004  mult  0.01315  0.0  1
20531281  htvat  1320004  cntrlvar  3127
*
20531290  hc132005  function  1.0E-06  0.0  1
20531291  htvat  1320005  1
*
20531300  es132005  mult  0.01315  0.0  1
20531301  htvat  1320005  cntrlvar  3129
*
20531310  hc132006  function  1.0E-06  0.0  1
```

```
20531311  htvat  1320006  1
*
20531320  es132006  mult  0.01315  0.0  1
20531321  htvat  1320006  cntrlvar  3131
*
20531330  hc132007  function  1.0E-06  0.0  1
20531331  htvat  1320007  1
*
20531340  es132007  mult  0.01315  0.0  1
20531341  htvat  1320007  cntrlvar  3133
*
20531350  hc132008  function  1.0E-06  0.0  1
20531351  htvat  1320008  1
*
20531360  es132008  mult  0.01315  0.0  1
20531361  htvat  1320008  cntrlvar  3135
*
20531370  hc132009  function  1.0E-06  0.0  1
20531371  htvat  1320009  1
*
20531380  es132009  mult  0.01315  0.0  1
20531381  htvat  1320009  cntrlvar  3137
*
20531390  hc132010  function  1.0E-06  0.0  1
20531391  htvat  1320010  1
*
20531400  es132010  mult  0.01315  0.0  1
20531401  htvat  1320010  cntrlvar  3139
*
20531410  hc132011  function  1.0E-06  0.0  1
20531411  htvat  1320011  1
*
20531420  es132011  mult  0.01315  0.0  1
20531421  htvat  1320011  cntrlvar  3141
*
20531430  hc132012  function  1.0E-06  0.0  1
20531431  htvat  1320012  1
*
20531440  es132012  mult  0.01315  0.0  1
20531441  htvat  1320012  cntrlvar  3143
*
20531450  hc132013  function  1.0E-06  0.0  1
20531451  htvat  1320013  1
*
20531460  es132013  mult  0.01670  0.0  1
20531461  htvat  1320013  cntrlvar  3145
*
20531470  hc132014  function  1.0E-06  0.0  1
20531471  htvat  1320014  1
*
20531480  es132014  mult  0.01670  0.0  1
20531481  htvat  1320014  cntrlvar  3147
*
20531510  hc134001  function  1.0E-06  0.0  1
20531511  htvat  1340001  1
*
20531520  es134001  mult  0.00243  0.0  1
20531521  htvat  1340001  cntrlvar  3151
*
20531530  hc134002  function  1.0E-06  0.0  1
20531531  htvat  1340002  1
*
20531540  es134002  mult  0.00243  0.0  1
```

```
20531541  htvat  1340002  cntrlvar  3153
*
20531550  hc134003  function  1.0E-06  0.0  1
20531551  htvat  1340003  1
*
20531560  es134003  mult  0.00252  0.0  1
20531561  htvat  1340003  cntrlvar  3155
*
20531570  hc134004  function  1.0E-06  0.0  1
20531571  htvat  1340004  1
*
20531580  es134004  mult  0.00252  0.0  1
20531581  htvat  1340004  cntrlvar  3157
*
20531590  hc134005  function  1.0E-06  0.0  1
20531591  htvat  1340005  1
*
20531600  es134005  mult  0.00252  0.0  1
20531601  htvat  1340005  cntrlvar  3159
*
20531610  hc134006  function  1.0E-06  0.0  1
20531611  htvat  1340006  1
*
20531620  es134006  mult  0.00252  0.0  1
20531621  htvat  1340006  cntrlvar  3161
*
20531630  hc134007  function  1.0E-06  0.0  1
20531631  htvat  1340007  1
*
20531640  es134007  mult  0.00252  0.0  1
20531641  htvat  1340007  cntrlvar  3163
*
20531650  hc134008  function  1.0E-06  0.0  1
20531651  htvat  1340008  1
*
20531660  es134008  mult  0.00252  0.0  1
20531661  htvat  1340008  cntrlvar  3165
*
20531670  hc134009  function  1.0E-06  0.0  1
20531671  htvat  1340009  1
*
20531680  es134009  mult  0.00252  0.0  1
20531681  htvat  1340009  cntrlvar  3167
*
20531690  hc134010  function  1.0E-06  0.0  1
20531691  htvat  1340010  1
*
20531700  es134010  mult  0.00252  0.0  1
20531701  htvat  1340010  cntrlvar  3169
*
20531710  hc134011  function  1.0E-06  0.0  1
20531711  htvat  1340011  1
*
20531720  es134011  mult  0.00252  0.0  1
20531721  htvat  1340011  cntrlvar  3171
*
20531730  hc134012  function  1.0E-06  0.0  1
20531731  htvat  1340012  1
*
20531740  es134012  mult  0.00252  0.0  1
20531741  htvat  1340012  cntrlvar  3173
*
20531750  hc134013  function  1.0E-06  0.0  1
```

```
20531751  htvat  1340013  1
*
20531760  es134013  mult  0.00320  0.0  1
20531761  htvat  1340013  cntrlvar  3175
*
20531770  hc134014  function  1.0E-06  0.0  1
20531771  htvat  1340014  1
*
20531780  es134014  mult  0.00320  0.0  1
20531781  htvat  1340014  cntrlvar  3177
*
20531790  es-crefl  sum  1.0  0.0  1
20531791  0.0  1.0  cntrlvar  3092  1.0  cntrlvar  3094
20531792  1.0  cntrlvar  3096  1.0  cntrlvar  3098
20531793  1.0  cntrlvar  3100  1.0  cntrlvar  3102
20531794  1.0  cntrlvar  3104  1.0  cntrlvar  3106
20531795  1.0  cntrlvar  3108  1.0  cntrlvar  3110
20531796  1.0  cntrlvar  3112  1.0  cntrlvar  3114
20531797  1.0  cntrlvar  3116  1.0  cntrlvar  3118
20531798  1.0  cntrlvar  3122  1.0  cntrlvar  3124
+  1.0  cntrlvar  3126  1.0  cntrlvar  3128
+  1.0  cntrlvar  3130  1.0  cntrlvar  3132
+  1.0  cntrlvar  3134  1.0  cntrlvar  3136
+  1.0  cntrlvar  3138  1.0  cntrlvar  3140
+  1.0  cntrlvar  3142  1.0  cntrlvar  3144
+  1.0  cntrlvar  3146  1.0  cntrlvar  3148
+  1.0  cntrlvar  3152  1.0  cntrlvar  3154
+  1.0  cntrlvar  3156  1.0  cntrlvar  3158
+  1.0  cntrlvar  3160  1.0  cntrlvar  3162
+  1.0  cntrlvar  3164  1.0  cntrlvar  3166
+  1.0  cntrlvar  3168  1.0  cntrlvar  3170
+  1.0  cntrlvar  3172  1.0  cntrlvar  3174
+  1.0  cntrlvar  3176  1.0  cntrlvar  3178
*
20531810  hc140001  function  1.0E-06  0.0  1
20531811  htvat  1400001  1
*
20531820  es140001  mult  0.02123  0.0  1
20531821  htvat  1400001  cntrlvar  3181
*
20531830  hc140002  function  1.0E-06  0.0  1
20531831  htvat  1400002  1
*
20531840  es140002  mult  0.02123  0.0  1
20531841  htvat  1400002  cntrlvar  3183
*
20531850  hc140101  function  1.0E-06  0.0  1
20531851  htvat  1401001  1
*
20531860  es140101  mult  0.02208  0.0  1
20531861  htvat  1401001  cntrlvar  3185
*
20531870  hc140102  function  1.0E-06  0.0  1
20531871  htvat  1401002  1
*
20531880  es140102  mult  0.02208  0.0  1
20531881  htvat  1401002  cntrlvar  3187
*
20531890  hc140103  function  1.0E-06  0.0  1
20531891  htvat  1401003  1
*
20531900  es140103  mult  0.02208  0.0  1
20531901  htvat  1401003  cntrlvar  3189
```

```
*
20531910  hc140104  function  1.0E-06  0.0  1
20531911  htvat  1401004  1
*
20531920  es140104  mult  0.02208  0.0  1
20531921  htvat  1401004  cntrlvar  3191
*
20531930  hc140105  function  1.0E-06  0.0  1
20531931  htvat  1401005  1
*
20531940  es140105  mult  0.02208  0.0  1
20531941  htvat  1401005  cntrlvar  3193
*
20531950  hc140106  function  1.0E-06  0.0  1
20531951  htvat  1401006  1
*
20531960  es140106  mult  0.02208  0.0  1
20531961  htvat  1401006  cntrlvar  3195
*
20531970  hc140107  function  1.0E-06  0.0  1
20531971  htvat  1401007  1
*
20531980  es140107  mult  0.02208  0.0  1
20531981  htvat  1401007  cntrlvar  3197
*
20531990  hc140108  function  1.0E-06  0.0  1
20531991  htvat  1401008  1
*
20532000  es140108  mult  0.02208  0.0  1
20532001  htvat  1401008  cntrlvar  3199
*
20532010  hc140109  function  1.0E-06  0.0  1
20532011  htvat  1401009  1
*
20532020  es140109  mult  0.02208  0.0  1
20532021  htvat  1401009  cntrlvar  3201
*
20532030  hc140110  function  1.0E-06  0.0  1
20532031  htvat  1401010  1
*
20532040  es140110  mult  0.02208  0.0  1
20532041  htvat  1401010  cntrlvar  3203
*
20532050  hc140201  function  1.0E-06  0.0  1
20532051  htvat  1402001  1
*
20532060  es140201  mult  0.02802  0.0  1
20532061  htvat  1402001  cntrlvar  3205
*
20532070  hc140202  function  1.0E-06  0.0  1
20532071  htvat  1402002  1
*
20532080  es140202  mult  0.02802  0.0  1
20532081  htvat  1402002  cntrlvar  3207
*
20532110  hc145001  function  1.0E-06  0.0  1
20532111  htvat  1450001  1
*
20532120  es145001  mult  0.01981  0.0  1
20532121  htvat  1450001  cntrlvar  3211
*
20532130  hc145002  function  1.0E-06  0.0  1
20532131  htvat  1450002  1
```

```
*
20532140  es145002  mult  0.01981  0.0  1
20532141  htvat  1450002  cntrlvar  3213
*
20532150  hc145101  function  1.0E-06  0.0  1
20532151  htvat  1451001  1
*
20532160  es145101  mult  0.02061  0.0  1
20532161  htvat  1451001  cntrlvar  3215
*
20532170  hc145102  function  1.0E-06  0.0  1
20532171  htvat  1451002  1
*
20532180  es145102  mult  0.02061  0.0  1
20532181  htvat  1451002  cntrlvar  3217
*
20532190  hc145103  function  1.0E-06  0.0  1
20532191  htvat  1451003  1
*
20532200  es145103  mult  0.02061  0.0  1
20532201  htvat  1451003  cntrlvar  3219
*
20532210  hc145104  function  1.0E-06  0.0  1
20532211  htvat  1451004  1
*
20532220  es145104  mult  0.02061  0.0  1
20532221  htvat  1451004  cntrlvar  3221
*
20532230  hc145105  function  1.0E-06  0.0  1
20532231  htvat  1451005  1
*
20532240  es145105  mult  0.02061  0.0  1
20532241  htvat  1451005  cntrlvar  3223
*
20532250  hc145106  function  1.0E-06  0.0  1
20532251  htvat  1451006  1
*
20532260  es145106  mult  0.02061  0.0  1
20532261  htvat  1451006  cntrlvar  3225
*
20532270  hc145107  function  1.0E-06  0.0  1
20532271  htvat  1451007  1
*
20532280  es145107  mult  0.02061  0.0  1
20532281  htvat  1451007  cntrlvar  3227
*
20532290  hc145108  function  1.0E-06  0.0  1
20532291  htvat  1451008  1
*
20532300  es145108  mult  0.02061  0.0  1
20532301  htvat  1451008  cntrlvar  3229
*
20532310  hc145109  function  1.0E-06  0.0  1
20532311  htvat  1451009  1
*
20532320  es145109  mult  0.02061  0.0  1
20532321  htvat  1451009  cntrlvar  3231
*
20532330  hc145110  function  1.0E-06  0.0  1
20532331  htvat  1451010  1
*
20532340  es145110  mult  0.02061  0.0  1
20532341  htvat  1451010  cntrlvar  3233
```

```
*
20532350  hc145201  function  1.0E-06  0.0  1
20532351  htvat  1452001  1
*
20532360  es145201  mult  0.02615  0.0  1
20532361  htvat  1452001  cntrlvar  3235
*
20532370  hc145202  function  1.0E-06  0.0  1
20532371  htvat  1452002  1
*
20532380  es145202  mult  0.02615  0.0  1
20532381  htvat  1452002  cntrlvar  3237
*
20532410  hc150001  function  1.0E-06  0.0  1
20532411  htvat  1500001  1
*
20532420  es150001  mult  0.03821  0.0  1
20532421  htvat  1500001  cntrlvar  3241
*
20532430  hc150002  function  1.0E-06  0.0  1
20532431  htvat  1500002  1
*
20532440  es150002  mult  0.03821  0.0  1
20532441  htvat  1500002  cntrlvar  3243
*
20532450  hc150101  function  1.0E-06  0.0  1
20532451  htvat  1501001  1
*
20532460  es150101  mult  0.03974  0.0  1
20532461  htvat  1501001  cntrlvar  3245
*
20532470  hc150102  function  1.0E-06  0.0  1
20532471  htvat  1501002  1
*
20532480  es150102  mult  0.03974  0.0  1
20532481  htvat  1501002  cntrlvar  3247
*
20532490  hc150103  function  1.0E-06  0.0  1
20532491  htvat  1501003  1
*
20532500  es150103  mult  0.03974  0.0  1
20532501  htvat  1501003  cntrlvar  3249
*
20532510  hc150104  function  1.0E-06  0.0  1
20532511  htvat  1501004  1
*
20532520  es150104  mult  0.03974  0.0  1
20532521  htvat  1501004  cntrlvar  3251
*
20532530  hc150105  function  1.0E-06  0.0  1
20532531  htvat  1501005  1
*
20532540  es150105  mult  0.03974  0.0  1
20532541  htvat  1501005  cntrlvar  3253
*
20532550  hc150106  function  1.0E-06  0.0  1
20532551  htvat  1501006  1
*
20532560  es150106  mult  0.03974  0.0  1
20532561  htvat  1501006  cntrlvar  3255
*
20532570  hc150107  function  1.0E-06  0.0  1
20532571  htvat  1501007  1
```

```
*
20532580  es150107  mult  0.03974  0.0  1
20532581  htvat  1501007  cntrlvar  3257
*
20532590  hc150108  function  1.0E-06  0.0  1
20532591  htvat  1501008  1
*
20532600  es150108  mult  0.03974  0.0  1
20532601  htvat  1501008  cntrlvar  3259
*
20532610  hc150109  function  1.0E-06  0.0  1
20532611  htvat  1501009  1
*
20532620  es150109  mult  0.03974  0.0  1
20532621  htvat  1501009  cntrlvar  3261
*
20532630  hc150110  function  1.0E-06  0.0  1
20532631  htvat  1501010  1
*
20532640  es150110  mult  0.03974  0.0  1
20532641  htvat  1501010  cntrlvar  3263
*
20532650  hc150201  function  1.0E-06  0.0  1
20532651  htvat  1502001  1
*
20532660  es150201  mult  0.05044  0.0  1
20532661  htvat  1502001  cntrlvar  3265
*
20532670  hc150202  function  1.0E-06  0.0  1
20532671  htvat  1502002  1
*
20532680  es150202  mult  0.05044  0.0  1
20532681  htvat  1502002  cntrlvar  3267
*
20532690  es-corec  sum  1.0  0.0  1
20532691  0.0  1.0  cntrlvar  3182  1.0  cntrlvar  3184
20532692  1.0  cntrlvar  3186  1.0  cntrlvar  3188
20532693  1.0  cntrlvar  3190  1.0  cntrlvar  3192
20532694  1.0  cntrlvar  3194  1.0  cntrlvar  3196
20532695  1.0  cntrlvar  3198  1.0  cntrlvar  3200
20532696  1.0  cntrlvar  3202  1.0  cntrlvar  3204
20532697  1.0  cntrlvar  3206  1.0  cntrlvar  3208
20532698  1.0  cntrlvar  3212  1.0  cntrlvar  3214
+  1.0  cntrlvar  3216  1.0  cntrlvar  3218
+  1.0  cntrlvar  3220  1.0  cntrlvar  3222
+  1.0  cntrlvar  3224  1.0  cntrlvar  3226
+  1.0  cntrlvar  3228  1.0  cntrlvar  3230
+  1.0  cntrlvar  3232  1.0  cntrlvar  3234
+  1.0  cntrlvar  3236  1.0  cntrlvar  3238
+  1.0  cntrlvar  3242  1.0  cntrlvar  3244
+  1.0  cntrlvar  3246  1.0  cntrlvar  3248
+  1.0  cntrlvar  3250  1.0  cntrlvar  3252
+  1.0  cntrlvar  3254  1.0  cntrlvar  3256
+  1.0  cntrlvar  3258  1.0  cntrlvar  3260
+  1.0  cntrlvar  3262  1.0  cntrlvar  3264
+  1.0  cntrlvar  3266  1.0  cntrlvar  3268
*
20532710  hc140301  function  1.0E-06  0.0  1
20532711  htvat  1403001  2
*
20532720  es140301  mult  0.00184  0.0  1
20532721  htvat  1403001  cntrlvar  3271
*
```

```
20532730  hc140302  function  1.0E-06  0.0  1
20532731  htvat  1403002  2
*
20532740  es140302  mult  0.00184  0.0  1
20532741  htvat  1403002  cntrlvar  3273
*
20532750  hc140303  function  1.0E-06  0.0  1
20532751  htvat  1403003  2
*
20532760  es140303  mult  0.00184  0.0  1
20532761  htvat  1403003  cntrlvar  3275
*
20532770  hc140304  function  1.0E-06  0.0  1
20532771  htvat  1403004  2
*
20532780  es140304  mult  0.00184  0.0  1
20532781  htvat  1403004  cntrlvar  3277
*
20532790  hc140305  function  1.0E-06  0.0  1
20532791  htvat  1403005  2
*
20532800  es140305  mult  0.00184  0.0  1
20532801  htvat  1403005  cntrlvar  3279
*
20532810  hc140306  function  1.0E-06  0.0  1
20532811  htvat  1403006  2
*
20532820  es140306  mult  0.00184  0.0  1
20532821  htvat  1403006  cntrlvar  3281
*
20532830  hc140307  function  1.0E-06  0.0  1
20532831  htvat  1403007  2
*
20532840  es140307  mult  0.00184  0.0  1
20532841  htvat  1403007  cntrlvar  3283
*
20532850  hc140308  function  1.0E-06  0.0  1
20532851  htvat  1403008  2
*
20532860  es140308  mult  0.00184  0.0  1
20532861  htvat  1403008  cntrlvar  3285
*
20532870  hc140309  function  1.0E-06  0.0  1
20532871  htvat  1403009  2
*
20532880  es140309  mult  0.00184  0.0  1
20532881  htvat  1403009  cntrlvar  3287
*
20532890  hc140310  function  1.0E-06  0.0  1
20532891  htvat  1403010  2
*
20532900  es140310  mult  0.00184  0.0  1
20532901  htvat  1403010  cntrlvar  3289
*
20532910  hc145301  function  1.0E-06  0.0  1
20532911  htvat  1453001  2
*
20532920  es145301  mult  0.00236  0.0  1
20532921  htvat  1453001  cntrlvar  3291
*
20532930  hc145302  function  1.0E-06  0.0  1
20532931  htvat  1453002  2
*
```

```
20532940  es145302  mult  0.00236  0.0  1
20532941  htvat  1453002  cntrlvar  3293
*
20532950  hc145303  function  1.0E-06  0.0  1
20532951  htvat  1453003  2
*
20532960  es145303  mult  0.00236  0.0  1
20532961  htvat  1453003  cntrlvar  3295
*
20532970  hc145304  function  1.0E-06  0.0  1
20532971  htvat  1453004  2
*
20532980  es145304  mult  0.00236  0.0  1
20532981  htvat  1453004  cntrlvar  3297
*
20532990  hc145305  function  1.0E-06  0.0  1
20532991  htvat  1453005  2
*
20533000  es145305  mult  0.00236  0.0  1
20533001  htvat  1453005  cntrlvar  3299
*
20533010  hc145306  function  1.0E-06  0.0  1
20533011  htvat  1453006  2
*
20533020  es145306  mult  0.00236  0.0  1
20533021  htvat  1453006  cntrlvar  3301
*
20533030  hc145307  function  1.0E-06  0.0  1
20533031  htvat  1453007  2
*
20533040  es145307  mult  0.00236  0.0  1
20533041  htvat  1453007  cntrlvar  3303
*
20533050  hc145308  function  1.0E-06  0.0  1
20533051  htvat  1453008  2
*
20533060  es145308  mult  0.00236  0.0  1
20533061  htvat  1453008  cntrlvar  3305
*
20533070  hc145309  function  1.0E-06  0.0  1
20533071  htvat  1453009  2
*
20533080  es145309  mult  0.00236  0.0  1
20533081  htvat  1453009  cntrlvar  3307
*
20533090  hc145310  function  1.0E-06  0.0  1
20533091  htvat  1453010  2
*
20533100  es145310  mult  0.00236  0.0  1
20533101  htvat  1453010  cntrlvar  3309
*
20533110  hc150301  function  1.0E-06  0.0  1
20533111  htvat  1503001  2
*
20533120  es150301  mult  0.00269  0.0  1
20533121  htvat  1503001  cntrlvar  3311
*
20533130  hc150302  function  1.0E-06  0.0  1
20533131  htvat  1503002  2
*
20533140  es150302  mult  0.00269  0.0  1
20533141  htvat  1503002  cntrlvar  3313
*
```

```
20533150  hc150303  function  1.0E-06  0.0  1
20533151  htvat  1503003  2
*
20533160  es150303  mult  0.00269  0.0  1
20533161  htvat  1503003  cntrlvar  3315
*
20533170  hc150304  function  1.0E-06  0.0  1
20533171  htvat  1503004  2
*
20533180  es150304  mult  0.00269  0.0  1
20533181  htvat  1503004  cntrlvar  3317
*
20533190  hc150305  function  1.0E-06  0.0  1
20533191  htvat  1503005  2
*
20533200  es150305  mult  0.00269  0.0  1
20533201  htvat  1503005  cntrlvar  3319
*
20533210  hc150306  function  1.0E-06  0.0  1
20533211  htvat  1503006  2
*
20533220  es150306  mult  0.00269  0.0  1
20533221  htvat  1503006  cntrlvar  3321
*
20533230  hc150307  function  1.0E-06  0.0  1
20533231  htvat  1503007  2
*
20533240  es150307  mult  0.00269  0.0  1
20533241  htvat  1503007  cntrlvar  3323
*
20533250  hc150308  function  1.0E-06  0.0  1
20533251  htvat  1503008  2
*
20533260  es150308  mult  0.00269  0.0  1
20533261  htvat  1503008  cntrlvar  3325
*
20533270  hc150309  function  1.0E-06  0.0  1
20533271  htvat  1503009  2
*
20533280  es150309  mult  0.00269  0.0  1
20533281  htvat  1503009  cntrlvar  3327
*
20533290  hc150310  function  1.0E-06  0.0  1
20533291  htvat  1503010  2
*
20533300  es150310  mult  0.00269  0.0  1
20533301  htvat  1503010  cntrlvar  3329
*
20533310  es-htrod  sum  1.0  0.0  1
20533311  0.0  1.0  cntrlvar  3272  1.0  cntrlvar  3274
20533312  1.0  cntrlvar  3276  1.0  cntrlvar  3278
20533313  1.0  cntrlvar  3280  1.0  cntrlvar  3282
20533314  1.0  cntrlvar  3284  1.0  cntrlvar  3286
20533315  1.0  cntrlvar  3288  1.0  cntrlvar  3290
20533316  1.0  cntrlvar  3292  1.0  cntrlvar  3294
20533317  1.0  cntrlvar  3296  1.0  cntrlvar  3298
20533318  1.0  cntrlvar  3300  1.0  cntrlvar  3302
+  1.0  cntrlvar  3304  1.0  cntrlvar  3306
+  1.0  cntrlvar  3308  1.0  cntrlvar  3310
+  1.0  cntrlvar  3312  1.0  cntrlvar  3314
+  1.0  cntrlvar  3316  1.0  cntrlvar  3318
+  1.0  cntrlvar  3320  1.0  cntrlvar  3322
+  1.0  cntrlvar  3324  1.0  cntrlvar  3326
```

```
+  1.0  cntrlvar  3328  1.0  cntrlvar  3330
*
20533410  hc160001  function  1.0E-06  0.0  1
20533411  htvat  1600001  1
*
20533420  es160001  mult  0.02046  0.0  1
20533421  htvat  1600001  cntrlvar  3341
*
20533430  hc160002  function  1.0E-06  0.0  1
20533431  htvat  1600002  1
*
20533440  es160002  mult  0.02046  0.0  1
20533441  htvat  1600002  cntrlvar  3343
*
20533450  hc160003  function  1.0E-06  0.0  1
20533451  htvat  1600003  1
*
20533460  es160003  mult  0.02128  0.0  1
20533461  htvat  1600003  cntrlvar  3345
*
20533470  hc160004  function  1.0E-06  0.0  1
20533471  htvat  1600004  1
*
20533480  es160004  mult  0.02128  0.0  1
20533481  htvat  1600004  cntrlvar  3347
*
20533490  hc160005  function  1.0E-06  0.0  1
20533491  htvat  1600005  1
*
20533500  es160005  mult  0.02128  0.0  1
20533501  htvat  1600005  cntrlvar  3349
*
20533510  hc160006  function  1.0E-06  0.0  1
20533511  htvat  1600006  1
*
20533520  es160006  mult  0.02128  0.0  1
20533521  htvat  1600006  cntrlvar  3351
*
20533530  hc160007  function  1.0E-06  0.0  1
20533531  htvat  1600007  1
*
20533540  es160007  mult  0.02128  0.0  1
20533541  htvat  1600007  cntrlvar  3353
*
20533550  hc160008  function  1.0E-06  0.0  1
20533551  htvat  1600008  1
*
20533560  es160008  mult  0.02128  0.0  1
20533561  htvat  1600008  cntrlvar  3355
*
20533570  hc160009  function  1.0E-06  0.0  1
20533571  htvat  1600009  1
*
20533580  es160009  mult  0.02128  0.0  1
20533581  htvat  1600009  cntrlvar  3357
*
20533590  hc160010  function  1.0E-06  0.0  1
20533591  htvat  1600010  1
*
20533600  es160010  mult  0.02128  0.0  1
20533601  htvat  1600010  cntrlvar  3359
*
20533610  hc160011  function  1.0E-06  0.0  1
```

```
20533611  htvat  1600011  1
*
20533620  es160011  mult  0.02128  0.0  1
20533621  htvat  1600011  cntrlvar  3361
*
20533630  hc160012  function  1.0E-06  0.0  1
20533631  htvat  1600012  1
*
20533640  es160012  mult  0.02128  0.0  1
20533641  htvat  1600012  cntrlvar  3363
*
20533650  hc160013  function  1.0E-06  0.0  1
20533651  htvat  1600013  1
*
20533660  es160013  mult  0.02701  0.0  1
20533661  htvat  1600013  cntrlvar  3365
*
20533670  hc160014  function  1.0E-06  0.0  1
20533671  htvat  1600014  1
*
20533680  es160014  mult  0.02701  0.0  1
20533681  htvat  1600014  cntrlvar  3367
*
20533710  hc162001  function  1.0E-06  0.0  1
20533711  htvat  1620001  1
*
20533720  es162001  mult  0.04244  0.0  1
20533721  htvat  1620001  cntrlvar  3371
*
20533730  hc162002  function  1.0E-06  0.0  1
20533731  htvat  1620002  1
*
20533740  es162002  mult  0.04244  0.0  1
20533741  htvat  1620002  cntrlvar  3373
*
20533750  hc162003  function  1.0E-06  0.0  1
20533751  htvat  1620003  1
*
20533760  es162003  mult  0.04413  0.0  1
20533761  htvat  1620003  cntrlvar  3375
*
20533770  hc162004  function  1.0E-06  0.0  1
20533771  htvat  1620004  1
*
20533780  es162004  mult  0.04413  0.0  1
20533781  htvat  1620004  cntrlvar  3377
*
20533790  hc162005  function  1.0E-06  0.0  1
20533791  htvat  1620005  1
*
20533800  es162005  mult  0.04413  0.0  1
20533801  htvat  1620005  cntrlvar  3379
*
20533810  hc162006  function  1.0E-06  0.0  1
20533811  htvat  1620006  1
*
20533820  es162006  mult  0.04413  0.0  1
20533821  htvat  1620006  cntrlvar  3381
*
20533830  hc162007  function  1.0E-06  0.0  1
20533831  htvat  1620007  1
*
20533840  es162007  mult  0.04413  0.0  1
```

```
20533841  htvat  1620007  cntrlvar  3383
*
20533850  hc162008  function  1.0E-06  0.0  1
20533851  htvat  1620008  1
*
20533860  es162008  mult  0.04413  0.0  1
20533861  htvat  1620008  cntrlvar  3385
*
20533870  hc162009  function  1.0E-06  0.0  1
20533871  htvat  1620009  1
*
20533880  es162009  mult  0.04413  0.0  1
20533881  htvat  1620009  cntrlvar  3387
*
20533890  hc162010  function  1.0E-06  0.0  1
20533891  htvat  1620010  1
*
20533900  es162010  mult  0.04413  0.0  1
20533901  htvat  1620010  cntrlvar  3389
*
20533910  hc162011  function  1.0E-06  0.0  1
20533911  htvat  1620011  1
*
20533920  es162011  mult  0.04413  0.0  1
20533921  htvat  1620011  cntrlvar  3391
*
20533930  hc162012  function  1.0E-06  0.0  1
20533931  htvat  1620012  1
*
20533940  es162012  mult  0.04413  0.0  1
20533941  htvat  1620012  cntrlvar  3393
*
20533950  hc162013  function  1.0E-06  0.0  1
20533951  htvat  1620013  1
*
20533960  es162013  mult  0.05602  0.0  1
20533961  htvat  1620013  cntrlvar  3395
*
20533970  hc162014  function  1.0E-06  0.0  1
20533971  htvat  1620014  1
*
20533980  es162014  mult  0.05602  0.0  1
20533981  htvat  1620014  cntrlvar  3397
*
20534010  hc164001  function  1.0E-06  0.0  1
20534011  htvat  1640001  1
*
20534020  es164001  mult  0.02025  0.0  1
20534021  htvat  1640001  cntrlvar  3401
*
20534030  hc164002  function  1.0E-06  0.0  1
20534031  htvat  1640002  1
*
20534040  es164002  mult  0.02025  0.0  1
20534041  htvat  1640002  cntrlvar  3403
*
20534050  hc164003  function  1.0E-06  0.0  1
20534051  htvat  1640003  1
*
20534060  es164003  mult  0.02106  0.0  1
20534061  htvat  1640003  cntrlvar  3405
*
20534070  hc164004  function  1.0E-06  0.0  1
```

```
20534071  htvat  1640004  1
*
20534080  es164004  mult  0.02106  0.0  1
20534081  htvat  1640004  cntrlvar  3407
*
20534090  hc164005  function  1.0E-06  0.0  1
20534091  htvat  1640005  1
*
20534100  es164005  mult  0.02106  0.0  1
20534101  htvat  1640005  cntrlvar  3409
*
20534110  hc164006  function  1.0E-06  0.0  1
20534111  htvat  1640006  1
*
20534120  es164006  mult  0.02106  0.0  1
20534121  htvat  1640006  cntrlvar  3411
*
20534130  hc164007  function  1.0E-06  0.0  1
20534131  htvat  1640007  1
*
20534140  es164007  mult  0.02106  0.0  1
20534141  htvat  1640007  cntrlvar  3413
*
20534150  hc164008  function  1.0E-06  0.0  1
20534151  htvat  1640008  1
*
20534160  es164008  mult  0.02106  0.0  1
20534161  htvat  1640008  cntrlvar  3415
*
20534170  hc164009  function  1.0E-06  0.0  1
20534171  htvat  1640009  1
*
20534180  es164009  mult  0.02106  0.0  1
20534181  htvat  1640009  cntrlvar  3417
*
20534190  hc164010  function  1.0E-06  0.0  1
20534191  htvat  1640010  1
*
20534200  es164010  mult  0.02106  0.0  1
20534201  htvat  1640010  cntrlvar  3419
*
20534210  hc164011  function  1.0E-06  0.0  1
20534211  htvat  1640011  1
*
20534220  es164011  mult  0.02106  0.0  1
20534221  htvat  1640011  cntrlvar  3421
*
20534230  hc164012  function  1.0E-06  0.0  1
20534231  htvat  1640012  1
*
20534240  es164012  mult  0.02106  0.0  1
20534241  htvat  1640012  cntrlvar  3423
*
20534250  hc164013  function  1.0E-06  0.0  1
20534251  htvat  1640013  1
*
20534260  es164013  mult  0.02673  0.0  1
20534261  htvat  1640013  cntrlvar  3425
*
20534270  hc164014  function  1.0E-06  0.0  1
20534271  htvat  1640014  1
*
20534280  es164014  mult  0.02673  0.0  1
```

```
20534281  htvat  1640014  cntrlvar  3427
*
20534290  es-crefl  sum  1.0  0.0  1
20534291  0.0  1.0  cntrlvar  3342  1.0  cntrlvar  3344
20534292  1.0  cntrlvar  3346  1.0  cntrlvar  3348
20534293  1.0  cntrlvar  3350  1.0  cntrlvar  3352
20534294  1.0  cntrlvar  3354  1.0  cntrlvar  3356
20534295  1.0  cntrlvar  3358  1.0  cntrlvar  3360
20534296  1.0  cntrlvar  3362  1.0  cntrlvar  3364
20534297  1.0  cntrlvar  3366  1.0  cntrlvar  3368
20534298  1.0  cntrlvar  3372  1.0  cntrlvar  3374
+  1.0  cntrlvar  3376  1.0  cntrlvar  3378
+  1.0  cntrlvar  3380  1.0  cntrlvar  3382
+  1.0  cntrlvar  3384  1.0  cntrlvar  3386
+  1.0  cntrlvar  3388  1.0  cntrlvar  3390
+  1.0  cntrlvar  3392  1.0  cntrlvar  3394
+  1.0  cntrlvar  3396  1.0  cntrlvar  3398
+  1.0  cntrlvar  3402  1.0  cntrlvar  3404
+  1.0  cntrlvar  3406  1.0  cntrlvar  3408
+  1.0  cntrlvar  3410  1.0  cntrlvar  3412
+  1.0  cntrlvar  3414  1.0  cntrlvar  3416
+  1.0  cntrlvar  3418  1.0  cntrlvar  3420
+  1.0  cntrlvar  3422  1.0  cntrlvar  3424
+  1.0  cntrlvar  3426  1.0  cntrlvar  3428
*
20534310  hc166001  function  1.0E-06  0.0  1
20534311  htvat  1660001  5
*
20534320  es166001  mult  0.11225  0.0  1
20534321  htvat  1660001  cntrlvar  3431
*
20534330  hc166002  function  1.0E-06  0.0  1
20534331  htvat  1660002  5
*
20534340  es166002  mult  0.11225  0.0  1
20534341  htvat  1660002  cntrlvar  3433
*
20534350  hc166003  function  1.0E-06  0.0  1
20534351  htvat  1660003  5
*
20534360  es166003  mult  0.11674  0.0  1
20534361  htvat  1660003  cntrlvar  3435
*
20534370  hc166004  function  1.0E-06  0.0  1
20534371  htvat  1660004  5
*
20534380  es166004  mult  0.11674  0.0  1
20534381  htvat  1660004  cntrlvar  3437
*
20534390  hc166005  function  1.0E-06  0.0  1
20534391  htvat  1660005  5
*
20534400  es166005  mult  0.11674  0.0  1
20534401  htvat  1660005  cntrlvar  3439
*
20534410  hc166006  function  1.0E-06  0.0  1
20534411  htvat  1660006  5
*
20534420  es166006  mult  0.11674  0.0  1
20534421  htvat  1660006  cntrlvar  3441
*
20534430  hc166007  function  1.0E-06  0.0  1
20534431  htvat  1660007  5
```

```
*
20534440  es166007  mult  0.11674  0.0  1
20534441  htvat  1660007  cntrlvar  3443
*
20534450  hc166008  function  1.0E-06  0.0  1
20534451  htvat  1660008  5
*
20534460  es166008  mult  0.11674  0.0  1
20534461  htvat  1660008  cntrlvar  3445
*
20534470  hc166009  function  1.0E-06  0.0  1
20534471  htvat  1660009  5
*
20534480  es166009  mult  0.11674  0.0  1
20534481  htvat  1660009  cntrlvar  3447
*
20534490  hc166010  function  1.0E-06  0.0  1
20534491  htvat  1660010  5
*
20534500  es166010  mult  0.11674  0.0  1
20534501  htvat  1660010  cntrlvar  3449
*
20534510  hc166011  function  1.0E-06  0.0  1
20534511  htvat  1660011  5
*
20534520  es166011  mult  0.11674  0.0  1
20534521  htvat  1660011  cntrlvar  3451
*
20534530  hc166012  function  1.0E-06  0.0  1
20534531  htvat  1660012  5
*
20534540  es166012  mult  0.11674  0.0  1
20534541  htvat  1660012  cntrlvar  3453
*
20534550  hc166013  function  1.0E-06  0.0  1
20534551  htvat  1660013  5
*
20534560  es166013  mult  0.14818  0.0  1
20534561  htvat  1660013  cntrlvar  3455
*
20534570  hc166014  function  1.0E-06  0.0  1
20534571  htvat  1660014  5
*
20534580  es166014  mult  0.14818  0.0  1
20534581  htvat  1660014  cntrlvar  3457
*
20534590  es-PSR  sum  1.0  0.0  1
20534591  0.0  1.0  cntrlvar  3432  1.0  cntrlvar  3434
20534592  1.0  cntrlvar  3436  1.0  cntrlvar  3438
20534593  1.0  cntrlvar  3440  1.0  cntrlvar  3442
20534594  1.0  cntrlvar  3444  1.0  cntrlvar  3446
20534595  1.0  cntrlvar  3448  1.0  cntrlvar  3450
20534596  1.0  cntrlvar  3452  1.0  cntrlvar  3454
20534597  1.0  cntrlvar  3456  1.0  cntrlvar  3458
*
20534610  hc175001  function  1.0E-06  0.0  1
20534611  htvat  1750001  3
*
20534620  es175001  mult  0.04499  0.0  1
20534621  htvat  1750001  cntrlvar  3461
*
20534630  hc175101  function  1.0E-06  0.0  1
20534631  htvat  1751001  1
```

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*
20534640  es175101  mult  0.09527  0.0  1
20534641  htvat  1751001  cntrlvar  3463
*
20534660  es-core  sum  1.0  0.0  1
20534661  0.0  1.0  cntrlvar  3179  1.0  cntrlvar  3269
20534662  1.0  cntrlvar  3331  1.0  cntrlvar  3429
20534663  1.0  cntrlvar  3459
*
20534680  es-pvesl  sum  1.0  0.0  1
20534681  0.0  1.0  cntrlvar  3038  1.0  cntrlvar  3042
20534682  1.0  cntrlvar  3044  1.0  cntrlvar  3081
20534683  1.0  cntrlvar  3084  1.0  cntrlvar  3086
20534684  1.0  cntrlvar  3088  1.0  cntrlvar  3462
20534685  1.0  cntrlvar  3464  1.0  cntrlvar  3466
*
20534710  hc200001  function  1.0E-06  0.0  1
20534711  htvat  2000001  3
*
20534720  es200001  mult  0.00291  0.0  1
20534721  htvat  2000001  cntrlvar  3471
*
20534730  hc200002  function  1.0E-06  0.0  1
20534731  htvat  2000002  3
*
20534740  es200002  mult  0.00439  0.0  1
20534741  htvat  2000002  cntrlvar  3473
*
20534750  hc200003  function  1.0E-06  0.0  1
20534751  htvat  2000003  3
*
20534760  es200003  mult  0.00278  0.0  1
20534761  htvat  2000003  cntrlvar  3475
*
20534770  hc200004  function  1.0E-06  0.0  1
20534771  htvat  2000004  3
*
20534780  es200004  mult  0.00278  0.0  1
20534781  htvat  2000004  cntrlvar  3477
*
20534790  hc200101  function  1.0E-06  0.0  1
20534791  htvat  2001001  3
*
20534800  es200101  mult  0.00609  0.0  1
20534801  htvat  2001001  cntrlvar  3479
*
20534810  hc200102  function  1.0E-06  0.0  1
20534811  htvat  2001002  3
*
20534820  es200102  mult  0.00609  0.0  1
20534821  htvat  2001002  cntrlvar  3481
*
20534830  hc210001  function  1.0E-06  0.0  1
20534831  htvat  2100001  3
*
20534840  es210001  mult  0.00820  0.0  1
20534841  htvat  2100001  cntrlvar  3483
*
20534850  hc215001  function  1.0E-06  0.0  1
20534851  htvat  2150001  3
*
20534860  es215001  mult  0.01715  0.0  1
20534861  htvat  2150001  cntrlvar  3485
```

```
*
20534870  hc220001  function  1.0E-06  0.0  1
20534871  htvat  2200001  3
*
20534880  es220001  mult  0.01075  0.0  1
20534881  htvat  2200001  cntrlvar  3487
*
20534890  hc220101  function  1.0E-06  0.0  1
20534891  htvat  2201001  3
*
20534900  es220101  mult  0.00113  0.0  1
20534901  htvat  2201001  cntrlvar  3489
*
20535010  hc225001  function  1.0E-06  0.0  1
20535011  htvat  2250001  3
*
20535020  es225001  mult  0.00184  0.0  1
20535021  htvat  2250001  cntrlvar  3501
*
20535030  hc225002  function  1.0E-06  0.0  1
20535031  htvat  2250002  3
*
20535040  es225002  mult  0.00184  0.0  1
20535041  htvat  2250002  cntrlvar  3503
*
20535050  hc225003  function  1.0E-06  0.0  1
20535051  htvat  2250003  3
*
20535060  es225003  mult  0.00186  0.0  1
20535061  htvat  2250003  cntrlvar  3505
*
20535070  hc225004  function  1.0E-06  0.0  1
20535071  htvat  2250004  3
*
20535080  es225004  mult  0.00186  0.0  1
20535081  htvat  2250004  cntrlvar  3507
*
20535090  hc225005  function  1.0E-06  0.0  1
20535091  htvat  2250005  3
*
20535100  es225005  mult  0.00186  0.0  1
20535101  htvat  2250005  cntrlvar  3509
*
20535110  hc225006  function  1.0E-06  0.0  1
20535111  htvat  2250006  3
*
20535120  es225006  mult  0.00186  0.0  1
20535121  htvat  2250006  cntrlvar  3511
*
20535130  hc225007  function  1.0E-06  0.0  1
20535131  htvat  2250007  3
*
20535140  es225007  mult  0.00186  0.0  1
20535141  htvat  2250007  cntrlvar  3513
*
20535150  hc225008  function  1.0E-06  0.0  1
20535151  htvat  2250008  3
*
20535160  es225008  mult  0.00186  0.0  1
20535161  htvat  2250008  cntrlvar  3515
*
20535170  hc225009  function  1.0E-06  0.0  1
20535171  htvat  2250009  3
```

```
*
20535180  es225009  mult  0.00186  0.0  1
20535181  htvat  2250009  cntrlvar  3517
*
20535190  hc225010  function  1.0E-06  0.0  1
20535191  htvat  2250010  3
*
20535200  es225010  mult  0.00186  0.0  1
20535201  htvat  2250010  cntrlvar  3519
*
20535210  hc225011  function  1.0E-06  0.0  1
20535211  htvat  2250011  3
*
20535220  es225011  mult  0.00238  0.0  1
20535221  htvat  2250011  cntrlvar  3521
*
20535230  hc225012  function  1.0E-06  0.0  1
20535231  htvat  2250012  3
*
20535240  es225012  mult  0.00238  0.0  1
20535241  htvat  2250012  cntrlvar  3523
*
20535250  hc225013  function  1.0E-06  0.0  1
20535251  htvat  2250013  3
*
20535260  es225013  mult  0.00186  0.0  1
20535261  htvat  2250013  cntrlvar  3525
*
20535270  hc225014  function  1.0E-06  0.0  1
20535271  htvat  2250014  3
*
20535280  es225014  mult  0.00186  0.0  1
20535281  htvat  2250014  cntrlvar  3527
*
20535290  hc225015  function  1.0E-06  0.0  1
20535291  htvat  2250015  3
*
20535300  es225015  mult  0.00186  0.0  1
20535301  htvat  2250015  cntrlvar  3529
*
20535310  hc225016  function  1.0E-06  0.0  1
20535311  htvat  2250016  3
*
20535320  es225016  mult  0.00186  0.0  1
20535321  htvat  2250016  cntrlvar  3531
*
20535330  hc225017  function  1.0E-06  0.0  1
20535331  htvat  2250017  3
*
20535340  es225017  mult  0.00186  0.0  1
20535341  htvat  2250017  cntrlvar  3533
*
20535350  hc225018  function  1.0E-06  0.0  1
20535351  htvat  2250018  3
*
20535360  es225018  mult  0.00186  0.0  1
20535361  htvat  2250018  cntrlvar  3535
*
20535370  hc225019  function  1.0E-06  0.0  1
20535371  htvat  2250019  3
*
20535380  es225019  mult  0.00186  0.0  1
20535381  htvat  2250019  cntrlvar  3537
```

```
*
20535390  hc225020  function  1.0E-06  0.0  1
20535391  htvat  2250020  3
*
20535400  es225020  mult  0.00186  0.0  1
20535401  htvat  2250020  cntrlvar  3539
*
20535410  hc225021  function  1.0E-06  0.0  1
20535411  htvat  2250021  3
*
20535420  es225021  mult  0.00184  0.0  1
20535421  htvat  2250021  cntrlvar  3541
*
20535430  hc225022  function  1.0E-06  0.0  1
20535431  htvat  2250022  3
*
20535440  es225022  mult  0.00184  0.0  1
20535441  htvat  2250022  cntrlvar  3543
*
20535460  es-Sgtub  sum  1.0  0.0  1
20535461  0.0  1.0  cntrlvar  3502  1.0  cntrlvar  3504
20535462  1.0  cntrlvar  3506  1.0  cntrlvar  3508
20535463  1.0  cntrlvar  3510  1.0  cntrlvar  3512
20535464  1.0  cntrlvar  3514  1.0  cntrlvar  3516
20535465  1.0  cntrlvar  3518  1.0  cntrlvar  3520
20535466  1.0  cntrlvar  3522  1.0  cntrlvar  3524
20535467  1.0  cntrlvar  3526  1.0  cntrlvar  3528
20535468  1.0  cntrlvar  3530  1.0  cntrlvar  3532
+  1.0  cntrlvar  3534  1.0  cntrlvar  3536
+  1.0  cntrlvar  3538  1.0  cntrlvar  3540
+  1.0  cntrlvar  3542  1.0  cntrlvar  3544
*
20535470  hc225101  function  1.0E-06  0.0  1
20535471  htvat  2251001  3
*
20535480  es225101  mult  0.00870  0.0  1
20535481  htvat  2251001  cntrlvar  3547
*
20535490  hc225102  function  1.0E-06  0.0  1
20535491  htvat  2251002  3
*
20535500  es225102  mult  0.00870  0.0  1
20535501  htvat  2251002  cntrlvar  3549
*
20535510  hc228001  function  1.0E-06  0.0  1
20535511  htvat  2280001  3
*
20535520  es228001  mult  0.00909  0.0  1
20535521  htvat  2280001  cntrlvar  3551
*
20535530  hc230001  function  1.0E-06  0.0  1
20535531  htvat  2300001  3
*
20535540  es230001  mult  0.01237  0.0  1
20535541  htvat  2300001  cntrlvar  3553
*
20535550  hc235001  function  1.0E-06  0.0  1
20535551  htvat  2350001  3
*
20535560  es235001  mult  0.17279  0.0  1
20535561  htvat  2350001  cntrlvar  3555
*
20535570  hc240001  function  1.0E-06  0.0  1
```

```
20535571  htvat  2400001  3
*
20535580  es240001  mult  0.00701  0.0  1
20535581  htvat  2400001  cntrlvar  3557
*
20535590  hc250001  function  1.0E-06  0.0  1
20535591  htvat  2500001  3
*
20535600  es250001  mult  0.00592  0.0  1
20535601  htvat  2500001  cntrlvar  3559
*
20535610  hc250002  function  1.0E-06  0.0  1
20535611  htvat  2500002  3
*
20535620  es250002  mult  0.00196  0.0  1
20535621  htvat  2500002  cntrlvar  3561
*
20535630  hc250003  function  1.0E-06  0.0  1
20535631  htvat  2500003  3
*
20535640  es250003  mult  0.00337  0.0  1
20535641  htvat  2500003  cntrlvar  3563
*
20535650  hc258001  function  1.0E-06  0.0  1
20535651  htvat  2580001  3
*
20535660  es258001  mult  0.00544  0.0  1
20535661  htvat  2580001  cntrlvar  3565
*
20535670  hc260001  function  1.0E-06  0.0  1
20535671  htvat  2600001  3
*
20535680  es260001  mult  0.00198  0.0  1
20535681  htvat  2600001  cntrlvar  3567
*
20535690  hc270001  function  1.0E-06  0.0  1
20535691  htvat  2700001  3
*
20535700  es270001  mult  0.00553  0.0  1
20535701  htvat  2700001  cntrlvar  3569
*
20535710  hc270002  function  1.0E-06  0.0  1
20535711  htvat  2700002  3
*
20535720  es270002  mult  0.00553  0.0  1
20535721  htvat  2700002  cntrlvar  3571
*
20535730  hc270003  function  1.0E-06  0.0  1
20535731  htvat  2700003  3
*
20535740  es270003  mult  0.00872  0.0  1
20535741  htvat  2700003  cntrlvar  3573
*
20535750  hc270004  function  1.0E-06  0.0  1
20535751  htvat  2700004  3
*
20535760  es270004  mult  0.00578  0.0  1
20535761  htvat  2700004  cntrlvar  3575
*
20535770  es-PCpip  sum  1.0  0.0  1
20535771  0.0  1.0  cntrlvar  3472  1.0  cntrlvar  3474
20535772  1.0  cntrlvar  3476  1.0  cntrlvar  3478
20535773  1.0  cntrlvar  3480  1.0  cntrlvar  3482
```

```
20535774  1.0  cntrlvar  3484  1.0  cntrlvar  3486
20535775  1.0  cntrlvar  3488  1.0  cntrlvar  3490
20535776  1.0  cntrlvar  3546  1.0  cntrlvar  3548
20535777  1.0  cntrlvar  3550  1.0  cntrlvar  3552
20535778  1.0  cntrlvar  3554  1.0  cntrlvar  3556
+  1.0  cntrlvar  3558  1.0  cntrlvar  3560
+  1.0  cntrlvar  3562  1.0  cntrlvar  3564
+  1.0  cntrlvar  3566  1.0  cntrlvar  3568
+  1.0  cntrlvar  3570  1.0  cntrlvar  3572
+  1.0  cntrlvar  3574  1.0  cntrlvar  3576
*
20535780  es-PCS  sum  1.0  0.0  1
20535781  0.0  1.0  cntrlvar  3468  1.0  cntrlvar  3577
*
****************************
*
.
*******************************************************
* split hot duct input model
*******************************************************
* Input for a split hot duct is provided below. In addition to the hot duct, the
outlet plenum
* and RCST nodalizations are changed.
*
* The hot duct is split into top and bottom halves, and is extended to include all of
the
* piping between the pressure vessel and the RCST.
*
* The upper volume in the RCST is modeled as a large, short volume so that both the
top
* half of the hot duct and the cold duct can be connected to it. This provides a
large, well-mixed
* volume of gas to be circulated back into the primary coolant system. A small
* component is added to make the connection from the large RCST volume to the
* bottom of the hot duct.
*
* The outlet plenum is divided into four components: a volume at the top that connects
* to all of the core channels, a volume between this upper volume and the top half of
the
* hot duct, a vertical pipe containing most of the plenum volume (connected at the top
* to the upper volume), and a volume between the bottom half of the hot duct and the
pipe.
*
* The hot duct heat structures are changed to reflect the new nodalization, and one
* structure in the vessel outlet plenum has its left volume connection changed.
*
* Control variables are added and updated to reflect the new nodalization.
*
* Delete replaced/unneeded components and structures if renodalizing on a restart. If
* this model is being used for a new problem, delete or comment out the full component
input.
*
2050000  V-313  delete
2100000  hot-RCST  delete
12100000  delete
*
* PSR-to-barrel gap outlet junction
*
1680000  PSRoutlt  sngljun
1680101  166150002  185010002  0.00596  0.84  0.46  0
1680201  0  0.0  0.0  0.0
*
* core outlet plenum
```

```
*
1750000  outplenm  branch
1750001  2  1
1750101  0.7296  0.02000  0.0
1750102  0.0  -90.0  -0.02000
1750103  0.000046  0.097  0
1750200  3  1.00E+05  960.15
1751101  175010000  185000000  0.0  0.0  0.0  0
1752101  183010000  175010000  0.0  0.0  0.0  0
1751110  0.0  0.0  1.0  1.0
1752110  0.0  0.0  1.0  1.0
1751201  0.0  0.0  0.0
1752201  0.0  0.0  0.0
*
* outlet plenum volume connected to hot duct bottom half
*
1800000  opbothd  branch
1800001  2  1
1800101  0.0365  0.16898  0.0
1800102  0.0  -90.0  -0.16898
1800103  0.000046  0.097  0
1800200  3  1.00E+05  960.15
1801101  206010000  180010003  0.0  0.0  0.0  0
1802101  180010002  183000000  0.0  0.0  0.0  0
1801110  0.0  0.0  1.0  1.0
1802110  0.0  0.0  1.0  1.0
1801201  0.0  0.0  0.0
1802201  0.0  0.0  0.0
*
* outlet plenum pipe
*
1830000  oplenum  pipe
1830001  5
1830101  0.6931  5
1830301  0.04045  5
1830401  0.0  5
1830601  90.0  5
1830801  0.000046  0.097  5
1830901  0.0  0.0  4
1831001  0  5
1831101  0  4
1831201  3  1.00E+05  960.15  0.0  0.0  0.0  5
1831300  1
1831301  0.0  0.0  0.0  4
1831401  0.0  0.0  1.0  1.0  4
*
* outlet plenum volume connected to hot duct top half
*
1850000  optophd  branch
1850001  1  1
1850101  0.0365  0.03327  0.0
1850102  0.0  -90.0  -0.03327
1850103  0.000046  0.097  0
1850200  3  1.00E+05  960.15
1851101  185010004  200000000  0.0  0.0  0.0  0
1851110  0.0  0.0  1.0  1.0
1851201  0.0  0.0  0.0
*
* hot duct top
*
2000000  "duct top" pipe
2000001  7
2000101  0.0349  4
```

```
2000102  0.0350  6
2000103  0.0350  7
2000301  0.43180  1
2000302  0.65095  2
2000303  0.41270  3
2000304  0.41270  4
2000305  0.49058  5
2000306  0.49058  6
2000307  0.66040  7
2001901  0.14898  7
2000401  0.0  7
2000601  0.0  7
2000801  0.000046  0.29797  4
2000802  0.000046  0.29845  6
2000803  0.000046  0.29845  7
2002401  0.0  0.0  7
2000901  0.0  0.0  4
2000902  0.057  0.057  5
2000903  0.0  0.0  6
2001001  0  7
2001101  0  6
2001201  3  1.00E+05  960.15  0.0  0.0  0.0  1
2001202  3  1.00E+05  960.15  0.0  0.0  0.0  2
2001203  3  1.00E+05  960.15  0.0  0.0  0.0  3
2001204  3  1.00E+05  960.15  0.0  0.0  0.0  4
2001205  3  1.00E+05  960.15  0.0  0.0  0.0  5
2001206  3  1.00E+05  960.15  0.0  0.0  0.0  6
2001207  3  1.00E+05  960.15  0.0  0.0  0.0  7
2001300  1
2001301  0.0  0.0  0.0  6
2001401  0.0  0.0  1.0  1.0  6
*
* hot duct top connection to RCST
*
2010000  "top-RCST" sngljun
2010101  200010000  280020003  0.0350  1.0  0.5  0
2010201  1  0.0  0.0  0.0
*
* hot duct bottom
*
2060000  "duct bot" pipe
2060001  7
2060101  0.0350  1
2060102  0.0350  3
2060103  0.0349  7
2060301  0.66040  1
2060302  0.49058  2
2060303  0.49058  3
2060304  0.41270  4
2060305  0.41270  5
2060306  0.65095  6
2060307  0.43180  7
2061901  0.05327  7
2060401  0.0  7
2060601  0.0  7
2060801  0.000046  0.29845  1
2060802  0.000046  0.29845  3
2060803  0.000046  0.29797  7
2062401  0.0  0.0  7
2060901  0.0  0.0  1
2060902  0.06  0.06  2
2060903  0.0  0.0  6
2061001  0  7
```

```
2061101  0  6
2061201  3  1.00E+05  960.15  0.0  0.0  0.0  1
2061202  3  1.00E+05  960.15  0.0  0.0  0.0  2
2061203  3  1.00E+05  960.15  0.0  0.0  0.0  3
2061204  3  1.00E+05  960.15  0.0  0.0  0.0  4
2061205  3  1.00E+05  960.15  0.0  0.0  0.0  5
2061206  3  1.00E+05  960.15  0.0  0.0  0.0  6
2061207  3  1.00E+05  960.15  0.0  0.0  0.0  7
2061300  1
2061301  0.0  0.0  0.0  6
2061401  0.0  0.0  1.0  1.0  6
*
* connections between hot duct top and bottom volumes
*
2090000  hotduct  mtpljun
2090001  7  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090011  206070006  200010005  0.12866  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090012  0  0  0  1
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090021  206060006  200020005  0.19396  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090022  0  0  0  2
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090031  206050006  200030005  0.12297  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090032  0  0  0  3
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090041  206040006  200040005  0.12297  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090042  0  0  0  4
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090051  206030006  200050005  0.14641  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090052  0  0  0  5
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090061  206020006  200060005  0.14641  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090062  0  0  0  6
* 0nnm  from  to  area  kfor  krev  efvcahs  sub  2ph  sup
2090071  206010006  200070005  0.19710  0.1  0.1  0  1.0  1.0  1.0
*  inc-frm  inc-to  0  limit
2090072  0  0  0  7
* 1nnm  mflowf  mflowg  #
2091011  0.0  0.0  1
2091021  0.0  0.0  2
2091031  0.0  0.0  3
2091041  0.0  0.0  4
2091051  0.0  0.0  5
2091061  0.0  0.0  6
2091071  0.0  0.0  7
* 2nnm  Dhyd  b  c  m  #
2092011  0.0  0.0  1.0  1.0  1
2092021  0.0  0.0  1.0  1.0  2
2092031  0.0  0.0  1.0  1.0  3
2092041  0.0  0.0  1.0  1.0  4
2092051  0.0  0.0  1.0  1.0  5
2092061  0.0  0.0  1.0  1.0  6
2092071  0.0  0.0  1.0  1.0  7
*
* reactor cavity simulation tank (two-volume configuration)
*
```

```
2800000  RCST  pipe
2800001  2
2800101  0.0  2
2800301  1.5240  1
2800302  0.14898  2
2800401  3.8  1
2800402  14.1  2
2800601  90.0  2
2800701  1.5240  1
2800702  0.14898  2
2800801  0.000046  2.0828  2
2800901  0.0  0.0  1
2801001  0  2
2801101  0  1
2801201  3  1.00E+05  300.00  0.0  0.0  0.0  2
2801300  1
2801301  0.0  0.0  0.0  1
*
* small RCST volume connected to hot duct bottom half
*
2820000  optophd  branch
2820001  2  1
2820101  0.0340  0.02663  0.0
2820102  0.0  -90.0  -0.02663
2820103  0.000000  2.083  0
2820200  3  1.00E+05  300.00
2821101  280020001  282000000  0.0  0.0  0.0  0
2822101  282010000  206000000  0.0350  0.5  1.0  0
2821110  0.0  0.0  1.0  1.0
2822110  0.0  0.0  1.0  1.0
2821201  0.0  0.0  0.0
2822201  0.0  0.0  0.0
*
* outlet plenum lower plate - heat structure 1750
*
11750000  1  9  1  0  0.0  0
11750100  0  1
11750101  4  0.079375
11750102  2  0.111375
11750103  2  0.136775
11750201  -1  4
11750202  -1  6
11750203  3  8
11750301  0.0  8
11750400  -1
11750401  960.0  960.0  900.0  900.0  800.0  700.0  700.0  600.0  600.0
11750501  183010000  0  1  1  1.7713  1
11750601  105020000  0  1  1  1.7713  1
11750701  0  0.0  0.0  0.0  1
11750800  1
11750801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.14  1.1  1.0  1
11750900  1
11750901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.14  1.1  1.0  1
*
* hot duct top half, volumes 1-4 - heat structure 2000
*
12000000  4  9  2  0  0.148984  0
12000100  0  1
12000101  1  0.1524
12000102  4  0.161925
12000103  3  0.1653413
12000201  3  1  * 304 stainless steel
12000202  -8  5  * alumina silica insulation
```

```
12000203  3  8  * 304 stainless steel
12000301  0.0  8
12000400  -1
12000401  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12000402  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12000403  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12000404  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12000501  200010000  0  1  1  0.2159  1
12000502  200020000  0  1  1  0.3255  2
12000503  200030000  0  1  1  0.2064  3
12000504  200040000  0  1  1  0.2064  4
12000601  270040000  0  1  1  0.2159  1
12000602  270030000  0  1  1  0.3255  2
12000603  270020000  0  1  1  0.2064  3
12000604  270010000  0  1  1  0.2064  4
12000701  0  0.0  0.0  0.0  4
12000800  1
12000801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  4
12000900  1
12000901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.33  1.1  1.0  4
*
* hot duct top half, volumes 5 and 6 - heat structure 2001
*
12001000  2  7  2  0  0.149225  0
12001100  0  1
12001101  3  0.161925
12001102  3  0.212925
12001201  3  3  * 304 stainless steel
12001202  -9  6  * pipe insulation
12001301  0  6
12001400  -1
12001401  400.0  400.0  400.0  350.0  350.0  300.0  300.0
12001402  400.0  400.0  400.0  350.0  350.0  300.0  300.0
12001501  200050000  10000  1  1  0.2453  2
12001601  -950  0  3951  1  0.2453  2
12001701  0  0.0  0.0  0.0  2
12001800  1
12001801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  2
*
* hot duct top half, volume 7 - heat structure 2002
*
12002000  1  4  2  0  0.1492  0
12002100  0  1
12002101  3  0.161925
12002201  3  3  * 304 stainless steel
12002301  0.0  3
12002400  -1
12002401  400.0  400.0  350.0  300.0
12002501  200070000  0  1  1  0.3302  1
12002601  280020000  0  1  1  0.3302  1
12002701  0  0.0  0.0  0.0  1
12002800  1
12002801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  1
12002900  1
12002901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.32  1.1  1.0  1
*
* hot duct bottom half, volume 1 - heat structure 2060
*
12060000  1  4  2  0  0.1492  0
12060100  0  1
12060101  3  0.161925
12060201  3  3  * 304 stainless steel
12060301  0.0  3
```

```
12060400  -1
12060401  400.0  400.0  350.0  300.0
12060501  206010000  0  1  1  0.3302  1
12060601  280020000  0  1  1  0.3302  1
12060701  0  0.0  0.0  0.0  1
12060800  1
12060801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  1
12060900  1
12060901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.32  1.1  1.0  1
*
* hot duct bottom half, volumes 2 and 3 - heat structure 2061
*
12061000  2  7  2  0  0.149225  0
12061100  0  1
12061101  3  0.161925
12061102  3  0.212925
12061201  3  3  * 304 stainless steel
12061202  -9  6  * pipe insulation
12061301  0  6
12061400  -1
12061401  400.0  400.0  400.0  350.0  350.0  300.0  300.0
12061402  400.0  400.0  400.0  350.0  350.0  300.0  300.0
12061501  206020000  10000  1  1  0.2453  2
12061601  -950  0  3951  1  0.2453  2
12061701  0  0.0  0.0  0.0  2
12061800  1
12061801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  2
*
* hot duct bottom half, volumes 4-7 - heat structure 2062
*
12062000  4  9  2  0  0.148984  0
12062100  0  1
12062101  1  0.1524
12062102  4  0.161925
12062103  3  0.1653413
12062201  3  1  * 304 stainless steel
12062202  -8  5  * alumina silica insulation
12062203  3  8  * 304 stainless steel
12062301  0.0  8
12062400  -1
12062401  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12062402  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12062403  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12062404  900.0  800.0  700.0  600.0  500.0  450.0  400.0  350.0  300.0
12062501  206040000  0  1  1  0.2064  1
12062502  206050000  0  1  1  0.2064  2
12062503  206060000  0  1  1  0.3255  3
12062504  206070000  0  1  1  0.2159  4
12062601  270010000  0  1  1  0.2064  1
12062602  270020000  0  1  1  0.2064  2
12062603  270030000  0  1  1  0.3255  3
12062604  270040000  0  1  1  0.2159  4
12062701  0  0.0  0.0  0.0  4
12062800  1
12062801  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.30  1.1  1.0  4
12062900  1
12062901  0.0  1.0  1.0  0.0  0.0  0.0  0.0  1.0  0.33  1.1  1.0  4
*
* control variables
*
* environmental heat loss calculations
*
20514010  hs200ehl  sum  1.0  0.0  1
```

```
20514011  0.0  0.328  htrnr  200100101  0.328  htrnr  200100201
20514012  0.328  htrnr  206100101  0.328  htrnr  206100201
*
* coolant mass calculations
*
20516150  masshleg  sum  1.0  0.0  1
20516151  0.0  1.0  tmassv  200010000  1.0  tmassv  200020000
20516152  1.0  tmassv  200030000  1.0  tmassv  200040000
20516153  1.0  tmassv  200050000  1.0  tmassv  200060000
20516154  1.0  tmassv  200070000  1.0  tmassv  206010000
20516155  1.0  tmassv  206020000  1.0  tmassv  206030000
20516156  1.0  tmassv  206040000  1.0  tmassv  206050000
20516157  1.0  tmassv  206060000  1.0  tmassv  206070000
*
20516210  massRCST  sum  1.0  0.0  1
20516211  0.0  1.0  tmassv  282010000  1.0  tmassv  258010000
20516212  1.0  tmassv  280010000  1.0  tmassv  280020000
*
* structure energy storage calculations
*
20534720  es200001  mult  0.00146  0.0  1
20534721  htvat  2000001  cntrlvar  3471
*
20534740  es200002  mult  0.00220  0.0  1
20534741  htvat  2000002  cntrlvar  3473
*
20534760  es200003  mult  0.00139  0.0  1
20534761  htvat  2000003  cntrlvar  3475
*
20534780  es200004  mult  0.00139  0.0  1
20534781  htvat  2000004  cntrlvar  3477
*
20534800  es200101  mult  0.00305  0.0  1
20534801  htvat  2001001  cntrlvar  3479
*
20534820  es200102  mult  0.00305  0.0  1
20534821  htvat  2001002  cntrlvar  3481
*
20534830  hc200201  function  1.0E-06  0.0  1
20534831  htvat  2002001  3
*
20534840  es200201  mult  0.00410  0.0  1
20534841  htvat  2002001  cntrlvar  3483
*
20535770  es-PCpip  sum  1.0  0.0  1
20535771  0.0  1.0  cntrlvar  3472  1.0  cntrlvar  3474
20535772  1.0  cntrlvar  3476  1.0  cntrlvar  3478
20535773  1.0  cntrlvar  3480  1.0  cntrlvar  3482
20535774  1.0  cntrlvar  3484  1.0  cntrlvar  3486
20535775  1.0  cntrlvar  3488  1.0  cntrlvar  3490
20535776  1.0  cntrlvar  3546  1.0  cntrlvar  3548
20535777  1.0  cntrlvar  3550  1.0  cntrlvar  3552
20535778  1.0  cntrlvar  3554  1.0  cntrlvar  3556
+  1.0  cntrlvar  3558  1.0  cntrlvar  3560
+  1.0  cntrlvar  3562  1.0  cntrlvar  3564
+  1.0  cntrlvar  3566  1.0  cntrlvar  3568
+  1.0  cntrlvar  3570  1.0  cntrlvar  3572
+  1.0  cntrlvar  3574  1.0  cntrlvar  3576
+  1.0  cntrlvar  3582  1.0  cntrlvar  3584
+  1.0  cntrlvar  3586  1.0  cntrlvar  3588
+  1.0  cntrlvar  3590  1.0  cntrlvar  3592
+  1.0  cntrlvar  3594
*
```

```
20535810  hc206001  function  1.0E-06  0.0  1
20535811  htvat  2060001  3
*
20535820  es206001  mult  0.00410  0.0  1
20535821  htvat  2060001  cntrlvar  3581
*
20535830  hc206101  function  1.0E-06  0.0  1
20535831  htvat  2061001  3
*
20535840  es206101  mult  0.00305  0.0  1
20535841  htvat  2061001  cntrlvar  3583
*
20535850  hc206102  function  1.0E-06  0.0  1
20535851  htvat  2061002  3
*
20535860  es206102  mult  0.00305  0.0  1
20535861  htvat  2061002  cntrlvar  3585
*
20535870  hc206201  function  1.0E-06  0.0  1
20535871  htvat  2062001  3
*
20535880  es206201  mult  0.00139  0.0  1
20535881  htvat  2062001  cntrlvar  3587
*
20535890  hc206202  function  1.0E-06  0.0  1
20535891  htvat  2062002  3
*
20535900  es206202  mult  0.00139  0.0  1
20535901  htvat  2062002  cntrlvar  3589
*
20535910  hc206203  function  1.0E-06  0.0  1
20535911  htvat  2062003  3
*
20535920  es206203  mult  0.00220  0.0  1
20535921  htvat  2062003  cntrlvar  3591
*
20535930  hc206204  function  1.0E-06  0.0  1
20535931  htvat  2062004  3
*
20535940  es206204  mult  0.00146  0.0  1
20535941  htvat  2062004  cntrlvar  3593
*
```