RAMONA-4B

A Computer Code With Three-Dimensional Neutron Kinetics for BWR and SBWR System Transient

User's Manual

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ABSTRACT

This document is the User's Manual for the Boiling Water Reactor (BWR), and Simplified Boiling Water Reactor (SBWR) systems transient code RAMONA-4B. The code uses a three-dimensional neutron-kinetics model coupled with a multichannel, nonequilibrium, drift-flux, phase-flow model of the thermal hydraulics of the reactor vessel. The code is designed to analyze a wide spectrum of BWR core and system transients.

Chapter 1 gives an overview of the code's capabilities and limitations; Chapter 2 describes the code's structure, lists major subroutines, and discusses the computer requirements. Chapter 3 is on code, auxiliary codes, and instructions for running RAMONA-4B on Sun SPARC and IBM Workstations. Chapter 4 contains component descriptions and detailed card-by-card input instructions. Chapter 5 provides samples of the tabulated output for the steady-state and transient calculations and discusses the plotting procedures for the steady-state and transient calculations.

Three appendices contain important user and programmer information: lists of plot variables (Appendix A) listings of input deck for sample problem (Appendix B), and a description of the plotting program PAD (Appendix C).

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EXECUTIVE SUMMARY

The RAMONA-4B code is designed to analyze a wide spectrum of core and system transients for Boiling Water Reactors (BWR). The code uses a three-dimensional neutron kinetics model coupled with a multichannel, non-equilibrium, drift-flux, two-phase flow model of the thermal hydraulics of the reactor vessel.

Since 1979, when the RAMONA-III code was acquired by the US Nuclear Regulatory Commission from Scandpower, Norway, numerous modifications and improvements to the code were made at Brookhaven National Laboratory (BNL). Several new models were developed and implemented into the code, and existing models were modified. RAMONA-4B has the following new models since RAMONA-III:

- Decay heat,
- new format for the cross-section feedback representation,
- post-CHF heat transfer and vapor generation,
- heat structure,
- drift-flux model for the thermal-hydraulics of the vessel,
- flow reversal logics,
- wall-friction factor calculation including the laminar-flow regime,
- new two-phase friction multiplier for the pressure form losses,
- flow-dependent loss coefficients,
- recirculation-pump model based on homologous curves,
- steam condensation on feedwater and/or safety injection water,
- jet-pump model,
- Stream Line dynamics,
- system pressure regulator,
- BWR-specific feedwater control system,
- plant protection systems,
- Standby Liquid Control System,
- boron transport,
- isolation condenser,
- balance of plant, and
- low-pressure properties.

An editing procedure for calculating the total core reactivity has been developed and, is available in RAMONA-4B. This procedure provides the code users with an important tool to interpret the total core power history predicted in the transient calculations.

RAMONA-4B code structure has been streamlined with consistent naming convention for all the routines, and common definitions for similar COMMON blocks. The new models and features added to the code are in modular forms and can be easily changed without affecting the rest of the code. RAMONA-4B is running and being maintained on SUN SPARC-10 as well as IBM RISC-6000 workstations at BNL. The code input description has been modified to include the new features in the code, such as the Isolation Condenser or Balance of Plant etc. Furthermore, the flexibility of the code has been increased by placing the coefficients in many models as user input. The RAMONA-4B output consists of major edit and plot files, both of which have been upgraded. The plot files are processed by PAD, a BNL program which produces inputs for plotting packages such as DISPLA and NASADIG.

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NOMENCLATURE

$\Delta\tau$	Time Step
ACCF	Time step control in neutronic calculation
ACCH	Maximum value for relative truncation error in hydraulics
EE	Accuracy
EF	Maximum (local) relative error of the fast neutron flux in the neutronic calculation
H	Hydraulics calculation
HS	Steady state hydraulics calculation
HT	Transient hydraulics calculation
IPTOTL	Option for output of scaler variables
ITEST	Test the consistency of some input data
ITYP	The type of calculation requested; steady state or transient
N	Neutronics calculation
NIN	Entrance boundary of the first cell of a component
NOUT	Exit boundary of the last cell of a component
NS	Steady state neutronics calculation
NSTMOP	Option for steamline calculation
NT	Transient neutronics calculation

1. INTRODUCTION

1.1 Report Outline

The present document consists of five chapters and three appendices. Chapter 1 overviews the code's capabilities and limitations. Chapter 2 describes the code's structure, lists major subroutines, and discusses the computer requirements. Chapter 3 provides details on implementation of the RAMONA-4B code on the Sun SPARC 10 Workstations and IBM RS 6000 Workstation and briefly discusses the auxiliary codes PAD, FRAM, and BLEND.

Manuals for the auxiliary codes FRAM and BLEND have not been published. The program FRAM produces cross-sections for a 1-D core model using the cross-sections for a 3-D RAMONA-4B core model. This feature allows one to construct a fast-running plant model for cases where the three-dimensional effects are not expected to play a dominant role in the transient. The neutron cross-section code BLEND, developed at BNL, generates cross-section sets in the format compatible with RAMONA-4B.

Chapter 4 contains component descriptions and detailed card-by-card input instructions. Chapter 5 provides samples of the code's tabulated output for the steady-state and transient calculations. The plotting procedures for the steady-state and transient calculations are also discussed in Chapter 5.

Three appendices contain important user and programmer information: lists of the plot variables (Appendix A), listings of the input decks for a sample problem (Appendix B), and a description of the plotting program PAD (Appendix C).

1.2 Code Objectives

The RAMONA-4B code is designed to analyze a wide spectrum of core and system transients for Boiling Water Reactor (BWR), Advanced BWR (ABWR) and Simplified BWR (SBWR). The code uses a three-dimensional neutron-kinetics model coupled with a multichannel, nonequilibrium, drift-flux, two-phase flow formulation of thermal hydraulics of the reactor vessel. In addition, the code also includes models for SBWR specific components, complete control systems, recirculation loop dynamics with motor/generator set, new mechanistic steam separator, new detailed boron transport, SLCS dynamics, heat structures, Balance of Plant (BOP), and containment.

There are four major classes of BWR transients where the RAMONA-4B code can be effectively applied:

- Reactivity Transients Driven by Control-Rod Actions and Boron Injection,
- System Pressure Transients: Load Rejection, Turbine Trip, MSIV Closure, Failure of Pressure Regulator,
- Coolant Inventory Transients, and
- Coolant Temperature Transients.

The RAMONA-4B three-dimensional neutron-kinetics capability makes the code a unique tool for predicting transients and accidents where the spatial core power variations are expected to be significant. The code can also predict thermal-hydraulic instabilities occurring in the reactor system during operation or start-up.

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1.3 Code General Features

A schematic of the BWR system which can be modeled with RAMONA-4B is shown in Figure 1.1. The system consists of a feedwater sparger, upper and lower downcomers, a combined recirculation loop with recirculation and jet pumps, lower plenum, core, riser including an upper plenum and steam separators, a steam dome, a steamline with safety/relief valves, main steam isolation valve, turbine bypass valve and turbine stop valve, balance of plant, and containment. The code also has models for plant protection systems, safety injection systems, and plant control systems. Figure 1.2 shows a schematic diagram of the Simplified Boiling Water Reactor (SBWR), which is a natural circulation system designed without recirculation pumps. A tall chimney region above the core ensures sufficient buoyancy head to sustain the desired core flow. The details of the models are described elsewhere [Wulff et al. 1984, Rohatgi et al. 1996].

The reactor core is modeled by a group of parallel coolant channels and a bypass channel. Each coolant (thermal hydraulic) channel is interfaced with one or more fuel bundles. The reactor power, including decay heat, is calculated in a three-dimensional geometry although a one-dimensional calculation is also possible. The fission power calculation takes into account the feedback due to the fuel and coolant temperatures, void fraction, boron, presence of control rods, and fission product poisons (e.g., xenon). Changes in power shape and total reactor power due to the control-rod movements (including accidental rod drop and scram) and boron injection can be calculated. Most of the energy generated by nuclear fission and decay is deposited in the fuel pellets; a user-specified fraction of the total power can be directly deposited in the coolant and cladding. Thermal conduction through the fuel pellet, gas gap and fuel cladding eventually transfers the heat generated in the fuel to the coolant.

The thermal-hydraulic calculation of RAMONA-4B is based on a four-equation, nonequilibrium, drift-flux model. The four balance equations are: conservation of (a) vapor mass, (b) mixture mass, (c) mixture momentum, and (d) mixture energy. Two-phase mixture is allowed in the downcomer, lower plenum, core, and riser. The steam dome (above the two-phase mixture level) is occupied by saturated vapor, whereas the recirculation loop is assumed to contain only single-phase liquid.

In the two-phase mixture regions, **the liquid can be subcooled, saturated or superheated. However, the vapor is assumed to be at saturation.** Nonequilibrium vapor generation or condensation is calculated using a model described in the other companion document for the model description of RAMONA-4B [Rohatgi et al. 1996]. In addition to the vapor generation model, the constitutive relations package includes correlations for single and two-phase flow wall friction, heat transfer correlations for pre- and post-critical heat flux (CHF) regimes, a CHF correlation, and a library of thermodynamic and transport properties for the coolant and fuel rod materials.

The RAMONA-4B code has upgraded its thermodynamic and transport properties package to cover a wide range of pressures from 0.03 bar to 200 bar. In particular, the low-pressure properties make it possible to simulate startup transients with subcooled initial conditions.

The code also provides the capability to simulate the dynamics of a recirculation loop with motor/generator set, a new mechanistic steam separator, the balance of plant (BOP), and a mechanistic Mark I containment.

A standby liquid control system (SLCS) for injecting highly concentrated borated water into the reactor vessel is also modeled. The code also includes model for boron transport to calculate the boron concentration as a function of space and time. The isolation condenser (IC) system of SBWR [GE SSAR 1992] has also been modeled in RAMONA-4B.

The reactor pressure vessel (RPV) contains a large amount of structures. During normal operation or plant transients with little variation in pressure, the heat structures are in equilibrium with the coolant and do not play an important role. However, during start-up transients or transients where the coolant pressure varies significantly, the stored energy in the

structures becomes important. RAMONA-4B has heat structure models to simulate RPV wall and internal solid structures.

Steamline dynamics between the reactor pressure vessel and turbine is accounted for by solving the local vapor mass and momentum conservation equations. Adiabatic expansion and/or compression of steam is assumed in the steamline model. Models for the safety/relief valves, main steam isolation valve, and turbine bypass and stop valves are included.

The code has a model for the pressure regulator, feedwater control system, recirculation flow controller, and a level controller for the Emergency Procedure Guidelines (EPG). A plant protection system (PPS) designed to protect the reactor during abnormal transients and accidents is also modeled in RAMONA-4B. This system includes the reactor scram, recirculation pump trip, MSIV closure, and turbine or generator trip based on transient time (manual) or setpoints (automatic) for the thermal-hydraulic and neutronic system parameters. The PPS is described in further detail in Chapter 5 of the other companion report [Rohatgi et al. 1996].

A simplified flowchart of the RAMONA-4B calculational logic is shown in Figure 1.3. Neutron-kinetics and thermal-hydraulics are the two major parts of the code, while heat conduction in the fuel rods links these two parts together.

1.4 Code Capabilities

As follows from the discussion above, RAMONA-4B can be used to calculate the following types of transients:

1. Transients with Reactivity Changes, such as:

- Gradual or sudden withdrawal or insertion of control rods. This includes accidental drop of a single control rod, a cluster of rods or an arbitrary combination of rods,
- Full or partial reactor scram,
- Boron injection,
- Transients which induce changes in the moderator density (e.g., void collapse due to pressure rise in the reactor vessel).

2. Transients with System Pressure Changes, such as:

- Electric generator load rejection with fast closure of the turbine control valve,
- Turbine trip with closure of the turbine stop valve,
- Main steam isolation valve closure,
- Failure of pressure regulator.

3. Transients with Coolant Inventory and/or Mass Flow Rate Changes, such as:

- Faulty opening of safety and/or relief valves,
- Changes in feedwater flow (User specified feedwater flow rate vs. time, or from BOP),

1. Introduction

- Inadvertent actuation of safety injection systems,
- Inadvertent opening of isolation condenser liquid return valve,
- Trip or seizure of both recirculation pumps,
- Inadvertent operation of the standby liquid control system.

Figure 1.1 Schematic of the BWR4 System with BOP and Control Systems.

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Figure 1.2 Schematic of the SBWR System with Isolation Condenser.

Figure 1.3 Simplified Flowchart of RAMONA-4B Calculational Logic.

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4. Transients with Coolant Temperature Changes, such as:

- Loss of feedwater heater (User specified feedwater temperature vs. time, or from BOP),
- Partial failure of feedwater heaters.

RAMONA-4B's capability to predict most of the transients listed above has been demonstrated through several calculations: (a) Peach Bottom 2 Turbine Trip Test Simulations, (b) an MSIV Closure Partial-ATWS Calculation, and a Control Rod Drop Accident (CRDA) Analysis. Results of these analyses are discussed in the previous RAMONA-3B description and assessment report [Wulff et al. 1984a]. An MSIV-closure full-ATWS event also has been calculated using RAMONA-3B at BNL [Saha et al. 1987]. A set of runs has also been performed with the RAMONA-4B version of the code for ATWS and Stability prediction [Cheng et al. 1993, 1994, 1996, Khan et al. 1992, 1993, 1994, and Rohatgi et al. 1996].

RAMONA-4B can also be used for non-reactor applications such as simulation of thermal-hydraulic experiments conducted in heated test facilities. In these applications, the power applied to the test section has to be specified as an input. Also, the test facility to be simulated should have a general configuration similar to a BWR (Figure 1.1): it should include a downcomer, lower plenum, core, riser, and a steam dome.

The following RAMONA-4B improvement tasks are recommended for future work: (a) implementation of two recirculation loops with individual recirculation and jet pumps in each loop, and (b) implementation of an improved vapor generation model. In addition, future improvements should allow prediction of two-phase flow in the recirculation loop.

1.5 Code Limitations

As mentioned in the introduction, RAMONA-4B is a plant transient code and, therefore, it does not include the models for (a) counter-current flow limitation, (b) quench front propagation, © metal-water reaction, etc., which are required for Large Break Loss of Coolant Accident (LOCA) predictions. Also, RAMONA-4B **restricts the vapor phase to be at saturation**. Thus, RAMONA-4B is not applicable to the following types of transients:

- Large or small break in the recirculation loop.
- Large break in the steamline. However, a small break in the steamline (e.g., stuck-open safety/relief valves) can be analyzed.
- Transients where a long period of core uncover may occur (e.g., degraded core accidents).

1.6 Major Changes from RAMONA-3B/MOD0/CYCLE4

Since the time of completion of the RAMONA-3B description and assessment document in 1984 [Wulff et al. 1984], the code was substantially modified. There were three classes of changes: models developments and modifications, general code improvements, and code corrections.

1.6.1 Models Developments and Modifications

A number of new models were developed and implemented into the code and numerous modifications were made to the existing models. This section lists these models; more detail information on modifications to the modeling can be found in Chapters 2 through 8 of RAMONA-4B model description document [Rohatgi et al. 1996].

- The drift-flux model has been implemented in the code to replace the slip model for the hydraulic calculations in the reactor pressure vessel.
- In addition to the two-phase mixture level, the elevation of the collapsed water level in the downcomer is also calculated. The level tracking method has been extensively modified to be more accurate and robust. The predicted collapse water level is passed to the models of the plant protection systems, emergency core cooling systems (RCIC and HPCI), and the feedwater control system. The HPCI and RCIC models can be turned "on" or "off" depending on the elevation of the collapsed water level.
- A flow reversal logic has been implemented, which allows prediction of a reverse flow anywhere in the vessel.
- A model for steam condensation on feedwater and/or safety injection liquid was implemented in the code. It allows the prediction of the situation during an accident when the two-phase mixture level drops below the elevation of the feedwater spargers in the downcomer, and liquid is injected into the steam environment.
- The wall-friction-factor calculation was modified to include the laminar-flow regime.
- The core inlet form losses have been modified from being held at a constant value to a Reynold's-number-dependent loss coefficient.
- A new two-phase multiplier for the pressure form loss calculations was implemented.
- The property library for water has been extended to cover from low pressure region (0.03 bar) to 200 bar.
- A realistic recirculation loop dynamics model with motor-generator set has been implemented. In addition, a new recirculation pump model based on homologous curves for the head and torque [Madni et al., 1978] was added as an option.
- The code's capability to calculate natural circulation was limited to only the transient with a recirculation-pump trip. The capability has been extended to predict natural circulation for both the transient and steady state with no recirculation or jet pumps.
- A procedure for collapsing cross sections for a three-dimensional core model to a set of cross sections for a one-dimensional core model was developed and tested. The one-dimensional neutron kinetics model can be used at great savings of computer time for the transient (or steady state) calculations where the effects of power distribution in the radial directions are not expected to be significant (cylindrical geometry).

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- An editing procedure for calculating the total core reactivity as well as reactivity components (Doppler, void, moderator temperature, etc.) was developed by Scandpower, Norway for BNL and implemented in RAMONA-4B. This feature provides an important tool for interpreting the history of the core power predicted in the transient. The reactivity changes due to variations in the void fraction, moderator, and fuel temperatures, and control-rod insertion are calculated as four separate output variables.
- A new model for the isolation condenser (IC) has been developed and implemented in the code. This component is available in some BWRs, and will be an integral part of the SBWR.
- A Standby Liquid Control System (SLCS) model has been developed and implemented in the code. As a part of the passive safety system in the SBWR, the boron is injected into the vessel from a pressurized boron tank.
- A detailed boron transport model with capability for boron flow reversal has been implemented to replace a simple lumped-parameter model.
- The LAMBDA subroutine, which was used in the earlier slip model version of RAMONA for estimating the numerical stability limit associated with the explicit integration of hydraulic state equations, was revised for the new drift-flux model for two-phase flow and implemented in the code.
- A mechanistic steam separator model developed by General Electric Company for the joint USNRC-EPRI-GE sponsored BWR Refill-Reflood Program has been implemented in the code. This capability allows prediction of time-dependent steam carry-under, liquid carry-over, effective L/A ratio, and separator pressure drop.
- BWR specific control systems (pressure regulator, feedwater control system, and recirculation flow controller) have been developed and implemented in the code. The pressure regulator controls the system pressure by monitoring the turbine valve inlet pressure against a desired pressure setpoint. The feedwater control system monitors the collapsed water level in the downcomer and, based on the history of the steamline and feedwater flows, adjusts the feedwater injection rate such that the water level remains at the prescribed elevation. The recirculation flow controller enables the control of core flow by regulating the recirculation pump speed. These control systems are essential for analyzing operational transients.
- In addition, a level control system model was developed and implemented for keeping the water level near the top of active fuel (TAF) as required by the Emergency Procedure Guidelines (EPG).
- A model for the reactor water cleanup (RWCU) system was developed and implemented in the code. This capability is needed for startup transient simulations.
- First-principle mechanistic models for various BOP components (turbines, condensers, feedwater heaters, feedwater pumps, etc.) have been developed and implemented in the code. This capability together with the control systems make it possible to simulate operational transients and startup transients. It also eliminates the necessity of having to prescribe time-dependent boundary conditions for many system transients. It also provides the capability to study the effect of BOP component failure and the feedback effect of BOP on thermal-hydraulic stability.
- A mechanistic containment model for calculation of the drywell and wetwell dynamics including the pressure suppression pool (PSP) temperature and level has been developed and implemented in the code. This capability allows simulations of transients where prolonged discharge of steam into PSP by the Safety/Relief valves may be of concern regarding the containment integrity (for example, during an anticipated transient without scram, ATWS.)

- A new model for the recirculation pump head and torque equations in a non-dimensional form (homologous curves) [Ansari et al. 1981] was added as an option.

1.6.2 General Code Improvements

Numerous code improvements have been made to the RAMONA-3B code since the code description was completed in 1981 and published in 1984 [Wulff, et al., 1984a]. They are summarized as follows:

- A bypass flow adjustment calculation was made available by specifying through the input the fraction of the total core flow that passes through the bypass region of the core. An adjustment to the **bypass entrance form loss coefficient** is made during the steady-state iterations.
- The iterative procedure for calculating the local vapor generation rate and void fraction at the steady state has been improved to be faster and more robust by means of Newton-Raphson iteration.
- A capability for plotting the three-dimensional core void fraction was implemented into the code. This provides important data needed for interpreting the spatial behavior of the core power, which is influenced by the void fraction distribution (void reactivity effect).
- A new scheme for assigning cross sections to neutronics cells in the core has been implemented.
- A capability for periodic restart dumps controlled by users was made available to provide a restart capability after an unexpected termination of a computer run. (The original version created a restart file at the end of a calculation.)
- The wrap-up/restart capability has been extended to include all the new models implemented in the code.
- The physical limits imposed on the void fraction ($0 \leq \alpha \leq 1$) in the earlier version has been revised to impose the limits instead on the local vapor mass, the state variable which determines the void fraction. This guarantees the consistency between the two variables.
- Continuous monitoring of the computer time spent in different parts of the code is now available to the users for optimizing the plant model in terms of the code's running speed.
- A special message file (fort.3) has been added to record and store information on all trips triggered during the calculation, safety/relief or main steam isolation valves actions, control-rods' movements, messages generated by the numerical procedures, and time-step control.
- A debug file (fort.64) has been added to store information on various models for debugging.
- Code structure has been improved by defining a common set for common blocks. The variable names have been made consistent among the subroutines. Read and write files have been reduced, and the code has been installed on workstations and is being used to address SBWR transients.
- The graphics package has been expanded to include the NASADIG program. The PAD program has also been modified to produce the required input for NASADIG code.

1. Introduction

- The time-dependent boundary conditions in the code was limited to either a linear ramp or a sinusoidal function. Many realistic boundary conditions can not be represented by these functions. A new table-lookup function capability has been added in the code for the following operational variables:
 - (1) Core thermal power vs. Time,
 - (2) Feedwater flow vs. Time,
 - (3) Feedwater temperature vs. Time,
 - (4) Steam flow vs. Time,
 - (5) Level setpoint vs. Time (needed for EPG level control).
- A need arose in the investigation of SBWR startup instability to hold the system pressure constant once it reached a prescribed value. An option has therefore been added in the code to do just that via the input switch IPRES=-1 and the target pressure PTARGET.

1.6.3 Code Corrections

Corrections to the following parts of the code were made:

- Logic in the calculations for the steam flow boundary condition with "no steamline option" through the input variable NSTMOP=0 on Card 880000,
- Two-phase friction multiplier calculation,
- Static driving head calculation in the steam dome region,
- Void fraction and moderator temperature averaging procedures in the reactivity feedback calculations,
- Mixture level tracking in the steam dome and downcomer regions,
- Eigenvalue calculations at time zero, and
- Decay-heat model.

Also, the code's option for the "hydraulics only" calculation (input variable ITYP=5 or 7 on Card 140000) has been corrected. This option can be used to perform fast-running thermal-hydraulics calculations with the core power imposed as a boundary condition.

2 CODE STRUCTURE

2.1 General Overview of the Code

RAMONA-4B is written in FORTRAN 77. It is currently running and being maintained on SUN-SPARC-10 and IBM-RISC-6000 Workstations at BNL.

Operational features include restart from steady-state and transient calculations by restarting from the last transient time step.

The user-specified calculation data are stored at the conclusion of the calculation as an ASCII output file. The output file name is specified by the user at run time. This file also includes a summary of the data which are written out to the plot file. The plot data are stored on disk file fort.49 as a binary file formatted for processing by a general purpose plotting program, PAD (Appendix C) or NASADIG.

RAMONA-4B is a fixed dimensions code. Therefore, there is a number of model parameters which have an upper limit. The present values of the model limiting parameters are shown below.

Model list of limiting parameters for RAMONA-4B Neutronics and Thermal Hydraulics Calculations:

• Maximum number of axial cells in the core	24.
• Maximum number of hydraulic channels	200.
• Maximum number of neutronic channels	804.
• Maximum number of hydraulic cells in a loop	55.
• Maximum number of cross-section sets (fuel types)	1000.

The present limiting parameters allow one to create a full core neutronic model with each fuel bundle represented explicitly. It should be noted that these limits can be changed through code modification.

2.2 RAMONA-4B Program Flow

For easier understanding of the RAMONA-4B computer program, several block diagrams are presented in this section. The subroutines called by the main program RAMONA and other major subroutines are presented here. Program flow diagrams with descriptions are presented in Figures 2.1 through 2.4. The subroutines called by the main program RAMONA are shown in Figure 2.1. They consist of the routines performing the input data processing, steady-state calculation (subroutine STATIC), data preparation for transient, transient calculation (subroutine DYNICS), and the output data processing.

2. Code Structure

Figure 2.2 shows the subroutines called by the steady-state steering routine **STATIC**. There are two main subroutines; namely, **SAHRA** and **POLKA**, which control the steady-state hydraulic and neutronic calculations; respectively. The subroutines called by these two steady-state routines are also depicted in Figure 2.2.

Figures 2.3 and 2.4 show the flow diagrams pertinent to the transient calculation. The steering program for the transient hydraulic and neutronic calculations are the subroutines **NUMINT** and **DYN**; respectively. Figure 2.3 shows the details of the code structure related to the transient thermal-hydraulic calculation, whereas Figure 2.4 shows similar details for the transient neutronic calculation. Figure 2.3 also shows the subroutines related to the control and protection systems.

In what follows, we will present more detailed program flow diagrams for the main program and key steering routines. Brief descriptions of all the subroutines of RAMONA-4B are presented in alphabetical order in Section 2.3.

2.2.1 Detailed Flow Diagram for Main Program Routine RAMONA (Figure 2.5)

Figure 2.5 shows the detailed flow diagram for the main program routine **RAMONA**. The main routine in RAMONA-4B first initializes variables in the common block **TRIPS** in subroutine **INITDT**. The input deck is then read and the deck processed in subroutine **PRINP**. If only a hydraulic calculation was specified (the "H calculation only" with **ITYP** = 5 or 9), the plot variables are initialized via routines **PLTLCH** and **PLTSCM**. If, in addition to the hydraulic(H) calculation, a neutronic(N) calculation is also requested, then **PLTLCH** is entered directly. If a user specifies a steamline calculation (**NSTMOP**=1), an additional entry is made into **PLTSCM**. If the user further specified 2-D or 3-D variables ($f(x,y,t)$ is considered as a 2-D variable, and $f(x,y,z,t)$ is considered to be a 3-D variable, because time is implicit in the definition), another entry is made into **PLTLCH**.

The entry into the **OPTION** routine causes the writing of the program name, code version, time and date stamps of the calculation, and the user input options to be written to the output file. The subroutine **OPTION** also initializes the message file (**fort.3**).

If a restart option was specified (**ITYP** = 0, 8, or 9), then the **DYNICS** steering subroutine for the transient calculation is called. The **DYNICS** subroutine is discussed in the description of Figure 2.7(b).

If (**ITYP**=3), only a steady-state calculation was done previously, and the transient calculation begins by entering the subroutine **DYNPUT**, which prepares data for the transient calculation. The paths that **DYNPUT** follows are discussed in the description of Figure 2.7(a).

Subroutine **DATAIN** for processing neutronic input data is called if options (**ITYP** = 1, 2, 4, 6, 10) are specified, and this call is followed by the subroutine **INPUT** which controls the input and output for the neutronic and hydraulic data for the steady-state calculation. The **INPUT** subroutine is entered directly if the neutronic calculation is bypassed (options **ITYP** = 5, 7, or 9).

For a hydraulics only steady-state calculation (without a restart specified) (**ITYP** = 7), or a hydraulics only steady-state plus transient calculation (**ITYP**=5), then subroutines **READ** and **AUXSUB** are called in turn. **READ** edits and writes the output file of the hydraulic data, geometric and steamline input data. **READ** also generates the hydraulic symmetry factors and reference temperature for the thermal-hydraulic properties. Subroutine **AUXSUB** calculates auxiliary parameters and initializes variables for the vessel hydraulic calculation.

RAMONA-4B: Main Program **Figure 2.1 Subroutines Called by the Main Program RAMONA**

2. Code Structure

RAMONA-4B: Steady-State and Transient Steering Subroutines

Figure 2.2 Subroutines Called by the Steady-State Steering Subroutine STATIC and Transient Steering Subroutine DYNICS

RAMONA-4B: Transient Hydraulics

Figure 2.3 Subroutines Called by the Transient Steering Subroutine NUMINT for Hydraulic Calculations.

RAMONA-4B: Transient Neutronics

Figure 2.4 Subroutines Called by the Transient Steering Subroutine DYN for Neutronic Calculations.

Figure 2.5 Annotated Program Flow Diagram of the Main Program RAMONA

2. Code Structure

If a neutronic calculation is specified (but not a restart) (ITYP not equal to 5,7), then subroutine BASIN is entered to write the input neutronic data to the output file and to compute auxiliary quantities related to the initial heat deposition, and to initialize the decay heat model variables. After BASIN, if the user specifies a transient calculation, the hydraulic and neutronic channel maps, and locations of control rods, and the steady-state control rod pattern are written to the output file in subroutine INDEX, and the boron transport equations are integrated in subroutine BORON, followed by calls to the subroutines READ and AUXSUB. Brief Description of the subroutines called by RAMONA-4B main program are given in Table 2.1.

Subroutine INIT2 is finally called. This is an entry point in INITDT, and it initializes the post-CHF variables during steady-state calculations. If the user wishes to test for consistency of input data (ITEST = 1), the subroutine TSTINP is called. Users should generally test their input data. The STATIC steering subroutine is entered next (this is not a restart path). STATIC controls the steady-state calculation only. Next the steamline equations are solved in the subroutine STMLN. If no transient calculations are specified, it will STOP here. If transient calculations are specified, it will call the steering subroutines DYNPUT (see description of Figure 2.7(a)) and DYNICS (see description of Figure 2.7(b)).

Table 2.1 List of Subroutines called by RAMONA-4B Main Program

Subroutine Name	Subroutine Description
DATAIN	Input data processing for neutronics
DYNICS	Controls the transient calculation
DYNPUT	Steering subroutine to prepare for a transient calculation
HEADER	Provide page number for output listing
INIT2	Initializes the post-CHF variables for steady-state
INITDT	Initializes the variables in a common block
INPUT	Controls data for steady-state calculation
OPTION	Writes the options of calculation to the output file
PLT	Writes data for post processing and graphics
PLTLCM	Processes data for plotting routine
PLTSCM	Processes data for plotting routine
PRINP	Reads input data
STATIC	Controls the steady-state calculation
STMLN	Steering subroutine for integration of steamline dynamic equations
TSTINP	Tests the input data for inconsistencies and lists them for warning

2.2.2 Steady-State Program Flow Diagram in Subroutine STATIC (Figure 2.6)

Figure 2.6 shows the detailed program flow diagram for the steady-state calculation. Subroutine STATIC is the steering routine for the steady-state calculation. In STATIC, the convergence tests are checked for every power-void iteration loop, and calls to the hydraulic and neutronic driving subroutines continue until either the maximum number of iterations has been reached (NCMAX on Card 800000) or the calculation has converged. A restart of the steady state is available if the maximum number of iterations is reached.

The subroutine FTCHSS is called only if a hydraulic and neutronic steady-state calculation is requested (ITYP=10). FTCHSS reads the restart data for neutronic and hydraulic steady-state (NS + HS) disturbance calculations. Data files are prepared for subsequent processing by the FRAM code, an auxiliary code for producing 1-D cross sections.

Subroutine SAHRA is entered no matter what type of calculation is specified. SAHRA is the steering routine for the hydraulic steady-state calculation. It uses the core channel power distribution as an input from the neutronic calculation, and predicts the corresponding hydraulic variable in the reactor. If a neutronic calculation is also specified (ITYP not equal to 5 or 7), then subroutine SHUFL1 is called. SHUFL1 obtains the power distribution at each iteration of the steady-state neutronic calculation.

SHUFL1 calls the subroutine AUXPOW which calculates the total power in each hydraulic channel during the hydraulic part of the steady-state calculation. Next, subroutine SEARCH calculates the flow distribution in the heated and bypass channels. Subroutine PRINT, as its name implies, prints the calculated results.

Subroutine SHUFL2 is called if any neutronic calculation is specified. SHUFL2 rearranges the hydraulic channel data for the neutronic channel nodalization.

Subroutine PUTHS is called if the steady-state hydraulic calculation has converged. It will proceed to the transient hydraulic calculation or save the steady-state data for restart. If only a hydraulic calculation is specified (ITYP = 5, 7), it will return to the calling subroutine in STATIC (see Figure 2.2).

If a neutronic calculation is specified (ITYP not equal to 5 or 7), the subroutine POLKA is called. POLKA controls the neutronic calculation. If the neutronic calculation does not converge, it will branch back to STATIC until convergence is reached. Although shown in Figure 2.2, there is no active test on "Computer Time Left", because there are no limits placed on computer time in the current workstation environment. The code is still present, but the computer time limit is set to a large enough number that it is never reached.

When the neutronic convergence is reached, subroutine PUTNS is called to store the necessary information in file fort.39 for use in a restart or a later transient calculation. A return to the main routine RAMONA finishes the steady-state calculation. A brief description of the subroutines called by STATIC is given in Table 2.2.

2. Code Structure

Figure 2.6 Annotated Program Flow Diagram of the Steady-State Steering Subroutine **STATIC**.

Table 2.2 List of Subroutines Called by Subroutine STATIC for Steady-state Calculation

Subroutine Name	Subroutine Description
FTCHSS	Reads data for restart in the steady-state calculation
HEADER	Provides page number for output listing
POLKA	Controls steady-state neutronic calculation
PUTHS	Initialization to begin transient calculation after steady-state
PUTNS	Stores steady-state results
SAHRA	This is the steering subroutine for the steady-state hydraulic calculation

2.2.3 Transient Program Flow Diagrams DYNPUT and DYNICS (Figure 2.7 (a)-(b))

Figure 2.7 shows the detailed program flow diagrams for the transient calculation. Subroutine DYNPUT is the steering routine for input to the neutron kinetics and hydraulics for preparing a transient calculation. Subroutine FETCHH is called if one is restarting a transient calculation that contains hydraulics. Subroutine DYNINH continues reading hydraulic data for the transient hydraulic calculation. In a calculation where neutronics is specified, subroutines FETCHN and DYNINN process input data for the transient neutronic calculation. Restart data are read from the restart file fort.39.

The DYNICS steering subroutine controls the dynamic (transient) portion of the calculation. It calls subroutine FPTOT to control the restart of the dynamic calculation. It also reads data from the restart input file (fort.39) and begins writing to the restart output file (fort.33) for the next restart.

Subroutine DYN steers the transient neutronic calculation. It is called from subroutine DYNICS. DYN calculates the size of the time step and controls the neutronic back-stepping procedure when the initial time step turns out to be too large for the convergence of the fast-neutron flux calculation. The steering subroutine DYN periodically calls FPTOT when the time criteria for writing the restart (fort.33) file are met.

Subroutine NUMINT (numerical integration) is called for the transient hydraulic calculation. NUMINT initiates and controls the thermal-hydraulic part of the transient calculation, determines the size of the hydraulic time step, invokes the back-stepping procedure for the hydraulics when necessary for numerical stability and accuracy, and performs the explicit EULER (Adams-Bashforth 1) integration of the local mass, energy, and loop momentum conservation equations.

If the user specified end of transient time (TMAX on card 870000) has not been reached, the DYN-NUMINT procedure is repeated. When TMAX is reached, a final restart dump is performed on file fort.33. A brief description of the subroutines called by the subroutines DYNPUT and DYNICS are given in Table 2.3 (a) and (b), respectively.

2. Code Structure

Table 2.3(a) List of Subroutines Called by Subroutine DYNPUT

Subroutine Name	Subroutine Description
DYNINH	Reads and writes additional hydraulic data following FETCHH
DYNINN	Reads and writes additional neutronic data following FETCHN
FETCHH	Reads hydraulics data from restart file for transient calculation
FETCHN	Reads neutronic data from restart files for transient calculation
INITIA	Initialize H variables for vessel components

Table 2.3(b) List of Subroutines Called by Subroutine DYNICS for Transient Calculation

Subroutine Name	Subroutine Description
DYN	Steering routine for neutronics during a transient calculation
FPTOT	Controls restart for a transient calculation
NUMINT	Steering routine for hydraulic during a transient calculation
PLTSCM	Processes data for plotting routine

Figure 2.7 Annotated Program Flow Diagram of the Transient Calculation:
 (a) Input (DYNPUT) and (b) Steering (DYNICS) Subroutines.

2. Code Structure

2.2.4 Transient Neutronic Program Flow Diagram of DYN (Figure 2.8)

Figure 2.8 shows the detailed program flow diagram for the transient neutronic calculation. Subroutine DYN is the steering routine for the transient neutronic calculation. It calculates the size of the neutronic time step and also controls the neutronic back-stepping procedure. The subroutine DYN calls subroutine XEDYN, which calculates the two-group neutron diffusion parameters (cross section data) as a function of fuel temperature, moderator temperature, and void fraction with xenon corrections. Other parameters needed to solve the transient neutron kinetics equations are also calculated.

The subroutine XEDYN calls subroutine SCRMMR which calculates the position of the control rods in the event of a scram, calls subroutine MOVROD if there is control-rod movement specified during the transient, and calls subroutine CROSS which calculates the neutron cross-section data as a function of fuel temperature, moderator temperature, control-rod fractional insertion, and void fraction. (The input cross sections are input as polynomial coefficients of these variables, and are generated by the auxiliary code BLEND). Next, subroutine BORON is called to calculate the increase in absorption cross section due to boron concentration in the reactor core.

The subroutine XEDYN then calls subroutine MATDYN, which calculates the matrix elements and parameters needed for the fast neutron flux calculation. Subroutine FIDYN calculates the fast neutron flux using an accelerated Gauss-Seidel iteration procedure. The variable ACCF, defined on card 720000, is tested against the truncation error (EF) on the fast flux to determine if back-stepping is required. For each neutronic back-stepping, the time step (Δt) is cut in half.

If back-stepping is not required, subroutine F2DYN is called to calculate the nodal average fast flux and asymptotic average thermal flux. F2DYN also calculates time derivatives, delayed-neutron precursors, and nodal fission powers. Subroutine TFDYN calculates the average temperature, temperature distribution and derivative of the fuel temperature during the transient. It also calculates the fuel heat-transfer coefficient for the fuel-clad gap. Next, subroutine DYNLST prints the results of the neutronic and fuel conduction calculation, and performs reactivity edits, as well as adding these data to the plot file (fort.49).

Finally, subroutine PREDYN predicts the new values of the fast and thermal fluxes, fuel rod temperatures, the power deposition to the hydraulic channels, and fission rate at the advanced neutronic time in the calculation. After PREDYN, it returns to the subroutine DYNICS in Figure 2.7(b). A brief description of the subroutines called by the neutronic steering subroutine DYN is given in Table 2.4.

subroutines PCHFST, REGSTR, FWSTR, and LEVSTR are called to store the post-CHF, pressure-regulator, feedwater-controller, and mixture-level variables; respectively. Finally, at the bottom of Figure 2.9(b) HYDRO1, a key subroutine in the thermal-hydraulic part of the code, calculates the steam and water mass distributions for each computational cell in the vessel. The two-phase mixture level and collapsed-liquid level in the downcomer and steam dome are also calculated. If the option for BOP calculations is not specified (IOPT(6) = 0), the feedwater boundary conditions are imposed by calling subroutines FWTRIP, HPCI, and RCIC. Subroutine TCAN then calculates the fuel rod surface temperature for non-boiling, boiling, or post-CHF heat-transfer regimes, as appropriate.

NUMINT calculation continues as illustrated in Figure 2.9(c), the right-most branch of Figure 2.9. When the hydraulic and neutronic transient times are aligned, subroutine PRINT is called. PRINT prints hydraulic information to the output file in either the "small" (abbreviated) or "large" (detailed) formats, and additionally writes the thermal-hydraulic data to the plot file (fort.49). For a thermal-hydraulic calculation only, it will return to the main program RAMONA after the PRINT subroutine. If neutronic calculation is specified, it will pass through subroutine SHUFL2 to arrange the data for the neutronic calculation, then return to the main program RAMONA.

Figure 2.8 Annotated Program Flow Diagram of the Transient Neutronic Calculation Steering Subroutine DYN.

2. Code Structure

Table 2.4 List of Subroutines Called by Subroutine DYN for Transient Neutronic Calculation

Subroutine Name	Subroutine Description
AVGF	A variable defined as corrected core-average fast flux by subroutine F1DYN.
AVGP	A variable defined as predicted core-average fast flux by subroutine PREDYN.
DYNLST	Calculates the reactor power distribution and other output variables, prints them and saves them on a plot file.
F1DYN	Calculates the fast flux distribution in the core.
F2DYN	Calculates the thermal flux and precursor distributions in the core.
MATDYN	Calculates the coefficient matrix associated with the fast flux equations.
PREDYN	Predicts the fluxes, fuel temperatures, nodal power and decay heat based on the past derivations and time step.
SUMDF	A variable defined as core-average fast flux residual by subroutine F1DYN.
TFDYN	Calculates the average fuel temperature, temperature distribution and derivative.
TIME	Neutronic transient time.
XEDYN	Calculates cross sections and other parameters for transient neutronic calculation.

2.2.5 Transient Hydraulic Program Flow Diagram of NUMINT (Figure 2.9)

Figure 2.9 shows the detailed program flow diagram of the hydraulic steering subroutine NUMINT which performs numerical integration of the hydraulic state equations. NUMINT initiates and controls the hydraulic part of the transient calculation, defines the size of the hydraulic time step, invokes the back-stepping procedure for the hydraulics when necessary for numerical accuracy and stability, and performs the explicit EULER (Adams-Bashforth 1) integration of the local mass, energy, and loop momentum conservation equations.

The subroutine NUMINT calls subroutine SHUFL1 which transforms the power from the neutronic nodalization to the hydraulic nodalization. Subroutine PCHFST stores the post-CHF related data in anticipation of hydraulic back-stepping. Subroutine WSRSTR stores the safety and relief-valve associated data, also in anticipation of a neutronic or hydraulic back-stepping. Likewise, subroutine REGISTR stores the pressure-regulator variables in anticipation of a back-step. Subroutines LEVSTR and BORON store the downcomer mixture level variables and boron concentration variables, respectively, also in anticipation of back-stepping. Subroutine STMLN for steamline dynamics is then called to initialize the steamline variables.

The calculation continues as shown in the center branch of Figure 2.9(b). If a neutronic calculation is specified, the direct energy deposition is calculated for all the hydraulic channels from the neutronic calculation. At the start of the transient calculation, subroutines HYDRO1, HYDRO2, and BORON are called to initialize the thermal-hydraulic (TH) variables for the reactor vessel, initializing the derivatives of the thermal-hydraulic state equations, and initializing the

the transient times are not aligned, i.e., the hydraulic time has not reached the neutronic time, it calls subroutines HYDRO2 and BORON to calculate the derivatives of the thermal-hydraulic state equations and does the boron transport calculation. In case of a back-step for the hydraulic calculation, it will recall subroutines PCHFST, REGSTR, FWCSTR, and LEVSTR to retrieve the data that are stored in the previous entry to these subroutines. Then the boron transport calculation is redone in subroutine BORON.

Next, it calculates the next hydraulic time step and calls subroutine STMLN to perform the Runge-Kutta-Simpson integration of the steamline state equations. The steamline dynamics is the only place a 4th-order integration method is used in RAMONA-4B; everywhere else, the 1st-order integration method (Euler) is used. The steamline equations are stiffer than the other hydraulic state equations and require smaller time steps (sub-steps) to maintain numerical stability. When the final steamline dynamic time matches the time of the rest of the hydraulics calculation, the subroutine PRINT is called to print to the output file and update the plot file (fort.49). After this PRINT, at an intermediate hydraulic time that is still less than the neutronic time, it keeps advancing the hydraulic time until the hydraulic time is equal to the neutronic time, at which point it returns to the main program RAMONA.

A brief description of the subroutines called by NUMINT is given in Table 2.5.

2.2.6 Time Step Control

The time-step control procedures for the calculation of neutron kinetics have not been changed since the RAMONA-3B description report [Wulff et al. 1984] was published. However, some modifications were made to the time-step control strategy for the hydraulic calculation which uses the Euler-Cauchy method to solve the state equations.

2.2.6.1 Transient Neutronic Calculation

The time-step control strategy for the neutronic calculation is discussed in Chapter 6.7 of the RAMONA-3B report [Wulff et al. 1984]. For the sake of completeness, the diagram showing the time-step selection logic is shown in Figure 2.10.

The neutronic time-step control is executed in subroutine DYN. The time-step control algorithm is based on the input neutronic accuracy criterion ACCF on Card 720000. To help the reader understand the diagram, Figure 2.10, a brief description of the subroutines and key variables is given in Table 2.4.

2.2.6.2 Transient Hydraulic Calculation

A description of the procedure for hydraulic time-step selection that is currently implemented in RAMONA-4B follows. The hydraulic time step is limited from above according to the RAMONA-4B method of coupling the transient neutronic and hydraulic calculations: the hydraulic time step can not exceed the neutronic time step which is the master time step, $\Delta t_n^{\text{hydr}} \leq \Delta t_N$, n being the hydraulic time step index and N the neutronic time step index. At the same time, the step size can not exceed a maximum value specified by the user via the input variable SDTMAX on Card 500082.

2. Code Structure

Figure 2.9 (a)-(c) Annotated Program Flow Diagram of the Transient Hydraulic Steering Subroutine NUMINT.

Figure 2.10 Neutronic Time Step Control Logic Diagram.

2. Code Structure

Table 2.5 List of subroutines called by subroutine NUMINT for the Transient Hydraulic Calculation

Subroutine Names	Subroutine Description
BORON	Solves boron transport equations and calculates boron concentrations in the RPV.
FWCSTR	Stores information related to the feedwater controller.
HYDRO1	Key hydraulic subroutine used to obtain two-phase mass distributions.
HYDRO2	Calculates derivatives of the hydraulic state variables and performs time integration.
LEYSTR	Stores variables of mixture level for restart.
PCHFST	Stores post-CHF data during hydraulic backstepping.
PRINT	Controls the general hydraulic output printing.
REGSTR	Stores variables for the pressure regulator model.
SHUFL1	Organizes the power distribution during each iteration.
SHUFL2	Organizes the variables of the hydraulic calculation.
STMLN	Performs integration of the steamline state equations.
TCAN	Calculates the clad surface temperature of fuel rods.
WSRSTR	Stores key information during hydraulic or neutronic back-stepping.

The procedure for time-step selection starts from a search for the state equation which incurs the largest truncation error. Equations for the following variables are tested in this search:

- system pressure,
- vapor mass in the feedwater junction cell,
- integrated loop momenta for NPC hydraulic loops, where NPC is the total number of hydraulic channels representing the core,
- specific energy at the exit cells of NPC hydraulic channels.

First, determine the maximum relative truncation error, TRUNC, from the 2nd-order term of a Taylor series expansion:

$$TRUNC = \frac{\Delta t_n^2 y_n''}{2y_n}$$

where y_n is the state variable of interest and y_n'' is the second derivative of y_n . The following time step control strategy is used:

- (1) If TRUNC is less than the hydraulic accuracy criterium ACCH (input on Card 500082),

$$\Delta t_{aux} = 0.8 \Delta t_n \sqrt{\frac{ACCH}{TRUNC}},$$

$$\Delta t_{n+1}^* = \text{Min} (SDTMAX, \Delta t_{aux}),$$

$$\Delta t_{n+1} = \text{Max} (\Delta t_{n+1}^*, HMIN),$$

where HMIN is the minimum hydraulic time step defined as $0.01 * SDTMAX$, and SDTMAX is the maximum allowable hydraulic time-step specified via the input on Card 500082.

- (2) If TRUNC is greater than or equal to ACCH, perform a back-stepping: Integrate the hydraulic state equations with a negative time step, $-\Delta t_n$. Calculate a cut-back time step multiplier:

$$\gamma_{CB} = 0.8 \sqrt{\frac{ACCH}{TUNCH}},$$

$$\Delta t_n = \gamma_{CB} \Delta t_n,$$

subject to the minimum hydraulic time step HMIN:

$$\Delta t_n = \text{Max} (\Delta t_n, HMIN),$$

In either case, the hydraulic time step is further limited by the condition,

$$\Delta t_n = \text{Min} (\Delta t_n, TIME-TSEC),$$

in order to synchronize with the neutronic time step. Here TIME is the neutronic time and TSEC is the hydraulic time. Note that the neutronic time is always ahead of the hydraulic time ($TIME > TSEC$).

The subroutine LAMBDA determines the numerical stability limit from the largest eigenvalue of the Jacobian matrix of the hydraulic state equations. The formulations pertaining to LAMBDA are given in Chapter 4, Section 4.10 of the companion RAMONA-4B report [Rohatgi et al., 1996].

2. Code Structure

2.3 Description of RAMONA-4B Subroutines

This section provides a brief description of major subroutines and function subroutines of the RAMONA-4B code, listed in alphabetical order.

AFWR

This subroutine contains a simple model for the automatic feedwater runback (AFWR) feature of the SBWR and is called by subroutine **HYDRO1**.

ALFCUT

This function subroutine limits the values of the void fraction to $10^{-6} \leq \alpha \leq 0.9999$ for the phasic velocity calculations (see function subroutine **VFVG**).

AUXPOW

This subroutine calculates the total core power and power in each hydraulic channel (including bypass) during the hydraulic part of the steady-state calculation.

AUXSUB

This subroutine calculates auxiliary parameters and initialize variables for the vessel hydraulic calculation.

BASIN

This subroutine organizes and writes the neutronic input data to the output file. It also computes auxiliary quantities related to the initial heat deposition, and initializes the decay-heat model variables.

BOP

This subroutine contains the balance of plant (BOP) models for the turbine dynamics, feedwater flow dynamics, feedwater pump dynamics, feedwater heater dynamics, and condenser dynamics. It supplies the feedwater flow rate and feedwater temperature for the pressure-vessel dynamics as well as the turbine stop valve and bypass valve flow rates for the steamline dynamics.

BORON

This subroutine deals with boron propagation through the reactor pressure vessel. It integrates the local boron mass balance equations from which the local boron concentrations are calculated. Boron flow reversal is accounted for everywhere in the vessel. In case of the regular BWR, the boron solution can be injected into the system at any prescribed cell with the concentration and flow rate specified by the user through input Cards 460000, 461000, 462000, 463000, 464000, and 465000. For the SBWR, the boron solution is injected into the core bypass region via the Standby Liquid Control System (SLCS) via input Cards 466000, 467000, 468000, and 469000.

BYTRIP

This subroutine controls the turbine bypass trip on time or turbine inlet valve closure.

CLOCKK

This is a system routine. It reads the clock time in the format: Hour/Minute/Seconds.

CMBLKS

Block data in common blocks.

CNOT

This function subroutine calculates the Zuber-Findley void distribution parameter C_0 .

CNTRL

This subroutine controls the steamline dynamics related systems: pressure regulator, MSIV, turbine bypass line, and Safety/Relief valves. It also writes the steamline flow parameters to the output, summary, and plot files.

CONDNT

This subroutine calculates the rate of heat removal from steam to the IC pool. The following operations are performed by this subroutine:

1. Calculates the effect of downcomer liquid level on liquid return line,
2. Calculates return liquid flow rate (calls subroutine **WLRET**),
3. Adjusts flow to valve flow area (calls subroutine **FVALVE**),
4. Determines liquid level within the IC during operation (calls subroutine **ELEVEL**),
5. Calculate steam inlet flow rate from quasi steady momentum balance coupled to first order time lag (calls subroutine **TLAG**),
6. Calculates the rate of steam condensation (calls subroutine **QOUT**),
7. Performs mass and energy balance within the IC (calls subroutine **WSUM**),
8. Calculates the depressurization rate and the pressure within IC, and
9. Calculates the rate of change of enthalpy and enthalpy within IC.

COREIO

This subroutine calculates mass flow rates and velocities of liquid and vapor and mixture energy convection rates at the lower plenum-core and core-riser interfaces. Flow reversal at these interfaces are accounted for via standard donor-cell differencing scheme.

COREM

This subroutine calculates auxiliary variables used for the calculation of the Downcomer 1 and core entrance mixture volumetric flow rates: integration along the contour flow path through the core parallel channels.

2. Code Structure

CROSSS

This subroutine calculates the two-group neutron diffusion parameters (i.e., D_1 , D_2 , $\nu\Sigma_{f1}$, $\nu\Sigma_{f2}$, Σ_{a1} , Σ_{a2} , Σ_{r1} etc.) as functions of fuel temperature, moderator temperature, and void fraction. Table 4.1 shows the exact form of the polynomial fits used for these neutron diffusion parameters.

CTOMAP

This function subroutine is used to map the neutronic data for use in the plotting program PAD (Appendix C).

DATAIN

This subroutine performs neutronic input data processing. The $1\frac{1}{2}$ group neutron diffusion model factors, as expressed by Eqs. (6.2.68) and (6.2.69) in the RAMONA-3B description document [Wulff et al. 1984], are calculated along with the parameters needed for the nodal method.

DATER

This is a system routine. It reads the current date in the format: MONTH/DAY/YEAR.

DERV

This subroutine calculates the time derivatives of the steamline state variables.

DIFFTH

This subroutine calculates and stores the function Λ_2 , variable DLAM (See Chapter 2.3.2 in the RAMONA-3B report [Wulff et al. 1984]). Λ_2 is an estimate of the thermal-neutron leakage between internal cells. Setting $\Lambda_2=0$ suppresses the thermal-neutron leakage calculation. This subroutine is called only if IOPT(12)=1 on Card 110000 is specified.

DISTRI

This subroutine calculates the normalized power distribution, QK, in the reactor core.

DISTUR

This subroutine calculates ramp and sinusoidal time disturbances as time-dependent boundary conditions, if requested by the user through input Cards 500083, 500084, 500085, 500086, 500087, and 500088.

DOWNCM

This subroutine calculates auxiliary variables used for the Downcomer 1 and core entrance mixture volumetric flow calculations: integration along the contour flow path through the Downcomers 1 and 2, and the Lower Plena 1 and 2.

DYN

This subroutine steers the neutronic calculation during a transient. It also calculates the size of the neutronic time step and controls the neutronic back-stepping procedure exercised when the acceptance criteria for convergence of the fast-flux prediction are not met.

DYNICS

This subroutine controls the dynamic (or transient) calculation. It repeatedly calls subroutine DYN to determine the new neutronic values, then calls subroutine NUMINT for the hydraulic values until the transient termination time TMAX is reached.

DYNINH

This subroutine reads and writes the additional data which were not read in FETCHH for the dynamic hydraulics according to the input description.

DYNINN

This subroutine reads and writes the additional data which were not read and initialized in FETCHN for the dynamic neutronics according to the input description.

DYNLST

This subroutine writes the calculated data of the neutronic and fuel conduction calculation to the output and plot files.

DYNPUT

This is a steering subroutine for input to neutron kinetics and hydraulics for preparing a transient calculation.

ELEVEL

This subroutine is used to calculate the liquid level within the isolation condenser (IC) during a transient.

ENTRN

This subroutine calculates the steam entrainment into the condensate return line (not used at present).

EVAP

This subroutine calculates the nonequilibrium vapor generation rate for all cells in the vessel. Total vapor generation rate is the sum of the bulk and heated-surface vapor-generation rates.

FIDYN

In this subroutine, the fast neutron flux is computed by using an accelerated Gauss-Seidel iteration scheme. An optimum relaxation factor is determined in the least-squares sense by using the local corrections obtained by a double sweep: going through every cell from the bottom of the coefficient matrix to the top, then by going from the top to the bottom.

2. Code Structure

F2DYN

This subroutine calculates the thermal flux after the fast flux has been accepted. The average fast flux and average thermal flux are calculated. The delayed-neutron precursor concentrations and nodal powers are also calculated in this subroutine.

FDECAY

This subroutine calculates the decay-heat power according to ANS Standard 5.1 (revised). It computes the values from a table lookup, as prescribed in the Standard.

FETCHH

This subroutine reads the restart-dump file (fort.39) for the hydraulic parameters when restarting a transient calculation.

FETCHN

This subroutine reads the restart-dump file written in steady state to continue with a transient calculation (i.e., used for ITYP = 3).

FLUPO

This subroutine solves the steady-state finite-difference equations for the fast flux as described in Chapter 6, Section 6.2.5.2 of the RAMONA-3B description document [Wulff et al. 1984]. The average fast and thermal fluxes are also calculated along with the eigenvalue k_{eff} .

FPSIB

This subroutine calculates the bulk vapor generation term during the steady-state calculation.

FPTOT

This subroutine controls restart for a transient calculation. The data from the disk files and COMMON blocks are written to fort.33 for restart later. When the transient calculation is restarted, the data are read from fort.39 and transferred to the disk files and COMMON blocks.

FRCT

This function subroutine computes the single-phase friction factor for the steamline dynamics.

FTCHSS

This subroutine reads the data for restart from a steady-state calculation.

FUNCSS

This is the main subroutine for the steady-state hydraulic calculation. It computes thermal-hydraulics variables (such as void fraction, phasic velocities, liquid temperatures, and vapor generation rates) for each cell in all vessel components, pressure drops across one dimensional components (downcomers, lower plena, riser) and core parallel channels. This subroutine also calculates the consistent feedwater and steamline flow rates based on the overall vessel energy balance. Also, if the option for the new mechanistic separator model is not requested by the user via ISTAGE=0 on Card 624000, the steam carryunder mass flow rate (from the steam separators into the downcomer) is calculated. In this case, the carryunder fraction is kept constant during a transient calculation. If ISTAGE = 2 (2-stage separator) or 3 (3-stage separator) is specified by the user, the steady-state carryunder fraction is calculated by subroutine MARK1IC and the transient carryunder fraction is dynamically calculated by subroutine MARK1.

FVALVE

This subroutine modifies the liquid flow rate by the valve area and the time delay in the operation of the IC.

FWCSTR

This subroutine stores information related to the feedwater controller in anticipation of a back-step.

FWCTRL

This subroutine contains the feedwater control system model. It takes the feedwater flow rate, steam flow rate, and collapsed-liquid level as input signals and produces the feedwater-valve-stem position as the output signal that is required by the feedwater flow dynamics to calculate the feedwater flow rate.

FWTRIP

This subroutine activates the feedwater trip either automatically on "high water level" setpoint or manually on time. For the manual trip, time vs. flow rate tables are used through input on Cards 611000, 611100, 611200, and 611300.

GEOMC

This subroutine is used to calculate the volumes of the isolation condenser.

GESUP

This subroutine is called by subroutine STMSEP and solves the new mechanistic steam separator model equations.

GEXL

This function subroutine calculates the critical power ratio, based on a boiling-length-type correlation (GE proprietary GEXL correlation). This prediction does not change the course of calculation (RAMONA-4B has its own post-CHF package.) The coding of Function GEXL is not available for distribution outside BNL and USNRC.

2. Code Structure

HCFILM

This function subroutine calculates the film-boiling heat-transfer coefficient according to either the Groeneveld or modified Bromley correlations given by Eqs. 4.4.40 and 4.4.42 of the RAMONA-3B report [Wulff et al. 1984].

HCOEF

This function subroutine predicts occurrence of the critical heat flux (CHF) condition in the core heated channels. Either a wall heat-transfer coefficient or a wall heat flux is calculated in the post-CHF heat transfer regime.

HCONDIC

This subroutine calculates the heat-transfer coefficient for laminar film condensation in the IC.

HEADER

This subroutine calculates the page number in the output listing.

HMAXIM

This function subroutine calculates the cell average fuel enthalpy at the "hot spot" for plotting purposes.

HPCI

This subroutine calculates the High Pressure Coolant Injection (HPCI) system flow rate. The HPCI option data including the table of flowrate vs. time (WCIX vs. TCIX) are entered as input data on Cards 616000, 616100, 616200, 616300, 616400, 616500, and 616600. Trip is initiated by tests on time or downcomer water level. A delay on HPCI initiation can be introduced. Provision is made to allow back-stepping.

HPOOL

This subroutine calculates the heat-transfer coefficient for pool boiling in the IC.

HPOOL2

This subroutine calculates the heat-transfer coefficient for pool-boiling heat-transfer in the IC.

HSCORE

This subroutine calculates the rate of heat-transfer between the fluid and all internal components in the IC. These components are assumed to be at a uniform temperature. At steady state they are at equilibrium with the fluid temperature; therefore, no heat transfer is calculated.

HSDRIV

This is the driver routine for the heat-structure calculation. It is called in steady-state calculation (by **SEARCH**) and transient calculation (by **NUMINT**). This subroutine performs the following set of operations:

1. Check option for the heat-structure calculation,
2. Update material properties for the structures (calls subroutine **HSMAT**),
3. Calculate cell-averaged fluid properties (calls subroutine **HSFLUID**),
4. Calculate heat transfer to the structures (calls subroutine **HTCAL**), and
5. Stores data for subroutine **NUMINT**.

HSFLUID

This subroutine is used to calculate the cell-averaged fluid properties, flow velocities, and temperatures, for each component and thermal-hydraulic channel. The fluid heat-transfer coefficients are calculated with these values.

HSMAT

This subroutine initializes the physical properties of the materials of the heat structures. Stainless steel and Zircaloy are the material choices.

HSTRUCT

Using the geometric parameters, heat-transfer coefficients and material properties, this subroutine performs the following:

1. Calculates Biot number for each structure in the RPV during a transient,
2. Calculates the surface temperatures of the structures by the integral method, and,
3. Calculates the temperature of the structures and the rate of heat transfer by calling subroutine **SOLVEHS**.

HTCAL

This subroutine calculates the rate of heat transfer to the heat structures. This subroutine performs the following:

1. Calculate the heat-transfer coefficient for each surface of each structure interfaced with fluid in a component or hydraulic channel (calls subroutine **HTLIQ**),
2. Calculate the heat-transfer coefficient for the structures exposed to air (calls subroutine **HTAIR**),
3. Calculates the rates of heat transfer for each slab geometry (Calls subroutine **SSHS** for steady-state calculation, and Calls subroutine **HSTRUCT** for transient calculation),
4. Calculates core heat-transfer rate for each thermal-hydraulic channel (Calls **HSCORE** for transient calculation),
5. Assumes no heat transfer with the internal structures during steady state,
6. Saves data on the rate of heat transfer to structural material to be used in the energy balance equation in subroutine **HYDRO2**.

HTLIQ

This subroutine calculates the heat-transfer coefficient of flowing liquid in contact with solid surfaces bounding a component. Internal flow is assumed. Dittus-Boelter correlation is used for the heat-transfer coefficient calculation.

2. Code Structure

HTNAT

This subroutine calculates the heat-transfer coefficient of air in contact with a solid surface. Natural convection of air is assumed on the external to vessel wall. If known values of the heat-transfer coefficient are provided through input, this calculation is omitted.

HYDRO1

This is one of the major subroutines of the hydraulic part of the code, which calculates steam and water mass distributions and all thermal-hydraulic parameters for each computational cell in the vessel. Both the two-phase mixture level and collapsed-liquid level in the downcomer and steam dome are determined. On option, a feedwater boundary condition is imposed by calling subroutine FWTRIP. In addition, if requested by the user via option switches, subroutines HPCI and RCIC are called to calculate the HPCI and RCIC mass flow rates.

HYDRO2

This is another major subroutine of the thermal-hydraulic part of the code. Derivatives of the hydraulic state variables are calculated in preparation for time integration performed subsequently in subroutine NUMINT. Among the derivatives are three global system variables: the rate of change of the vessel pressure, the total vapor mass in the vessel, and the total mixture energy in the vessel.

ICNTRL

This subroutine is the controller for the IC startup during the SBWR operation of the code.

ICONV

This function subroutine converts EBCDIC numerals to INTEGER, i.e., '456' becomes 456.

ICMAIN

This is the driver routine for the isolation-condenser calculation. It is called in the transient calculation by subroutine NUMINT. This subroutine performs the following operations:

1. Checks options for the isolation-condenser operation (calls subroutine **ICNTRL**),
2. Updates the output variables for the steady-state calculation,
3. Performs the control logic for IC operation, and
4. Performs the heat-transfer calculation (calls subroutine **CONDNT**).

ICSTS

This subroutine is the driver for the steady-state IC calculation. It is called by subroutine **SEARCH**. This subroutine performs the following:

1. Initializes the steady-state calculation for IC,
2. Initializes the transient variables for IC,
3. Initializes the geometric variables (calls subroutine **GEOMC**), and
4. Calculates initial liquid height within the IC (calls subroutine **ELEVEL**).

INDEX

This subroutine writes to the output file all core maps showing the locations of the hydraulic and neutronic channels, locations of the control rods, and the steady-state control-rod pattern.

INIT2

This is an ENTRY point to subroutine INITDT: initialization of post-CHF variables during the steady-state calculation.

INITDT

This subroutine initializes variables in the COMMON block /TRIPS/.

INITIA

This subroutine prepares for the transient calculation by computing the initial conditions from the initial values of the void fraction, water temperature, evaporation rate, and coolant flow rate in the vessel.

INPUT

This subroutine controls the input and output of the neutronic and hydraulic data for the steady-state calculation.

LAMBDA

This subroutine determines the stability limit of the explicit Euler integration by finding the largest eigenvalue of the Jacobian matrix of the hydraulic state equations based on the drift-flux formulation. This subroutine is called by NUMINT after the accuracy limit of the explicit integration has been estimated from the truncation error.

LEVSTR

This subroutine stores the downcomer mixture level variables in anticipation of a back-stepping.

LHHF

This function subroutine calculates an index of a neutronic channel.

LWEST

This function subroutine calculates location of the core's "western" boundaries depending on the core symmetry option.

M2MF

This is an auxiliary function subroutine for calculating an array pointer.

2. Code Structure

MARK1

This subroutine solves the state equations for the wetwell and drywell dynamics of the BWR containment and calculates important secondary variables such as the suppression pool temperature and level, pressures and temperatures of wetwell and drywell gas spaces. It also call subroutine MARK1IC at $t=0$ to calculate the initial conditions of the containment.

MARK1IC

This subroutine calculates the initial conditions for both the wetwell and drywell dynamics of the containment.

MATADD

This is a subroutine for adding elements of two two-dimensional matrices.

MATDYN

This subroutine calculates the elements of matrices [P] and [S] as defined by Equation (6.2.89) in the RAMONA-3B description document [Wulff et al. 1984]. These data are needed to predict the mid-point fast flux using the Gauss-Seidel iteration method. Also, some auxiliary parameters needed for the fast and thermal flux calculations are calculated.

MATEQ

This subroutine assigns values of elements of one two-dimensional matrix to another.

MATMLT

This subroutine multiplies two two-dimensional matrices.

MATRIC

This subroutine receives all the calculated parameters from subroutine XEDOP and prepares to perform the Gauss-Seidel iteration. Parameters r_i , Q_i , P_i , and q_i are calculated for each cell so that the iterative solution for the fast flux can be accomplished.

MATSUB

This subroutine subtracts one two-dimensional matrix from another.

MATVEC

This subroutine multiplies a two-dimensional matrix by a vector.

MINATR

This subroutine formerly returned the CPU time remaining for the calculation, it now returns a large value because the CPU time is not limited.

MINIMA

This subroutine calculates the total number of neutronic channels and core periphery locations.

MINMAX

This subroutine calculates MINJ(I)-J-coordinate for the first channel on the row number I along with MAXJ(I)-J-coordinate for the last channel on the row number I. The total number of channels also is calculated and compared with the total number of neutronic channels KAN on input Card 200000. If an inconsistency is found in the input testing, it terminates the job with an error message.

MOVROD

This subroutine calculates the position of control rods during a transient calculation.

MSIVFL

This subroutine activates the MSIV closure trip either manually on time, or automatically on low downcomer water level, or system pressure, or too-high steamline flow rate. The subroutine uses a table of mass flow rate versus time from input on Cards 619000, 619100, 619200, 619300, 619400, and 619500.

NEIGHB

This subroutine calculates the array NEIG and the core fraction of each cell depending on the ISYM symmetry indicator on input Card 200000. The array NEIG holds the indices for the neighbors to the cell of interest.

NORTH

This function subroutine calculates the location of the core's "northern" boundaries depending on the core symmetry option.

NUMINT

This is the steering subroutine for the transient hydraulic calculation. It initiates and controls the thermal-hydraulic part of a transient calculation, triggers the back-stepping procedures, defines the size of the hydraulic time step, controls hydraulic printouts and plotting, and finally, performs the explicit Euler integration of the local mass, energy, and loop momentum conservation equations.

OPTION

This subroutine writes to the output file the program name, code version, date and time of the calculation, and general options selected for the calculation. It also initialize the message file **fort.3**.

P00

This function subroutine extrapolates pressure in time during the steamline dynamic calculation.

2. Code Structure

PCHFST

This function subroutine stores the post-CHF related data in anticipation of a hydraulic back-stepping.

PLT

This subroutine writes data to the plot file (fort.49) for subsequent processing and display by the program PAD. It also writes to the output file a summary of these data.

PLTLCM/PLTSCM

These subroutines transfer plotting data to an array for subsequent writing to the plot file (fort.49).

POLKA

This subroutine is called by subroutine STATIC to control the steady-state neutronic calculation. The eigenvalue iteration scheme is controlled from here.

PREDYN

This subroutine predicts the new values of the fast and thermal-neutron fluxes, fuel rod temperatures, power to liquid, and fission rate at the advanced time in the transient neutronic calculation.

PRINP

This subroutine reads the input file and assigns the data values according to the 6-digit identifiers in Columns 1 through 6 of the input deck records.

PRINT

This subroutine controls the general hydraulic output for both static and transient calculations. It prepares the short ("small") and long ("large") printed outputs and calls the plotting subroutines to transfer hydraulic data to the plot array. The short output contains some limited information on the thermal-hydraulic conditions in the vessel, whereas the long output provides more detailed local thermal-hydraulic data. Thermal-hydraulic data for plotting are also written to the plot file (fort.49).

PSP

This subroutine contains a simplistic dynamic model for the pressure suppression pool (PSP) of a BWR containment. It calculates the PSP temperature, PSP total liquid mass, and PSP liquid enthalpy using the mass flow rate discharged by the MSIV and the pressure at the MSIV as input. This subroutine is called by subroutine NUMINT as an option if the input IPSP on Card 625000 is set to 1.

PUTHS

The subroutine is called after the steady-state solution has converged, and controls the options to proceed to the transient calculation and/or save the steady-state data for restart.

PUTNS

This subroutine stores the steady-state results on the plot file fort.39. This information can be used later as an input for a transient calculation. The cross sections $v_1 \Sigma_{f1}$ and $v_2 \Sigma_{f2}$ are normalized using the predicted value of k_{eff} so that the reactor is exactly critical prior to starting a transient calculation.

QCZGRB

This function subroutine calculates a value of the critical heat flux using either the Zuber-Griffith or the RELAP4/MOD7 correlation.

QOUT

This subroutine calculates the rate of heat transfer from steam to the IC pool. The following functions are performed:

1. Calculates the resistance to heat conduction through the tube wall,
2. Obtain the heat-transfer coefficient for condensation within the tubes (calls subroutine **HCONDIC**),
3. Obtain the heat-transfer coefficient for pool boiling (calls subroutine **HPOOL**),
4. Calculate outside temperature for tube walls iteratively (calls subroutine **TWALLS**), and
5. Calculate the rate of steam condensation.

RAMONA

This is the MAIN program. It specifies the common block lengths and assigns numbers to the file names. The steady-state and transient steering subroutines (i.e., **STATIC** and **DYNICS**) are called from this program.

RCIC

This subroutine initiates the Reactor Core Isolation Cooling (RCIC) system either manually on time or automatically on low downcomer water level. A user-specified time delay and flowrate vs. time data are input on Cards 617000, 617100, 617200, 617300, 617400, 617500, and 617600.

RCTRIP

This subroutine initiates the recirculation-pump trip either manually on time, or automatically on low downcomer water level, high system pressure, or turbine valve closure. This is accomplished by setting the electric torque to zero in the recirculation-pump model.

RCLOOP

This subroutine contains the new recirculation loop dynamic model which solves an effective recirculation flow equation with recirculation pumps and jet pumps. As the output, it calculates the recirculation drive flow rate and jet pump head for use in the vessel loop momentum equations. This subroutine is called by subroutine **NUMINT**.

2. Code Structure

READ

This subroutine edits and writes to the output file the hydraulic input data, geometrical specifications, and the steamline input data. READ also generates the hydraulic symmetry factors and the reference temperature for the thermal-hydraulic properties.

REGSTR

This subroutine stores the pressure-regulator model variables in anticipation of a back-stepping.

RESFIL

This subroutine initialize arrays during the first pass in the steady-state calculation. The subroutine is needed for the first pass through the numerical integration scheme.

RFCNTRL

This subroutine contains the new recirculation flow control system model. It takes the steam demand error from pressure regulator as input and calculates the scoop tube stem position as the output for use in the motor/generator set dynamics. The control system model equations are solved by explicit Euler integration using the hydraulic time step after it has been accepted.

RKS

This is the fourth-order Runge-Kutta-Simpson integration subroutine of the steamline dynamics. It calls the subroutine DERV to calculate the derivatives of the local steamline pressures and mass flow rates.

RMM

This subroutine calculates a parameter specific to each symmetry type (ITYP) specified in the input on Card 140000.

ROOT1

This function subroutine called by subroutine SETRUT calculates the corrected turbine control valve flow rate during the pressure-regulator calculation.

RTPH

This function subroutine calculates a two-phase friction multiplier using the Becker correlation.

RWCTRL

This subroutine contains the new level control system model for automatic level control in accordance with the revised Emergency Procedure Guidelines (EPG). It solves the model equations by explicit Euler integration using the hydraulic time step after it has been accepted. This same control system model can also be used as an alternative feedwater flow controller as well as a reactor water cleanup (RWCU) system model for startup transients in the SBWR. For the EPG level control, it is called by subroutine **HYDRO1**, for the RWCU flow control, it is called by subroutine **HYDRO2**, and for the alternative feedwater controller, it is called by subroutine **NUMINT**.

SAHRA

This is the steering subroutine for the steady-state hydraulic calculation. Using the core channel power distribution as an input from the neutronic calculation, this subroutine predicts the corresponding hydraulic variables in the hydraulic channels representing the reactor core.

SCDENS

This subroutine calculates the fluid density for the SLCS model.

SCNTRL

This is the controller subroutine for the SLCS operation.

SCRMMR

This subroutine calculates the positions of the control rods in the course of a scram.

SCSTS

This subroutine performs the steady-state initialization for SLCS. This subroutine performs the following:

1. Calculates the geometric variables needed (calls subroutine **SGEOM**),
2. Initializes the variables for SLCS calculation (calls subroutine **SINT**), and
3. Initializes physical properties (calls subroutine **SCDENS**).

SDALDT

This subroutine performs the steady-state initialization for SLCS. This subroutine performs the following:

1. Calculates the geometric variables needed (calls subroutine **SGEOM**),
2. Initializes the variables needed for SLCS calculation (calls subroutine **SINIT**), and
3. Initializes physical properties (calls subroutine **SCDENS**).

SDPDT

This subroutine calculates the rate of change of pressure for the SLCS operation.

SEARCH

This subroutine calculates by iteration the steady-state momentum balance so that the pressure drop across the parallel channels in the core is nearly the same and that the total pressure drop in a closed flow loop is negligibly small. It allocates the total core flow rate among the parallel core channels in accordance with the channel flow areas, form loss coefficients and hydraulic diameters. The loop momentum balance is achieved by adjusting iteratively the core channel inlet loss coefficients. On option, it can also be achieved by adjusting the steady-state jet pump head in case of a BWR with jet pumps.

2. Code Structure

SETRUT

This function subroutine is called by the function subroutine WRGCV in the pressure-regulator calculation. It calls subroutine ROOT1 to obtain a corrected value of the turbine control-valve flow rate.

SGEOM

This subroutine calculates the geometric parameters needed for SLCS.

SHUFL1

In this subroutine, the power distribution obtained at each iteration of the steady-state part of the neutronic calculation (or at the end of a neutronic time step during transient) for each neutronic cell, is reorganized according to the hydraulic nodalization. In general, a few neutronic cells are associated with one hydraulic cell at each axial level.

SHUFL2

In this subroutine, data obtained in the hydraulic calculation, such as the liquid temperature, liquid density, and void fraction distributions are rearranged in accordance with the neutronic nodalization for the subsequent use in the feedback calculation for neutron kinetics.

SINIT

This subroutine initializes the iteration variables, such as the liquid density, velocity, and accumulator pressure for the SLCS calculation.

SLCS

This is the driver routine for the Standby Liquid Control System (SLCS) calculation. This subroutine is called by subroutine **SEARCH** during the steady-state calculation, and by subroutine **NUMINT** for the transient calculation. The following operations are performed by this subroutine:

1. Check to test steady-state or transient calculation,
2. Performs steady-state calculation (calls subroutine **SCSTS**),
3. For ATWS related SLCS initiation, it calls the controller subroutine **SCNTRL**,
4. For manual initiation of SLCS, it checks the time delay setting,
5. Performs time-step calculation for SLCS (calls subroutine **DTCUL**), and
6. Performs transient calculation of SLCS (calls subroutine **SCTAN**).

This subroutine also calculates the rate of change of liquid velocity.

SLEVEL

This subroutine calculates the level inside the SLCS tank. It is the transient driver for the SLCS calculation. The following functions are performed by this routine:

1. Calculates the liquid level in the tank (calls subroutine **SLEVEL**),
2. Calculates fluid density (calls subroutine **SCDENS**),
3. Calculates rate of change of liquid velocity (calls subroutine **SDVDT**),
4. Calculates rate of change of pressure (calls subroutine **SDPDT**),
5. Calculates rate of change of void fraction (calls subroutine **SDALDT**), and
6. Performs explicit time integration for the state equations.

This subroutine also performs the time-step calculation for SLCS.

SOLVEHS

This subroutine integrates an ordinary differential equation for each time step to solve for the mean temperature of a slab structure using an explicit scheme.

SSHS

During a steady-state calculation, this subroutine evaluates the rate of heat transfer between the fluid and all boundary structures. These structures interface with fluid within the RPV and may also interface with outside air.

STATIC

This subroutine is the driver for the steady-state (or static) calculation. The convergence tests are checked for every power-void iteration. It calls the hydraulic and neutronic driving subroutines, and continues the steady-state calculation until either the maximum number of iterations has been reached (i.e., NCMAX on Card 800000) or the calculation has converged.

STMLN

This is the driver routine for performing the Runge-Kutta-Simpson integration of the steamline state equations. Each integration interval is constrained to be five times smaller than the preceding hydraulic time step due to the stiffness of the steamline state equations.

STMSEP

This subroutine contains the new mechanistic steam separator model. It takes the separator inlet conditions as input from the nodal (cell) properties (pressure, liquid and vapor mass flow rates, and flow quality) of the second cell in the riser, then computes at each accepted hydraulic time step the effective L/A ratio, steam carryunder fraction, liquid carryover fraction, separator pressure drop, and effective riser inlet form loss coefficient as the output variables. These output variables are then used in the vessel flow calculation. This subroutine calls another subroutine **GESUP** which solves the mechanistic separator model equations. The **STMSEP** subroutine is called by subroutine **HYDRO2**.

TBTRIP

This subroutine initiates a turbine trip automatically by various events such as low or high downcomer water level, low system pressure, or low turbine inlet pressure. The "trip on time" option is also included to simulate a manual trip.

2. Code Structure

TCAN

This subroutine calculates the temperature of the fuel rod surface for either non boiling, boiling, or post-CHF heat-transfer regime for each cell of the heated hydraulic channels in the reactor core.

TEMPIN

This subroutine defines and writes the geometric parameters of the fuel heat-conduction model to the output file.

TEPLO

In this subroutine, the fuel pellet and cladding temperature distributions for the steady state are calculated using the calculated thermal-hydraulic conditions and the nodal power.

TFDYN

This subroutine calculates the average fuel temperature, the fuel temperature distribution, and the derivatives of the fuel temperature during the transient calculation. It also calculates the heat-transfer coefficient for the fuel-clad gap.

THERMO

This subroutine determines the thermodynamic properties of water and steam for either the local or non-local pressure dependency. In the latter case, the average system (RPV) pressure is used for all hydraulic cells in the reactor vessel.

TLAG

This subroutine is used to introduce a first-order time lag in the steam flow and condensate return flow of the IC.

TMIN

This function subroutine calculates the minimum stable film-boiling temperature based on the homogeneous nucleation theory.

TSTINP

In this subroutine, the input data (primarily on geometry and hydraulics) are examined for inconsistencies. If an inconsistency is found, a diagnostic message is written and the program terminates.

TWALLS

This subroutine calculates the outer wall temperature of the condenser tubes in the IC.

VALPOS

This subroutine contains the pressure-regulator model. It takes the turbine inlet pressure as the input signal and produces the stem position of the turbine stop valve and bypass valve, and the steam demand error as the output signals. The valve-stem positions are used to obtain the mass flow rates through the turbine and bypass valves. The steam demand error is fed into the recirculation flow control system as the input signal.

VFVG

This function subroutine calculates the phasic velocities in each hydraulic cell of the vessel 1-D components and parallel hydraulic channels in the core.

VGJ

This function subroutine calculates the drift velocity v_{gj} in each hydraulic cell of the vessel 1-D components and parallel hydraulic channels in the core.

VENT

This subroutine calculates the steam and gas flow rates through the vent line between IC and suppression pool of SBWR (for future, not used at present).

VOIDSS

This function subroutine calculates the cell-average void fraction in each hydraulic cell of the vessel 1-D components and parallel hydraulic channels in the core during the steady-state hydraulic calculation.

WBYP

This function subroutine produces the turbine bypass flow rate during a turbine bypass-valve trip event. A table lookup via input is used to control the valve operation in time.

WFULL

This subroutine calculates the limiting liquid flow rate through the condensate return line of the IC.

WLRET

This subroutine calculates the liquid return flow rate from IC to the RPV (calls subroutine TLAG).

WRGBY

This function subroutine calculates the steam flow rate through the turbine bypass valve as a function of pressure at the valve location in the steamline.

WRGCV

This function subroutine calculates iteratively the steam flow rate through the turbine control valve as a function of pressure in the steamline. This function subroutine is used when the pressure-regulator calculation is performed.

WSRSTR

This subroutine stores and restores the current information on safety and relief valves status in anticipation of either a hydraulic or a neutronic back-stepping.

2. Code Structure

WSRTOT

This function subroutine controls the safety and relief valves (SRV) operation either automatically on "high-low" pressure setpoints, or manually on time, and calculates the total mass flow rate through the SRV.

WSUM

This subroutine calculates the mass and energy balance within the IC.

WTRB

This function subroutine calls the turbine trip subroutine TBTRIP and returns the turbine steam flow rate.

XEDOP

This subroutine calculates the neutron diffusion parameters and some auxiliary variables used during the steady-state neutronic calculation for all neutronic cells.

XEDYN

This subroutine calculates the neutron diffusion parameters as a function of fuel average temperature, moderator temperature, and void fraction. Parameters needed to solve the transient neutron-kinetics equations are also calculated in this subroutine.

XIPR

This function subroutine is used to predict initial pressure distribution in the steamline dynamic calculation.

ZUBGRF

This function subroutine calculates Q_{CHF} for low-flow conditions using the Zuber-Griffith correlation.

3. INSTALLATION OF RAMONA-4B ON WORKSTATIONS

3.1 RAMONA-4B on Unix Workstations

3.1.1 Introduction

The RAMONA-4B code has been converted from the mainframe environment to the Unix workstation environment for both the Sun-SPARC-10 and IBM RISC-6000 systems. The Sun SPARC-10 and RISC-6000 versions are identical except for timing routines (time, date, etc.) and one plot file generation routine called "AXIPLT". Neither the timing routines nor the plot file generation routine are formally part of RAMONA-4B, and these machine-specific routines can be replaced by dummy routines if RAMONA-4B is implemented on other platforms, such as Digital Equipment Corporation (DEC) or Hewlett Packard (HP) workstations. The plot file generation routine generates a plot-program-specific binary file. The plot program (called PAD) is available from Brookhaven National Laboratory (BNL) but the plot libraries (DISSPLA or NASADIG) that PAD calls are licensed products that are not available from BNL.

3.1.2 Generic Installation and Execution of the RAMONA-4B Distribution on Sun SPARC Workstations

RAMONA-4B code can be installed on Sun SPARC workstation by using the following steps:

1. To create a local directory for the distribution and change directory to it, enter:

```
mkdir my_local_dir
cd my_local_dir
```

2. To "un-tar" the distribution, enter:

```
tar xvf "name_of_tarfile",
```

where "name_of_tarfile" will be the device (dev) name for a 1/4" magnetic tape or an 8-mm magnetic tape cassette, designated as:

```
/dev/rst      (Sun tapes)
```

```
/dev/rmt0     (IBM tapes)
```

3. To compile RAMONA-4B and create an executable, enter:

```
gocompile
```

where the "gocompile" script file invokes the "ramona4b.compile.scr" script file that compiles the main RAMONA-4B routines, and in a separate compile step, compiles the time and date routines for the Sun. The object files of the two compilations are then linked together into a single executable named "ramona4b.exe".

3. Installation of RAMONA-4B on Workstations

4. To run the two sample problems, enter:

```
godemo1
godemo2
```

where both "godemo1" and "godemo2" are script files which execute "ramona4b.exe", read the appropriate demonstration problem input files, write the RAMONA-4B output to appropriately named output files, save the restart file and the plot file, and erase all the temporary scratch files. Only one RAMONA-4B problem can be run on a single directory at a given time because the scratch files have common names. To run "godemo1" and "godemo2" simultaneously, they must be run from different directories.

5. To restart a problem, copy the restart output file (fort.33) to the restart input file (fort.39) for restart, and modify the user input (demo1.inp) to indicate a restart. This was already done in the file "demo1rst.inp", and should provide the necessary instructions for a successful restart of any problem. Again, the actual script files should contain the specific instructions as to what the user is supposed to do for a successful restart.

3.1.3 Generic Installation and Execution of the RAMONA-4B Distribution on IBM RISC-6000 Workstations

The 5-step process for the installation of RAMONA-4B and running of the sample problems is the same as for the Sun SPARC. The generic names of the files are the same for the IBM RISC-6000 as for the Sun SPARC.

The contents of the IBM script (command) files differ from the contents of the Sun script files, even though both have the same generic name. The file name extensions ".ibm" and ".sun" are appended to the generic file names to distinguish the different machine versions of the files. As with the Sun distribution, the IBM distribution consists of "go*" script files which call other script files. A complete listing of the script files is shown at the end of this section. The listings are shown alphabetically, by the generic file names with ".sun" or ".ibm" extensions appended to the names to distinguish the different machine versions. The ".sun" files are presented alphabetically first, and the ".ibm" files are listed alphabetically second.

Although there is a large commonality in the generic files, (i.e., those file names without either the ".sun" or ".ibm" extension) the subtle differences necessitate separate listings of the Sun and IBM versions.

The different effects of the "-r8" flag on the Sun compiler, and the "-qautodbl=dblpad" on the IBM, lead to two versions of subroutine "ax1plt". Those different effects necessitate compiling the Sun versions with different flags for the timing routines and the main RAMONA-4b routines. The absence of a Fortran callable time and date routine for the IBM, leads to the necessity for obtaining that information via a "c" routine. The differences in the implementation on the Sun and IBM machines are not apparent to the user if the master (generic) "go*" files are executed. The differences only become apparent if the user compares the "go*" for the Sun and IBM.

3.1.4 Variations of the Installation files

Generally, the distribution contains duplicate files: the generic file (such as ramona4b.compile.scr) and its backup master copy (such as ramona4b.compile.scr.sun). The backup master copy is provided to distinguish between different machine versions. For the IBM workstations, the backup master copy of a generic file would have an ".ibm" extension. This

duplicate distribution of files is intended to avoid confusion between the Sun Sparc version and IBM RISC version of identically named generic files. Further, "time and date" stamps on the source or output files provide important clues as to the origin of the files, and we always use "cp -p" for the copy function in the distributed scripts.

The distribution contains "alternate" generic script files in addition to the generic script files. For example, there is "ramona4b.compile2.scr", as a possible substitute for "ramona4b.compile.scr". This script takes one argument, and has three compilation paths. If no argument is given, then the default compile options are taken. If "trace" is given as an argument, then a full traceback compile is used. If "o2" is given as an argument, then an optimized compilation is performed, which produces an executable that can be 3 times faster than "trace" code. One should use the "trace" option to help locate errors in developmental coding or in inconsistent input (i.e., bad or nonphysical user input), and the "o2" generated code for production runs with fully debugged code and fully debugged input deck. The default compiler options can be used for intermediate cases. To use the alternate generic script for compilation, the user could use the generic script "gocompile2". The script "gocompile2" performs each of the three different compiles, and puts an "o2", "default", or "trace" extension on each of the "ramona4b.exe" executables to distinguish one from another. The users are then free to use whichever of these executables they desire in their generic "godemo1" or "godemo2" files, simply by copying the specific "ramona4b.exe.*" to the generic "ramona4b.exe".

Finally, for those who wish to use "make", we provide the "create_makefile.scr", which creates a "makefile.ramona" for use with the Unix "make" program. Unix "make" enables the users to recompile only those subroutines which they have recently changed or added, and thus save compilation time. But as newer machines increase dramatically in speed, the need for "make" diminishes proportionally. Nevertheless, for a program such as RAMONA-4B, which does not contain any Fortran "include" files, the process of creating a "makefile" lends itself to automation, provided that the only "*.f" files that exist in a subdirectory and "*.c" files in that subdirectory are all part of the final executable, and no other "*.f" or "*.c" files be part of that subdirectory. The "create_makefile.scr.sun" assumes that the RAMONA-4B program has already been subdivided into its component subroutines. Using the "ramona4b.f.sun" main source file this can be done by:

```
fsplit ramona4b.f.sun      (subdivide the main program routines)
mv main000.f ax1plt.f      (necessary because of a preprocessor flag)
rm -f zzz000.f             (delete a fully commented non-routine)
```

To create a "make" file and compile the updated code, do the following steps:

```
create_makefile.scr        (creates makefile.ramona)
make -f makefile.ramona    (to compile the updated code)
```

Continued use of the existing "makefile.ramona" will recompile only updated routines. A similar approach can be used for IBM RS6000.

3.1.5 Distribution of RAMONA-4B

RAMONA-4B is distributed in tar file format to authorized users on either 1/4" tape cassette or 8-mm tape cassette. RAMONA-4B can also be distributed electronically via internet ftp. The RAMONA-4B tar file contains the RAMONA-4B source code, the RAMONA-4B executable, "Readme" files, sample input problems files, sample output problem files from BNL, and the Unix script files necessary to compile, load and run the RAMONA-4B sample problems on the user's machine. Unix script files generally have the extension ".scr" for ease of identification. Additional script files (prefixed

3. Installation of RAMONA-4B on Workstations

with "go") call the lower level script files (*.scr). The "go" files act as drivers for the intended operation and perform the record-keeping chores that are always necessary.

The "go" files and the ".scr" files are commented (comments are preceded by a "#" sign) so that the users can follow the logic of the script files and modify the script files to suit their needs.

The RAMONA-4B source program is distributed in two major files, namely "ramona4b.f.sun" and "timing_2.f.sun". The ".sun" extension to a file name is given to identify it uniquely as a Sun-specific set of routines. Similarly RAMONA-4B is distributed for IBM workstations. The two files for IBM version are identified with .ibm extension. The "go" and ".scr" script files copy the necessary files with the ".sun" extension to local files without the ".sun" extension before doing the compilation.

The compilation on the Sun Sparc workstations requires different flags for the compiler for the timing routines and for the main RAMONA-4B program. On the Sun, the "r8" compile flag is used for the main RAMONA-4B routines. The "r8" compiler flag promotes all dimension statements to real*8 for real variables, and promotes all integer variables to integer*8. Logicals are also promoted to logical*8. Variables that are prespecified to a specific size, such as real*4 or integer*4, are not changed. Character variables are not changed in size by the "r8" compiler flag.

The similar compiler flag on the IBM ("autodbl") behaves differently. On the IBM the real variables are promoted to real*8, but integers, logicals, and characters remain their default size. Size pre-specified variables (such as real*4) are promoted to real*8 on the IBM. The text in the distributed script files, and the commands in the distributed script files should help clarify this matter. The current script files are alphabetically listed in at the end of this section.

A standard compile script of RAMONA-4B is provided in the script "Ramona4b.compile.scr". A more advanced script is available as "Ramona4b.compile2.scr" which enables the user to choose the option of "trace" (for code traceback on error), "o2" (for optimization level 2 for higher speed) or "default".

Note that the names in the above text may have been capitalized for emphasis. Since Unix is case sensitive, the file names in the distribution may differ in case from the text above. For your own implementation, use the file names in the actual distribution.

Table 3.1 Alphabetical Listing of Script Files for RAMONA-4B Installation on Sun SPARC

S.1	Readme.1st
S.2	create_makefile.ramona.sun
S.3	gocompile.sun
S.4	gocompile2.sun
S.5	gocreate_makefile.sun
S.6	godemo1.sun
S.7	godemo1rst.sun
S.8	godemo2.sun
S.9	ramona4b.comple2.scr.sun
S.10	ramona4b.compile2.scr.sun
S.11	timing_2.f.sun

S.1 Readme.1st.sun

```
# -----
# Readme.1st
# -----
```

1. This tape contains the files necessary to compile, create an executable on a SUN workstation, and run the executable with a 200-second MSIV closure ATWS event test problem.
2. The file "ramona4b.compile.scr" is the script file to compile and create the executable "ramona4b.exe", from the source files "ramona4b.f" and "timing_2.f.sun". The file "gocompile" executes the compile procedure. The "ramona4b.compile.scr" script contains commented commands to enable a compilation with a full execution error traceback.
3. The file "godemo1" is the script file that runs "ramona4b.exe" for a density wave oscillation transient induced by a recirculation pump trip for 50 seconds of reactor time. The input for the problem is found in "demo1.inp" and the output is written to "demo1.out". The file "demo1rst.inp" replaces the "demo1.inp" for a restart run.
4. The file "godemo2" is the script file that runs "ramona4b.exe" for a MSIV closure ATWS event for 60 seconds of reactor time. The input for the problem is found in "demo2.inp" and the output is written to "demo2.out".
5. The "fort.33" is the output data necessary for a restart. It is to be renamed to "fort.39" to use as input to the restart. It is not included in the distribution.
6. The "fort.49" is a plot file, which is not supported at this time, except at the BNL site. It is not included in the distribution.
7. The script file "@tar3" was used to create the 1/4 inch tar tape.

S.2 create_makefile.ramona.sun

```
#!/bin/csh -f
# -----
# create_makefile.ramona
# Ramona4b version for sun, with traceback
# -----
echo "=====
echo "Caution..."
echo "Embedded <Tabs> in this file. Do not rely on listing."
echo "Use actual distributed file."
echo "=====
echo "Warning..."
echo "Because of built in IBM specific flags,"
echo "fsplit 'ramona4b.f.sun' will produce file 'main000.f' and"
echo "'zzz000.f'."
echo "=====
echo "main000 should be renamed to ax1plt, and"
```

3. Installation of RAMONA-4B on Workstations

```
echo " zzz000 should be deleted, in both this directory, and"
echo " in 'makefile.ramona'"
echo "===== "
set verbose
echo "Copying timing_2.f.sun ...To... timing_2.f"
echo "and Compiling without r8 flag."
cp -p timing_2.f.sun timing_2.f
f77 -c -g -C -fnonstd -temp=. -pipe timing_2.f
echo "SHELL=/bin/sh" > top
echo "#" >> top
echo "# makefile for sun" >> top
echo "#" >> top
echo "CF = f77" >> top
echo "LDFLAGS = -g -fnonstd -C -Bstatic -pipe" >> top
echo "LIBS = " >> top
echo "CMD = ramona4b.exe" >> top
# Traceback option on sun
echo "FFLAGS = -r8 -g -C -fnonstd -NI40 -Bstatic -temp=. -pipe" >> top
echo "Edit file with list of fortran files"
echo "Put TABS before each filename (makefile format)"
ls *.f > tmp3f
echo "Editing file = 'tmp3f' "
ex tmp3f<<EOF
1,\$ s/^ /
1,\$-1 s/^\ \\\
1 s/ /SRCS = /
w! tmp2f
1,\$ s/././o/
1 s/SRCS =/OBS =/
w! tmp3o
quit!
EOF
echo ">> tmp2f"
echo ">> tmp3o"
echo '$(CMD): $(OBS)' > bot
echo '$(CF) $(LDFLAGS) $(OBS) -o $(@)' >> bot
echo ">> bot"
cat1 top tmp2f tmp3o bot > makefile.ramona
unset verbose
echo "===== "
echo "Created 'makefile.ramona' for Sun."
echo "Now, enter: make -f makefile.ramona"
echo "===== "
set verbose
unalias rm
rm tmp3f tmp2f tmp3o top bot
```


S.3 gocompile.sun

```
#!/bin/csh -f
#
# gocompile - Sun command file
#
set verbose
alias timex '/usr/5bin/time'
date
date                > & ramona4b.compile.out

timex ramona4b.compile.scr  >> & ramona4b.compile.out
date                      >> & ramona4b.compile.out
date
```

S.4 gocompile2.sun

```
#!/bin/csh -f
#
# gocompile2 - sun command file
# Compile 3 times, with traceback, default, and o2 options
#
set verbose
alias timex '/usr/5bin/time'
date
date                > & ramona4b.compile.out
timex ramona4b.compile2.scr trace >> & ramona4b.compile.out
date                      >> & ramona4b.compile.out
date
cp -p ramona4b.exe ramona4b.exe.trace
# -----

timex ramona4b.compile2.scr      >> & ramona4b.compile.out
date                            >> & ramona4b.compile.out
date
cp -p ramona4b.exe ramona4b.exe.default
# -----

timex ramona4b.compile2.scr o2   >> & ramona4b.compile.out
date                            >> & ramona4b.compile.out
date
cp -p ramona4b.exe ramona4b.exe.o2
# -----
```

3. Installation of RAMONA-4B on Workstations

S.5 gcreate_makefile.sun

```
#!/bin/csh -f
#
#gcreate_makefile - sun command file
#
# -----
#1. Create a subdirectory and copy this file as well as ramona4b.f.sun to that subdirectory. #Also copy timing_2.f.sun
    to the subdirectory. Also copy create_makefile.ramona.scr
    #to the subdirectory.
#
#2. Change your directory to the subdirectory.
#
#3. Do:
#   fslplit ramona4b.f.sun
#   unalias rm
#   rm zzz000.f
#   mv main000.f ax1plt.f
#4. Do the above steps only once.
#
#5. Run this command file
#
#6. Do:
#   make -f makefile.ramona
# -----
#
    date
    create_makefile.ramona
    date
```

S.6 godemo1.sun

```
#!/bin/csh -f
#
#godemo1 - sun command file
#
    set verbose
    alias timex '/usr/5bin/time'          # timing of the calculation
    date
#
    timex ramona4b.exe <demo1.inp      > & demo1.out
    date                               >> & demo1.out
    date
    echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo1.out
#
    mv fort.49 fort.49.demo1          # Save Plot file
    mv fort.33 fort.33.demo1          # Save Restart file
```

```

unalias rm
rm fort.? fort.??      #Erase all scratch files
date

```

S.7 godemo1rst.sun

```

#!/bin/csh -f
#
# godemo1rst - sun command file
#
set verbose
alias timex '/usr/5bin/time'    #timing of the calculation.
date
cp -p fort.33 fort.39          #Copy restart output to restart input file
timex ramona4b.exe <demo1rst.inp > & demo1rst.out
date                           >> & demo1rst.out
date
echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo1rst.out
mv fort.49 fort.49.demo1rst    #Save Plot file
mv fort.33 fort.33.demo1rst    # Save Restart file
unalias rm
rm fort.? fort.??              #Erase all scratch files
date

```

S.8 godemo2.sun

```

#!/bin/csh -f
#
# godemo2 - sun command file
#
set verbose
alias timex '/usr/5bin/time'    #timing of the calculation
date
timex ramona4b.exe <demo2.inp   > & demo2.out
date                           >> & demo2.out
date
echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo2.out
mv fort.49 fort.49.demo2       #Save Plot file
mv fort.33 fort.33.demo2       #Save Restart file
unalias rm
rm fort.? fort.??              #Erase all scratch files
date

```

3. Installation of RAMONA-4B on Workstations

S.9 ramona4b.compile.scr.sun

```
#!/bin/csh -f
# ramona4b.compile.scr - Sun default options
date
echo "Machine = `hostname` -- Directory = `pwd`"
echo "-----"
echo "ramona4b.compile.scr - script to compile Ramona4b on Sun"
echo "-r8 flag on compiler= auto-double"
echo "No r8 flag on timing_2.f"
echo "-----"
unalias rm
if (-e ramona4b.exe ) then
    cp -p      ramona4b.exe      ramona4b.exe.bak
    rm        ramona4b.exe      ramona4b.o
endif
    cp -p      timing_2.f.sun timing_2.f
    echo "Compiling with default options"
    f77 -c      timing_2.f
    f77 -c -r8 ramona4b.f
    echo "Linking with default options"
    f77        timing_2.o ramona4b.o    -o ramona4b.exe
# -----
# echo "Compiling on SUN"
# echo '(-g) Traceback with line numbers'
# echo '(-fnonstd) Traceback with line numbers'
# echo '(-r8) flag on compiler= auto-double'
# echo '(-NI40) permits 40 continuation lines'
# echo '(-temp=.) uses local directory for temporary files'
# echo '(-C) checks array bounds'
# echo '(-pipe) uses pipes instead of intermed. files'
# echo '(-Bstatic) traces Sun Lib. routines'
# -----
# Alternate options:
# echo "Compiling - with Traceback - big and slow .exe"
# f77 -temp=. -C -pipe -c -g -fnonstd timing_2.f
# f77 -temp=. -C -pipe -c -g -fnonstd -r8 -NI40 ramona-4b.f
# echo "Linking - with Traceback"
# f77 -C -pipe -g -fnonstd -Bstatic timing_2.o ramona-4b.o -o ramona-4b.exe
# -----
    ls -lat ramona4b*
    unalias rm
    rm ramona4b.o
```

S.10 ramona4b.compile2.scr.sun

```

#!/bin/csh -f
# ramona4b.compile2.scr
# 3 compile options for Sun
date
echo "Machine = `hostname` -- Directory = `pwd`"
echo "-----"
echo "ramona4b.compile2.scr - script to compile Ramona4b"
echo "r8 flag on compiler= auto-double"
echo "No r8 flag on timing_2.f"
echo "-----"
# -----
# echo "Compiling on SUN"
# echo '(-g) Traceback with line numbers'
# echo '(-fnonstd) Traceback with line numbers'
# echo '(-r8) flag on compiler= auto-double'
# echo '(-Nl40) permits 40 continuation lines'
# echo '(-temp=.) uses local directory for temporary files'
# echo '(-C) checks array bounds'
# echo '(-pipe) uses pipes instead of intermed. files'
# echo '(-Bstatic) traces Sun Lib. routines'
# -----
unalias rm
# set verbose
# set echo
if (-e ramona4b.exe) then
    cp -p      ramona4b.exe      ramona4b.exe.bak
    rm         ramona4b.exe      ramona4b.o
endif
    cp -p      timing_2.f.sun timing_2.f
# -----
if ( $1 == "O2" || $1 == "o2" ) then
    echo "Compiling - with O2 option"
    f77 -temp=. -O2 -c timing_2.f
    f77 -temp=. -O2 -c -r8 ramona4b.f
    echo "Linking"
    f77 -O2      timing_2.o ramona4b.o      -o ramona4b.exe
endif
# -----
if ( $1 != "O2" && $1 != "o2" && $1 != "trace" && $1 != "TRACE" ) then
    echo "Compiling - Default options"
    f77 -temp=. -c timing_2.f
    f77 -temp=. -c -r8ramona4b.f

    echo "Linking"
    f77      timing_2.o ramona4b.o      -o ramona4b.exe
endif

```

3. Installation of RAMONA-4B on Workstations

```
# -----
if ( $1 == trace || $1 == TRACE ) then
    echo "Compiling - with Traceback - big and slow .exe"
    f77 -temp=. -C -pipe -c -g -fnonstd timing_2.f
    f77 -temp=. -C -pipe -c -g -fnonstd -r8 -N140 ramona4b.f
    echo "Linking - with Traceback"
    f77 -C -pipe -g -fnonstd -Bstatic timing_2.o ramona4b.o -o ramona4b.exe
endif
# -----
ls -lat ramona4b*
unalias rm
rm ramona4b.o
```

S.11 timing_2.f.sun

```
com -----
com timing.f.sun
com 25 Jan. 93 - Modified for Sun Sparc
com -----
com timing_2.f -
com 02 oct. 92 - ramona routines clockk, timer, dater, second
com - modified for calls to ibm rs6000 timing routines
com 02 oct. 92 - ibm rs6000 workstation timing routines
com - datestamp --> 26 char date time from tdate.c
com - datez (dat11)--> 11 char date e.g. Oct 02 1992
com - datez8(dat8) --> 8 char date e.g. Oct02 92
com - timez (tim8) --> 8 char time e.g. 17:52:04
com - dayz (day3) --> 3 char day e.g. Fri
com - mclock() --> Rs6000 operating system routine for
com --> elapsed cpu time since job start.
com -----
com subroutine clockk(clocks)
com character*8 clocks
com dimension ib(8)
com call datim(ib)
com write(unit=clocks,fmt=100) ib(5),ib(4),ib(3)
co100 format(i2.2,' ',i2.2,' ',i2.2)
com -----
com Sun Sparc
com Ibm Rs6000
com -----
com clocks is in the form hh.mm.ss
com character*8 clocks
com call timez(clocks)
com return
com end
com -----
```

3. Installation of RAMONA-4B on Workstations

```

subroutine dater(idate)
com dimension ib(8)
com character*8 idate
com datim is a ibm 3090 system routine that returns
com ib(6) = i*4 day (1 to 31)
com ib(7) = i*4 mon (1 to 12)
com ib(8) = i*4 year (4 digits)
com call datim(ib)
com last 2 digits of year
com ib(8)=mod(ib(8),100)
com write(unit=idate,fmt=100) ib(7),ib(6),ib(8)
com 100 format(i2.2,'/',i2.2,'/',i2.2)
com -----
com Sun Sparc
com Ibm Rs6000
com -----
com idate was in the form "mm/dd/yy" (month/day/year)
com now is in the form "Oct02 92"
com character*8 idate
com call datez8 (idate)
com return
com end

com -----
com double precision function secund(dummy)

com second returns the cpu time used in seconds (to nearest hundredth)
com 10.31.90 aa ln: for the time being ...
com call vtime(ivtime,itime)
com ivtime=1
com secund=dbl(ivtime)/100.0
com -----
com Ibm Rs6000 follows
com -----
com Ibm Rs6000 CPU timing (integer 0.01 sec. mclock)
com secund = float(mclock()) * 0.01
com -----
com Sun Sparc follows
com -----
com Elapsed (User) time (not CPU time)
com secnds() is a Vax-like timing routine from Sun
com data icnt / 0 /
com data t0 / 0.0 /
com if(icnt.eq.0) t0 = secnds(0.0)
com icnt = icnt + 1
com t1 = secnds(t0) ! elapsed clock time in sec.
com ! not CPU time.
com secund = dbl(t1)
com return

```

3. Installation of RAMONA-4B on Workstations

```

        end
com  -----
        subroutine timer(itime)
com  itime is in the form hh.mm.ss
com  character*8 itime
com  call clockk(itime)

com  -----
com  Sun Sparc
com  Ibm Rs6000
com  -----
com  itime is in the form hh.mm.ss
        character*8 itime
        call timez(itime)
        return
        end

com  -----
com  -----
com  DateStamp.f
com  24 Jan. 93   - Sun Sparc workstation timing routines version
com  02 Oct. 92   - ibm rs6000 workstation timing routines
com               - datestamp      --> 26 char date time from tdate.c
com               - datez(dat11)    --> 11 char date e.g. Oct 02 1992
com               - datez8(dat8)     --> 8 char date e.g. Oct02 92
com               - timez(tim8)      --> 8 char time e.g. 17:52:04
com               - dayz(day3)       --> 3 char day e.g. Fri
com               - mclock()         --> ibm Rs6000 operating system routine for
com                                   --> elapsed cpu time since job start.
com  -----

        Subroutine datestamp
        character*26 char26
        character*24 char24b
        character*24 fdate      ! sun
        external fdate          ! sun
        char26= fdate( )        ! sun
com  call tdate( %ref(char26) )  ! ibm
        char24b( 1:10) = char26( 1:10) ! day3,bl,mon3,bl,nday2
        char24b(11:15) = char26(20:24) ! bl,year4
        char24b(16:24) = char26(11:19) ! bl,minutes8
        write(*,*) 'Datestamp = ', char24b
        return
        end

com  -----

        Subroutine datez(dat11)
        character*26 char26
        character*11 dat11
        character*8 tim8
        character*3 day3

```


3. Installation of RAMONA-4B on Workstations

```

        character*24      fdate      ! sun
        external          fdate      ! sun
        char26 =          fdate()    ! sun
com      call tdate( %ref(char26) )  ! ibm
        day3 ( 1: 3) = char26( 1: 3)
        tim8 ( 1: 8) = char26(12:19)
        dat11( 1: 7) = char26( 5:11)
        dat11( 8:11) = char26(21:24)
com      write(*,*) ' Day3      = ', day3
com      write(*,*) ' Tim8      = ', tim8
com      write(*,*) ' Dat11     = ', dat11

        return
        end
com      -----
        Subroutine datez8(dat8)
        character*26 char26
        character*8 dat8
        character*11 dat11
        character*8 tim8
        character*3 day3
        character*24      fdate      ! sun
        external          fdate      ! sun
        char26 =          fdate()    ! sun
com      call tdate( %ref(char26) )  ! ibm
        day3 ( 1: 3) = char26( 1: 3)
        tim8 ( 1: 8) = char26(12:19)
        dat11( 1: 7) = char26( 5:11)
        dat11( 8:11) = char26(21:24)
com      8 char date - format = Oct01 92
        dat8 ( 1: 3) = char26( 5: 7)
        dat8 ( 4: 6) = char26( 9:11)
        dat8 ( 7: 8) = char26(23:24)
com      write(*,*) ' Day3      = ', day3
com      write(*,*) ' Tim8      = ', tim8
com      write(*,*) ' Dat11     = ', dat11
com      write(*,*) ' Dat8      = ', dat8
        return
        end
com      -----
        Subroutine timez(tim8)
        character*26 char26
        character*11 dat11
        character*8 tim8
        character*3 day3
        character*24 fdate      ! sun
        external fdate      ! sun
        char26 = fdate()      ! sun

```

3. Installation of RAMONA-4B on Workstations

```

com    call tdate( %ref(char26)    ! ibm
      day3 ( 1: 3) = char26( 1: 3)
      tim8 ( 1: 8) = char26(12:19)
      dat11( 1: 7) = char26( 5:11)
      dat11( 8:11) = char26(21:24)
com    write(*,*) ' Day3      = ', day3
com    write(*,*) ' Tim8      = ', tim8
com    write(*,*) ' Dat11     = ', dat11
      return
      end
com    -----
      Subroutine dayz (day3)
      character*26 char26
      character*11 dat11
      character*8 tim8
      character*3 day3
      character*24 fdate      ! sun
      external      fdate      ! sun
      char26 = fdate( )      ! sun
com    call tdate( %ref(char26) )    ! ibm
      day3 ( 1: 3) = char26( 1: 3)
      tim8 ( 1: 8) = char26(12:19)
      dat11( 1: 7) = char26( 5:11)
      dat11( 8:11) = char26(21:24)
com    write(*,*) ' Day3      = ', day3
com    write(*,*) ' Tim8      = ', tim8
com    write(*,*) ' Dat11     = ', dat11
      return
      end
com    -----
com    /* ----- */
com    /* tdate.c:      Time and Date - Ibm Rs6000 */
com    /* from fortran: 'call tdate' */
com    /* from fortran: 'call tdate( %ref(char26) )' */
com    /* return to fortran: char26 */
com    /* input:      none */
com    /* output time and date stamp to standard output. */
com    /* ----- */
com    #include <stdio.h>
com    #include <time.h>
com    #include <sys/types.h>
com    #include <sys/times.h>
com    #include <string.h>
com    int tdate( char *qdate )
com    /* char *qdate; */
com    {
com    time_t ltime;
com    time(&ltime);

```

3. Installation of RAMONA-4B on Workstations

```
com strcpy (qdate,ctime(&ltime));
com /* printf("%s",qdate); */
com /* printf("%s",ctime(&ltime)); */
com }
com -----
```

Table 3.2 Alphabetical Listing of Script Files for RAMONA-4B Installation on IBM Workstation

I.1	create_makefile.ramona.ibm
I.2	datestamp.f.ibm
I.3	gocompile.ibm
I.4	gocompile2.ibm
I.5	gocreate_makefile.ibm
I.6	godemo1.ibm
I.7	godemo1rst.ibm
I.8	godemo2.ibm
I.9	ramona4b.compile.ibm
I.10	ramona4.compile2.ibm
I.11	ramona4b.compile.scr.ibm
I.12	ramoan4b.compile.trace.ibm
I.13	tdate.c.ibm

I.1 create_makefile.ramona.ibm

```
#!/bin/csh -f
# -----
# create_makefile.ramona
# Ramona4b version for ibm, with traceback
# -----
echo "=====
echo "Caution..."
echo "Embedded <Tabs> in this file."
echo "Do not try to duplicate this file from its listing."
echo "Use the file from the Ramona4b distribution."
echo "=====
echo "Warning..."
echo "Because of built in IBM specific flags,"
echo "fsplit '*.source' will produce file 'main000.f' and"
```

3. Installation of RAMONA-4B on Workstations

```
echo "z000.f."
echo "===== "
echo " main000 should be renamed to ax1plt, and"
echo " z000 should be deleted, in both this directory, and"
echo " in 'makefile.ramona' "
echo "===== "
set verbose
echo "SHELL=/bin/sh" > top
echo "# " >> top
echo "# makefile for sun" >> top
echo "# " >> top
echo "CF = xlf" >> top
echo "LDFlags = -g " >> top
echo "LIBS = " >> top
echo "CMD = ramona4b.x" >> top
# Traceback option
echo "FFlags = -qautodbl=dblpad -g -NQ20000 -ND4096 -NT40000 \
-qftrap=overflow:zerodivide:invalid:enable" >> top
# Normal options
# echo "FFlags = -qautodbl=dblpad -NQ20000 -ND4096 -NT40000" >> top
# Optimized options
# echo "FFlags = -O2 -qautodbl=dblpad -NQ20000 -ND4096 -NT40000" >> top
echo "Edit file with list of c and fortran files"
echo "Put TABS before each filename (makefile format)"
ls *.c > tmp3f
ls *.f >> tmp3f
echo "Editing file = 'tmp3f' "
ex tmp3f<<EOF
1,$ s/^/ /
1,$-1 s/$^ \\\
1 s/ /SRCS = /
w! tmp2f
1,$ s/^././
1 s/SRCS =/OBS =/
w! tmp3o
1,$ s/^././
w! tmp3o
quit!
EOF
echo "" >> tmp2f
echo "" >> tmp3o
echo "$(CMD): $(OBS)' > bot
echo ' $(CF) $(LDFlags) $(OBS) -o $(@)' >> bot
echo ' ' >> bot
cat top tmp2f tmp3o bot > makefile.ramona
unset verbose
echo "===== "
echo "Created 'makefile.ramona' for Ibm."
```

```

echo "Now, enter: make -f makefile.ramona"
echo "=====
set verbose
unalias rm
rm tmp3f tmp2f tmp3o top bot

```

I.2 datestamp.f.ibm

```

com -----
com   DateStamp.f
com   02 Oct. 92 - ibm rs6000 workstation timing routines
com   - datestamp      --> 26 char date time from tdate.c
com   - datez(dat11)   --> 11 char date e.g. Oct 02 1992
com   - datez8(dat8)   --> 8 char date e.g. Oct02 92
com   - timez(tim8)    --> char time e.g. 17:52:04
com   - dayz(day3)     --> 3 char day e.g. Fri
com   - mclock()       --> operating system routine for
com                       --> elapsed cpu time since job start.
com -----
com   Subroutine datestamp
com   character*26 char26
com   character*24 char24b
com   call tdate( %ref(char26) )
com   char24b( 1:10)      = char26( 1:10)      ! day,mon,nday
com   char24b(11:15)     = char26(20:24)      ! bl,year
com   char24b(16:24)     = char26(11:19)      ! bl,minutes
com   write(*,*) 'Datestamp' = ', char24b
com   return
com   end
com -----
com   Subroutine datez(dat11)
com   character*26 char26
com   character*11 dat11
com   character*8tim8
com   character*3day3
com   call tdate( %ref(char26) )
com   day3 ( 1: 3)       = char26( 1: 3)
com   tim8 ( 1: 8)       = char26(12:19)
com   dat11( 1: 7)       = char26( 5:11)
com   dat11( 8:11)       = char26(21:24)
com   write(*,*) ' Day3' = ', day3
com   write(*,*) ' Tim8' = ', tim8
com   write(*,*) ' Dat11' = ', dat11
com   return
com   end
com -----
com   Subroutine datez8(dat8)

```

3. Installation of RAMONA-4B on Workstations

```
character*26 char26
character*8dat8
character*11 dat11
character*8tim8
character*3day3
call tdate( %ref(char26) )
day3 ( 1: 3)      = char26( 1: 3)
tim8 ( 1: 8)      = char26(12:19)
dat11( 1: 7)      = char26( 5:11)
dat11( 8:11)      = char26(21:24)
com      8 char date - format = Oct01 92
dat8 ( 1: 3)      = char26( 5: 7)
dat8 ( 4: 6)      = char26( 9:11)
dat8 ( 7: 8)      = char26(23:24)
com      write(*,*) ' Day3      = ', day3
com      write(*,*) ' Tim8      = ', tim8
com      write(*,*) ' Dat11     = ', dat11
com      write(*,*) ' Dat8      = ', dat8
      return
      end
com      -----
      subroutine timez(tim8)
      character*26 char26
      character*11 dat11
      character*8tim8
      character*3day3
      call tdate( %ref(char26) )
      day3 ( 1: 3)      = char26( 1: 3)
      tim8 ( 1: 8)      = char26(12:19)
      dat11( 1: 7)      = char26( 5:11)
      dat11( 8:11)      = char26(21:24)
com      write(*,*) ' Day3      = ', day3
com      write(*,*) ' Tim8      = ', tim8
com      write(*,*) ' Dat11     = ', dat11
      return
      end
com      -----
      subroutine dayz(day3)
      character*26 char26
      character*11 dat11
      character*8tim8
      character*3day3
      call tdate( %ref(char26) )
      day3 ( 1: 3)      = char26( 1: 3)
      tim8 ( 1: 8)      = char26(12:19)
      dat11( 1: 7)      = char26( 5:11)
      dat11( 8:11)      = char26(21:24)
com      write(*,*) ' Day3      = ', day3
```

3. Installation of RAMONA-4B on Workstations

```
com    write(*,*) ' Tim8      = ', tim8
com    write(*,*) ' Dat11     = ', dat11
      return
      end
com    -----
com    /* ----- */
com    /*tdate.c : Time and Date */
com    /*from fortran: 'call tdate' */
com    /*from fortran: 'call tdate( %ref(char26) )' */
com    /*return to fortran: char26 */
com    /*input: none */
com    /*output time and date stamp to standard output. */
com    /*----- */
com    #include    <stdio.h>
com    #include    <time.h>
com    #include    <sys/types.h>
com    #include    <sys/times.h>
com    #include    <string.h>
com
com    int tdate( char *qdate )
com    /*char *qdate; */
com    {
com    time_t ltime;
com    /* char xdate[26]; */
com
com    time(&ltime);
com    strcpy (qdate,ctime(&ltime));
com
com    /* printf(" %s",qdate); */
com    /* printf(" %s",ctime(&ltime)); */
com    }
com    -----
```

I.3 gocompile.ibm

```
#!/bin/csh -f
#
# gocompile- Ibm command file
#
set verbose
date
date > & ramona4b.compile.out
timex ramona4b.compile.scr >> & ramona4b.compile.out
date >> & ramona4b.compile.out
date
```

3. Installation of RAMONA-4B on Workstations

I.4 gocompile2.ibm

```
#!/bin/csh -f
# gocompile2 - Ibm command file
# Compile 3 times, with traceback, default, and o2 options
set verbose
date
date                >& ramona4b.compile2.out
timex ramona4b.compile.trace >> & ramona4b.compile2.out
date                >> & ramona4b.compile2.out
date
# The above generates ramona4b.exe.trace
# -----
timex ramona4b.compile.scr   >> & ramona4b.compile2.out
date                       >> & ramona4b.compile2.out
date
# The above does not generate ramona4b.exe.default
# We must generate with the next statement.
cp -p ramona4b.exeramona4b.exe.default
# -----
timex ramona4b.compile.o2   >> & ramona4b.compile2.out
date                       >> & ramona4b.compile2.out
date
# The above generates ramona4b.exe.o2
# -----
```

I.5 gcreate_makefile.ibm

```
#!/bin/csh -f

# gcreate_makefile - ibm command file
# -----
#1. Create a subdirectory and copy this file as well as ramona4b.f.sun to that # subdirectory. Also copy
    timing_2.f.sun to the subdirectory. Also copy # create_makefile.ramona.scr to the subdirectory.

#2. Change your directory to the subdirectory.

#3. Do:
#       fslplit ramona4b.f.sun
#       unalias rm
#       rm zzz000.f
#       mv main000.f ax1plt.f

#4. Do the above steps only once.

#5. Run this command file
```


3. Installation of RAMONA-4B on Workstations

```
#6. Do:
#      make -f makefile.ramona
# -----
date
create_makefile.ramona
date
```

I.6 godemo1.ibm

```
#!/bin/csh -f
#
# godemo1 - ibm command file
#
set verbose
date

timexramona4b.exe          < demo1.inp      > & demo1.out
date                      >> & demo1.out
date
echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo1.out

mv fort.49 fort.49.demo1   # Save Plot file
mv fort.33 fort.33.demo1   # Save Restart file
unalias rm
rm fort.? fort.??          # Erase all scratch files
date
```

I.7 godemo1rst.ibm

```
#!/bin/csh -f
#
# godemo1rst - sun command file
#
set verbose
date

cp -p fort.33 fort.39      # Copy restart output to restart input file

timexramona4b.exe          <demo1rst.inpx    > & demo1rst.out
date                      >> & demo1rst.out
date
echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo1rst.out

mv fort.49 fort.49.demo1rst # Save Plot file
mv fort.33 fort.33.demo1rst # Save Restart file
unalias rm
```

3. Installation of RAMONA-4B on Workstations

```
rm fort.? fort.??          # Erase all scratch files
date
```

I.8 godemo2.ibm

```
#!/bin/csh -f
#
# godemo2 - sun command file
#
set verbose
date

timexramona4b.exe          < demo2.inp                > & demo2.out
date                       >> & demo2.out
date
echo "Remember, copy fort.33 to fort.39 before RESTART" >> & demo2.out

mv fort.49 fort.49.demo2   # Save Plot file
mv fort.33 fort.33.demo2   # Save Restart file
unalias rm
rm fort.? fort.??          # Erase all scratch files
date
```

I.9 ramona4b.compile.ibm

```
#!/bin/csh -f
echo ""
date
echo "|-----|"
echo "| ramona4b.compile.scr - file to compile on RS6000 |"
echo "|-----|"
set verbose
date
# -----
# We do NOT copy ax1plt.f.ibm to ax1plt.f because ax1plt.f.ibm is already included in # ramona4b.f.ibm
# -----
# cp -p ax1plt.f.ibm          ax1plt.f
# -----
cp -p ramona4b.f.ibm          ramona4b.f
cp -p timing.f.ibm            timing.f
cp -p datestamp.f.ibm         datestamp.f
cp -p tdate.c.ibm             tdate.c
unset verbose
echo "-----"
echo "Compiling tdate.c"
echo "-----"
```

3. Installation of RAMONA-4B on Workstations

```
set verbose
cc -c                                tdate.c
unset verbose
echo "-----"
echo "Copy all fortran files to ram4b.f"
echo "-----"
set verbose
cat ramona4b.f timing.f datestamp.f > ram4b.f
unset verbose
echo " "
echo "|=====|"
echo "| Compiling ram4b.f |"
echo "|=====|"
set verbose
# Alternate without traceback
# Fast compile, moderate execution time
timex xlf -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate without traceback but with optimization
# Slow compile, fast execution time
# timex xlf -O2 -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate with traceback
# Moderate compile, slowest execution time
# timex xlf -c -qautodbl=dblpad -g -NQ20000 -ND4096 -NT40000 -qxref=full \
# -qfltrap=overflow:zerodivide:invalid:enable \
# ram4b.f

unset verbose
echo " "
echo "|=====|"
echo "| Linking |"
echo "|=====|"
set verbose

timex xlf tdate.oram4b.o              -oramona4b.exe
date
unalias rm
rm tdate.o ram4b.o
cp -p ram4b.f ram4b.f.source
dir ram*.*
```

I.10 ramona4b.compile.o2.ibm

```
#!/bin/csh -f
echo " "
date
```

3. Installation of RAMONA-4B on Workstations

```
echo "|-----|"
echo "| ramona4b.compile - file to compile on RS6000 |"
echo "|-----|"
set verbose
date

# -----
# We do NOT copy ax1plt.f.ibm to ax1plt.f because ax1plt.f.ibm is already included in #
# ramona4b.f.ibm
# -----
# cp -p ax1plt.f.ibm      ax1plt.f
# -----
cp -p ramona4b.f.ibm      ramona4b.f
cp -p timing.f.ibm        timing.f
cp -p datestamp.f.ibm     datestamp.f
cp -p tdate.c.ibm         tdate.c
unset verbose

echo "-----"
echo "Compiling tdate.c"
echo "-----"
set verbose
cc -c                      tdate.c
unset verbose
echo "-----"
echo "Copy all fortran files to ram4b.f"
echo "-----"
set verbose
cat ramona4b.f timing.f datestamp.f > ram4b.f
unset verbose
echo " "
echo "|=====|"
echo "| Compiling ram4b.f|"
echo "|=====|"
set verbose

# Alternate without traceback
# Fast compile, moderate execution time
# timex xlf -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate without traceback but with optimization
# Slow compile, fast execution time
# timex xlf -O2 -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate with traceback
# Moderate compile, slowest execution time
# timex xlf -c -qautodbl=dblpad -g -NQ20000 -ND4096 -NT40000 -qxref=full \
# -qfltrap=overflow:zerodivide:invalid:enable \
```

3. Installation of RAMONA-4B on Workstations

```
# ram4b.f

unset verbose
echo ""
echo "|=====|"
echo "| Linking |"
echo "|=====|"
set verbose
timex xlfdate.oram4b.o -oramona4b.exe.o2
date
unalias rm
rm tdate.o ram4b.o
cp -p ram4b.f ram4b.f.source
dir ram*.exe*
```

I.11 ramona4b.compile.scr.ibm

```
#!/bin/csh -f
echo ""
date
echo "|-----|"
echo "| ramona4b.compile.scr - file to compile on RS6000 |"
echo "|-----|"
set verbose
date
# -----
# We do NOT copy ax1plt.f.ibm to ax1plt.f because ax1plt.f.ibm is already included # in ramona4b.f.ibm
# -----
# cp -p ax1plt.f.ibm ax1plt.f
# -----
cp -p ramona4b.f.ibm ramona4b.f
cp -p timing.f.ibm timing.f
cp -p datestamp.f.ibm datestamp.f
cp -p tdate.c.ibm tdate.c
unset verbose
echo "-----"
echo "Compiling tdate.c"
echo "-----"
set verbose
cc -c tdate.c
unset verbose
echo "-----"
echo "Copy all fortran files to ram4b.f"
echo "-----"
set verbose
cat ramona4b.f timing.f datestamp.f > ram4b.f
unset verbose
```

3. Installation of RAMONA-4B on Workstations

```
echo " "
echo "|=====|"
echo "| Compiling ram4b.f|"
echo "|=====|"
set verbose
# Alternate without traceback
# Fast compile, moderate execution time
timex xlf -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f
# Alternate without traceback but with optimization
# Slow compile, fast execution time
# timex xlf -O2 -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate with traceback
# Moderate compile, slowest execution time
# timex xlf -c -qautodbl=dblpad -g -NQ20000 -ND4096 -NT40000 -qxref=full \
# -qfltrap=overflow:zerodivide:invalid:enable \
# ram4b.f
unset verbose
echo " "
echo "|=====|"
echo "| Linking |"
echo "|=====|"
set verbose
timex xlf tdate.oram4b.o -oramona4b.exe
date
unalias rm
rm tdate.o ram4b.o
cp -p ram4b.f ram4b.f.source
dir ram*.exe*
```

I.12 ramona4b.compile.trace.ibm

```
#!/bin/csh -f
echo " "
date
echo "|-----|"
echo "| ramona4b.compile - file to compile on RS6000 |"
echo "|-----|"
set verbose
date
# -----
# We do NOT copy ax1plt.f.ibm to ax1plt.f because ax1plt.f.ibm is already included in # ramona4b.f.ibm
# -----
# cp -p ax1plt.f.ibm ax1plt.f
# -----
cp -p ramona4b.f.ibm ramona4b.f
cp -p timing.f.ibm timing.f
```

3. Installation of RAMONA-4B on Workstations

```
cp -p datestamp.f.ibm      datestamp.f
cp -p tdate.c.ibm          tdate.c
unset verbose
echo "-----"
echo "Compiling tdate.c"
echo "-----"
set verbose
cc -c                      tdate.c
unset verbose
echo "-----"
echo "Copy all fortran files to ram4b.f"
echo "-----"
set verbose
cat ramona4b.f timing.f datestamp.f > ram4b.f
unset verbose
echo " "
echo "|=====|"
echo "| Compiling ram4b.f|"
echo "|=====|"
set verbose
# Alternate without traceback
# Fast compile, moderate execution time
# timex xlf -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate without traceback but with optimization
# Slow compile, fast execution time
# timex xlf -O2 -c -qautodbl=dblpad -NQ20000 -ND4096 -NT40000 ram4b.f

# Alternate with traceback
# Moderate compile, slowest execution time
timex xlf -c -qautodbl=dblpad -g -NQ20000 -ND4096 -NT40000 -qxref=full \
-qfltrap=overflow:zerodivide:invalid:enable \
ram4b.f
unset verbose
echo " "
echo "|=====|"
echo "| Linking |"
echo "|=====|"
set verbose
timex xlf tdate.oram4b.o -oramona4b.exe.trace
date
unalias rm
rm tdate.o ram4b.o
cp -p ram4b.f ram4b.f.source
dir ram*.exe*
```

3. Installation of RAMONA-4B on Workstations

I.13 tdate.c.ibm

```
/* ----- */
/*tdate.c:      Time and Date      */
/*from fortran: 'call tdate'        */
/*from fortran: 'call tdate( %ref(char26) )' */
/*return to fortran: char26        */
/*input:      none                  */
/*output time and date stamp to standard output. */
/* ----- */

#include <stdio.h>
#include <time.h>
#include <sys/types.h>
#include <sys/times.h>
#include <string.h>

int tdate ( char *qdate )
/* char *qdate; */
{
    time_t ltime;
/* char xdate[26]; */
    time(&ltime);
    strcpy (qdate,ctime(&ltime));
/* printf("%s",qdate); */
/* printf("%s",ctime(&ltime)); */
}

timing.f.ibm =
com -----
com timing_2.f -
com 02 oct. 92 - ramona routines clockk, timer, dater, second
com - modified for calls to ibm rs6000 timing routines
com 02 oct. 92 - ibm rs6000 workstation timing routines
com - datestamp --> 26 char date time from tdate.c
com - datez (dat11) --> 11 char date e.g. oct 02 1992
com - datez8(dat8) -->8 char date e.g. oct02 92
com - timez (tim8) -->8 char time e.g. 17:52:04
com - dayz(day3) -->3 char daye.g. fri
com - mclock() --> operating system routine for
com --> elapsed cpu time since job start.
com -----

subroutine clockk(clocks)

com clocks is in the form hh.mm.ss
com character*8 clocks
com dimension ib(8)
```


3. Installation of RAMONA-4B on Workstations

```

csg call datim(ib)

com write(unit=clocks,fmt=100) ib(5),ib(4),ib(3)
com co100 format(i2.2,',',i2.2,',',i2.2)
com ibm rs6000
com call timez(clocks)
com return
com end

com -----
com subroutine dater(idate)
com idate was in the form "mm/dd/yy"(month/day/year)
com now is in the form "Oct02 92"
com dimension ib(8)
com character*8 idate
com datim is a ibm 3090 sytem routine that returns
com ib(6) = i*4 day (1 to 31)
com ib(7) = i*4 mon (1 to 12)
com ib(8) = i*4 year (4 digits)

csg call datim(ib)

com last 2 digits of year
com ib(8) =mod(ib(8),100)
com write(unit=idate,fmt=100) ib(7),ib(6),ib(8)
com co100 format(i2.2,',',i2.2,',',i2.2)
com ibm rs6000
com call datez8 (idate)
com return
com end

com -----
com double precision function secund(dummy)
com secund returns the cpu time used in seconds (to nearest hundredth)
com 10.31.90 aa ln: for the time being ...
com call vtime(ivtime,itime)
com ivtime=1
com secund=dble(ivtime)/100.0
com ibm rs6000 timing (integer 0.01 sec. mclock)
com secund = float(mclock()) * 0.01
com return
com end

com -----
com subroutine timer(itime)
com itime is in the form hh.mm.ss
com character*8 itime
com call clockk(itime)

```

3. Installation of RAMONA-4B on Workstations

```
call timez(itime)

return
end
com -----
```

3.2 Auxiliary Codes

A suite of auxiliary codes associated with the RAMONA-4B code for performing calculations includes PAD, FRAM, and BLEND.

3.2.1 PAD Program

The PAD program is used to read the plot file created by RAMONA-4B, process the information, and display array functions of the form $F(X, Y, Z; \text{Time})$. The IBM machine version of PAD uses plot routines from the DISSPLA package. The Sun machine version of the code uses the NASADIG plot library. The user manual for the PAD program can be found in Appendix C.

3.2.2 FRAM Program

The purpose of the FRAM code is to provide RAMONA-4B with a capability to represent the complex 3-D reactor core in a more economical way by using the one-dimensional neutron-kinetics core modeling. FRAM serves as a 3-D to 1-D collapsing program for two-group cross sections: it generates the two-group cross sections for a 1-D model by using the full 3-D description of the core as an input.

3.2.3 BLEND Program

BLEND (Blending Libraries of Exposures and Nuclear Data) [Eisenhart et al., 1980, Diamond et al., 1986] is a cross section processing code used to generate cross-section sets in the TWIGL [Yasinsky et al., 1968] format adopted in RAMONA-4B. The cross-section input data for the BLEND code is generated by a multigroup two-dimensional transport theory code with burnup similar to CASMO [Ahlin et al., 1978]. Exposure and void history distributions obtained from plant data or from a depletion calculation are part of the required input.

3.3 RAMONA-4B Input-Output Files

The calculated results requested by the user are stored at the conclusion of the calculation as an ASCII output file. This file also includes a summary of the data which is written out to the plot file. The plot data are stored in fort.49 as a binary file formatted for processing by a general purpose plotting program, PAD (Appendix C).

In the process of calculations, the RAMONA-4B code uses scratch files to exchange information between the two major parts of the code: neutronics and hydraulics to store data for potential back-stepping. There are also seven files which serve special purposes in the code:

3. Installation of RAMONA-4B on Workstations

- fort.3 - log file of transient events; this file also contains a printout of the input deck,
- fort.5,
- fort.33 - restart file (at the time when the file is created),
- fort.39 - restart file (at the time when the file is used for restarting a transient calculation),
- fort.44 - data file for FRAM's 3-D to 1-D cross-section collapsing,
- fort.49 - plot data file,
- the user input file can have any file name the user desires,
- the output file name can also have any name,
- the input and output file names are specified using the unix re-direction functions as ramona4b.exe <input file> output.file.

4. INPUT SPECIFICATIONS

The purpose of this chapter is to provide detailed card-by-card instructions for preparing a RAMONA-4B input deck. The order of the cards in the input deck can be changed; however, the user is advised to examine the input instructions for any exception to this rule. The card type descriptions are preceded by a user guidance for input preparation: core neutronic modeling, neutronic cross-sections, and vessel and steamline nodalizations. A complete list of the input data category of RAMONA-4B is presented in Table 4.1.

The RAMONA-4B input deck includes cards of nine types. Each of these card types is briefly described in Section 4.2. Finally, the instructions for the input deck preparation are given in Section 4.3.

4.1 Organization of Component Input

This section provides guidance for input preparation: core neutronic modeling, neutronic cross-sections, and vessel and steamline nodalizations.

4.1.1 Core Geometry

The coordinates and nodalization of the core region for neutronic calculations are shown in Figure 4.1. In a coarse-mesh representation of the core, a cell can be either a cube or a parallelepiped. The cell width in the I and J directions (X, Y coordinates) is usually defined as the distance between the center of a bypass channel between two adjacent fuel assemblies to the center of the next bypass channel (note that in RAMONA-4B, $\Delta X = \Delta Y$). Therefore, the projection of any cell on the I,J (X,Y) plane coincides with a fuel assembly projection on the same plane. Larger cells containing several fuel assemblies can also be used, provided the corresponding cross-section sets are available.

Depending on the user's choice (ISYM on Card 200000), special **symmetry** core representation can be used instead of a full bundle-by-bundle core model; the symmetry options available in RAMONA-4B are shown graphically in Figures 4.2(a) through 4.2(m); the Figures were taken from the Scandpower report [Oye et al. 1977].

Figure 4.1 shows that two systems are used to number the neutronic cells. First, the indices I,J,K (or X,Y,Z coordinates) uniquely specify a cell. The second method uses an absolute numbering system which starts the cell count at the left corner cell at the bottom level and moves across the core. The latter method of numbering is used for arranging the neutronic input data.

Index IHYDR(I) on Card 200001 assigns the IHYDR(I)-th hydraulic channel to the I-th neutronic channel (neutronic channel is defined as a vertical stack of neutronic cells starting at the bottom and proceeding to the top of the core). On Card 330000, the fuel type, IFM(I) and control rod location, NKNR(I) are assigned to the I-th neutronic channel.

4. Input Specifications

Table 4.1 Category of Input Variables in RAMONA-4B

Figure 4.1 Schematic of a Typical Neutronic Cell in the RAMONA-4B Core Model.

4. Input Specifications

Figure 4.2 (a)-(m) RAMONA-4B Core Symmetry Options.

Figure 4.2 (a)-(m) RAMONA-4B Core Symmetry Options (Cont'd).

4. Input Specifications

Figure 4.2 (a)-(m) RAMONA-4B Core Symmetry Options (Cont'd).

4.1.2 Format of Neutronic Cross Sections

The coefficients comprising a nuclear cross-section set are specified on Cards 480000 through 480002. Only the BNL2 option with a 56-Coefficient set per fuel type is operational in RAMONA-4B at the present time. The 56 coefficients are defined as follows:

480000	a11	a21	a31	a41	a51	a61	a71
480001	a12	a22	a32	a42	a52	a62	a72
480001	a13	a23	a33	a43	a53	a63	a73
480001	a14	a24	a34	a44	a54	a64	a74
480001	a15	a25	a35	a45	a55	a65	a75
480002	a16	a26	a36	a46	a56	a66	a76
480002	a17	a27	a37	a47	a57	a67	a77
480002	a18	a28	a38	a48	a58	a68	a78

The neutron kinetics model parameters are defined in Table 4.2 where the control rod fraction, f , specifies the ratio of the control rod insertion into a particular neutronic cell and the axial dimension of the cell ($f=1$ for a cell with a fully inserted control rod).

Table 4.2 Cross-Sections Format for the BNL2 Option

$D_1 = (1-f) \cdot (a_{11} + a_{21}\alpha + a_{31}\alpha^2) + f \cdot (a_{16} + a_{26}\alpha + a_{36}\alpha^2) + a_{41} (T_m - T_{m,0}) .$
$D_2 = (1-f) \cdot (a_{51} + a_{61}\alpha + a_{71}\alpha^2) + f \cdot (a_{46} + a_{56}\alpha + a_{66}\alpha^2) + a_{12} (T_m - T_{m,0}) .$
$\Sigma_{r1} = (1-f) \cdot (a_{22} + a_{32}\alpha + a_{42}\alpha^2) + f \cdot (a_{76} + a_{17}\alpha + a_{27}\alpha^2) + a_{52} (T_m - T_{m,0}) + a_{62} (\sqrt{T_f} - \sqrt{T_{f0}}) .$
$\Sigma_{t1} = \Sigma_{a1} + \Sigma_{r1} = (1-f) \cdot (a_{72} + a_{13}\alpha + a_{23}\alpha^2) + f \cdot (a_{37} + a_{47}\alpha + a_{57}\alpha^2) + a_{33} (T_m - T_{m,0}) + a_{43} (\sqrt{T_f} - \sqrt{T_{f0}}) .$
$\Sigma_{a2} = (1-f) \cdot (a_{53} + a_{63}\alpha + a_{73}\alpha^2) + f \cdot (a_{67} + a_{77}\alpha + a_{18}\alpha^2) + a_{14} (T_m - T_{m,0}) .$
$v\Sigma_{f1} = (1-f) \cdot (a_{24} + a_{34}\alpha + a_{73}\alpha^2) + f \cdot (a_{28} + a_{38}\alpha + a_{48}\alpha^2) + a_{54} (T_m - T_{m,0}) + a_{64} (\sqrt{T_f} - \sqrt{T_{f0}}) .$
$v\Sigma_{f2} = (1-f) \cdot (a_{74} + a_{15}\alpha + a_{25}\alpha^2) + f \cdot (a_{58} + a_{68}\alpha + a_{78}\alpha^2) + a_{35} (T_m - T_{m,0}) .$
$v_1 = a_{65} .$
$v_2 = a_{75} .$
$T_{m,0} = 645, ^\circ F .$
$T_{f,0} = a_{55}, ^\circ F .$

4. Input Specifications

4.1.3 Vessel Components and Nodalization

The reactor vessel is always represented by seven components as shown in Figure 4.3. The list of components starting from the upper part of the downcomer region is given below:

1. Downcomer 1,
2. Downcomer 2,
3. Lower Plenum 1,
4. Lower Plenum 2,
5. Core,
6. Riser, and
7. Steam Dome.

All components in the vessel are one-dimensional; the Core component consists of NPC parallel channels (NCC, if there is no bypass flow channel) connecting the Lower Plenum 2 and Riser components. The Riser component represents the combination of upper plenum, standpipes, and steam separator dryer regions. Downcomer 1 is the upper downcomer followed by Downcomer 2 which represents the inner region of the jet pumps geometrically. Modeling of the jet pumps is described in the companion model description report [Rohatgi et al. 1996]. The pressure gain developed by the jet pumps is applied at a user-specified cell in Downcomer 2.

With the exception of the Lower Plenum 1, all vessel components are vertical; flow areas in all components do not change with distance. However, the flow areas for all components are different. Each component is evenly subdivided into computational cells, with the number of cells specified by the user. An index K is associated with each of these cells (Figure 4.3). The array NIN identifies the entrance boundary of the first cell of a component; array NOUT identifies the last cell of a component. The flow-related quantities such as velocities, mass flux, and energy convection terms use index K at the exit boundary of a cell.

The volume related quantities such as mass of vapor and liquid and void fraction in a cell utilize the same index K at the center of a cell in this case. The calculation of vapor generation rate also uses this index. The number of volumes in any component is one less than the number of cell boundaries. RAMONA-4B uses index K to identify a cell-centered quantity; this value of K coincides with the index of the exit boundary of the cell. The "reference" flow direction flow from the top of the Downcomer 1 downwards through the lower plena and upwards through the core and riser is used to determine the direction of increment for index K.

The scheme described above implies that the value of index K associated with the entrance boundary of a component is not used to refer to a real geometric volume, but it identifies a junction between components.

4.1.4 Steamline Geometry

The steam line (Figure 4.4) is modeled as a pipe with a set of Safety/Relief Valves located at cell M0 (Card 880000), a Main Steam Isolation Valve located at cell IMSIV, and a Turbine Stop Valve located at the end of the steam line. There is also a bypass line branching from the main steamline at cell M1ST; the bypass line ends with a Bypass Valve. The flow areas and cell lengths are fixed along the main steam line and bypass line; the corresponding values are specified separately for the main steam line and the bypass line.

Figure 4.3 RAMONA-4B Nodalization Scheme for the Vessel Thermal Hydraulics Calculation.

4. Input Specifications

Figure 4.4 RAMONA-4B Representation of the Steam Line.

4.2 Card Types

Each card of the input deck is uniquely specified by a six-digit identification number (ID) placed in columns 1 through 6. The first digit of an ID is the "card type" identifier.

Card Type	Description
1	Case Title, Options
2	Geometry, Spacers, Loss Coefficients
3	Neutronics Core Configuration, Fuel Rod Model
4	Neutronic Data

4. Input Specifications

5	Thermal Hydraulics, Steam Separator, Recirculation Loop, Jet Pump, Recirculation Flow Controller, Disturbance Specifications
6	Reactor Operation Data, Protection and Control Systems, SRV Data, HPCI/RCIC Data, Trip data, New Mechanistic Steam Separator, BOP, Containment, RWCU for SBWR
7	Neutronic Data, Control Rod Movements
8	Iteration Data, Duration of Transient, Steamline Data
9	End of Input Deck

Card Type 1

Cards in the 100000 series contain general information. The basic options are selected on Card 110000. IOPT(1) is used to select between BWR and SBWR calculations. IOPT(6) is used to choose balance of plant (BOP). With IOPT(3) and IOPT(8) set equal to 1, the code calculates the nodal cross sections with void and moderator and Doppler reactivity feedback, as discussed in Section 4.2.2. Also, the user can include the Xenon corrections by using IOPT(5). The method of approximation for the thermal diffusion equation is specified by IOPT(12). *The method which neglects the thermal leakage between cells is recommended.* On Cards 120000, 140000, and 150001, the steady-state output options are specified, along with the type of run to be executed (parameter ITYP on Card 140000).

Card Type 2

Cards 200000 through 210000 specify several geometrical and physical parameters of the core region and of the entire vessel. The parameters include the neutronic and hydraulic channel nodalization, geometrical data, and thermohydraulic characteristics of different vessel components. Card 200015 contains some miscellaneous information such as the initial water mixture level in the vessel, the in-bundle-to-bypass heat transfer coefficient, and the fraction of total heat deposited directly into coolant and bypass channels. Card group 200103 to 200200 are used to specify the parameters for flow-dependent loss coefficients.

Card Type 3

The 300000 series of cards relate the fuel type of each fuel cell to the corresponding cross-section set number, assign control rods to their appropriate neutronic channels, and define the dimensions and characteristics of the fuel rod. On Card 330000, a fuel type and a control rod group are defined for each neutronic channel. Nodalization of the fuel rods for the conduction calculation is specified on Card 380000, and the fuel and cladding thermal conductivities are specified on Card 391000.

Card Type 4

The parameters of the neutronic core boundaries and the cross-section mapping data are specified on these cards. The Borresen factors [Borresen, 1971] (AB1 and AB2) are assigned on Card 400000 with the appropriate extrapolation lengths and albedos given on Cards 410000 through 430000 for the top, bottom, and side reflectors. Card group 460000 to 469000 are used to input SLCS and boron injection data. ITAB2 on Card 470000 specifies the total number of the cross-section sets. Cross-section sets data with 56 coefficients for each cross-section set ICONST (see Section 4.2.2) are specified on ITAB2 groups of cards, each group consisting of Cards 480000 through 480002.

4. Input Specifications

Card Type 5

The set of cards 500010 through 560000 introduces the characteristics of some vessel components such as jet and recirculation pumps, and steam separators as well as system disturbance data. The Becker two-phase friction multiplier and the vapor generation model also are specified here. The user can specify an ideal pressure controller (constant system pressure) or a varying system pressure option. Cards 500040 to 500056 provide the input data for the recirculation loop dynamics and jet pumps, while Cards 500057 to 500059 specify the recirculation flow controller input. Cards 500083 through 500087 allow the user to impose certain disturbances on the system boundary conditions (steamline flow, feedwater flow and temperature and power). The truncation error for the hydraulic calculation and the initial time step size are specified on Card 500082.

Card Type 6

Cards 600000 through 650000 provide the data describing various plant protection systems such as scram and high pressure coolant injection systems (HPCI and RCIC). A number of safety-related trips are also specified for feedwater, turbine, recirculation pump, turbine bypass valve, SRVs, and MSIV. Cards 661010 to 663600 include data for isolation condenser model.

This card type also includes the cards defining the core thermal power (Card 600000) and the initial positions of control rods (Card 620000) as well as the cards controlling the frequency of printing the output of the hydraulic calculation (Cards 600080 and 600090). Cards 621000 to 621300 specify the pressure regulator data. Cards 622000 to 622800 provide data for Balance of Plant (BOP) calculations. Cards 623000 to 623300 specify the RWCU model input for SBWR. Cards 624000 to 624600 provide the input data for the new mechanistic steam separator model. Cards 625000 to 625900 specify the input data for the new Mark I containment model. Finally, Cards 631000 to 639500 are the input data for Heat Structure calculations.

Card Type 7

This group of cards specifies neutron kinetics data. Cards 710000 and 742000 specify the type of information written to the printed output file. Cards 720000 and 730000 define some information needed for the time step control and accuracy testing for each iteration along with parameters needed for the neutronic flux calculation. On Card 740000, the decay heat model data are specified. The remaining cards in this group specify the insertion of individual control rods during a transient.

Card Type 8

The set of cards 800000 to 820000 defines information pertaining to neutronic iteration and convergence test procedures. Transient termination time is also specified here on Card 870000. Cards 880000 to 880006 specify the input data for steamline dynamics describing the steam line geometry, nodalization, and a number of thermal hydraulic parameters required for the steamline dynamic calculation.

Card Type 9

This card signals the end of input deck.

4.3 Input Data Specifications

This section provides card-by-card instructions for the RAMONA-4B input preparation. The code uses *formatted* input data representation. As mentioned before, each card of the input deck is uniquely identified by a six-digit number in columns 1 through 6. Cards with an asterisk in the first column are treated as comment cards. An alphabetical list of all input variables can be found in Table 4.3. All input variables are in SI units unless where specified otherwise.

4.3.1 Card Type 1-Case Title, Options

100000 ITITLE(I6,12A6,A2)

ITITLE Heading printed on each page of the output, one line.

110000 NOP,(IOPT(I),I=1,NOP)(I6,I3,1X,30I2)

NOP Number of options specified: $1 \leq \text{NOP} \leq 12$. Default values for the elements of the IOPT array are zeros. See Chapters 4.1 and 4.2.2 for information on the IOPT parameters referring to the cross-sections input.

IOPT(1) = 0 BWR Type: 0=SBWR, 1=BWR.

IOPT(2) = 0 Recirculation Flow Option: 0 = Old Model, 1 =New EPA Model

IOPT(3) = 0 If IOPT(8)=0: Cross-sections are not calculated.

 = 1 Cross-sections with dependence on the void fraction, coolant and fuel temperatures are calculated in subroutine CROSS; recommended option.

IOPT(4) = 0 Void fraction distribution is calculated iteratively by the code with the initial value from Card 550000.

 = 1 Constant core void fraction is assumed (α =VOCON from Card 550000).

IOPT(5) = 0 Local equilibrium Xe correction is calculated.

 = 1 Local equilibrium Xe correction is not calculated.

IOPT(6) = 0 BOP Model Switch: 0=No BOP, 1=BOP.

IOPT(7) = 0 Not used.

IOPT(8) = 1 Input IOPT(8)=1.

IOPT(9) Used in conjunction with IOPT(10). IOPT(9) defines the number of adjustments (see IOPT(10)): $\psi_{new}^{n+1} = \psi_i^{n+1} + w(\psi_i^{n+1} - \psi_{i-1}^{n+1})$, Equation (a), where i is the present iteration index and w is a relaxation parameter, Equation 6.7.8, page 276 [Wulff et al. 1984]. Recommended option: IOPT(9)=2.

4. Input Specifications

IOPT(10)	= 1	The solution technique to solve the fast flux uses the previous equation together with Equation (b): $\psi_{new}^{n+1} = \omega_1 \psi_i^{n+1} + \omega_2 (\psi_i^{n+1} - \psi_{i-1}^{n+1})$, where ω_1 and ω_2 are relaxation parameters defined in Equations (6.7.11) through (6.7.13) in [Wulff et al. 1984]. After one adjustment with Equation (b), several adjustments can be done with Equation (a) according to the value of IOPT(9). (See Chapter 6.7.1 [Wulff et al. 1984] for details.).
IOPT(11)	= 0	No reading of FRAM files with 1-D cross-sections data.
	= 3	Read the 1-D cross-sections data from a file produced by the auxiliary code FRAM (read from file fort.1).
IOPT(12)	= 0	Thermal diffusion between internal cells is neglected. This is the Recommended method.
	= 1	Thermal diffusion between internal cells is calculated as discussed in Chapter 2.3.2 [Wulff et al. 1984].

120000 NOP,(IOUT(I),I=1,NOP) (I6,I3,I1,I4I2)

Neutronic steady-state output control.

NOP		Number of options for IOUT; NOP=3 is used in the current version.
IOUT(1)	= 0	SLCS and heat structure output control switch: 0=bypass output, 1=Print output.
IOUT(2)	= 0	Not used.
IOUT(3)	= 0	Normal printout.
	= 1	Long printout, for small test problems only. This option includes the following for each iteration: <ul style="list-style-type: none"> • Variables: EP, VE, RHO, UX, POW, CEOFF, YQ, TO, $1/T_{AVG}$, REFFV, REFD, TO (cell average ψ_1), POW (cell average ψ_2) • Everything mentioned for IOUT(3)=0 through 3. • A printout of each cell's cross-section set.
	= 2	Printout for each power-void iteration, including cross-sections.
	= 3	As in IOPT(3)=2, but without the cells' cross-sections. In IOUT(3) options 0 through 3, the printout includes (beside what is explicitly mentioned): normalized 3-D power distribution, axially-averaged channel power distribution normalized to 100, normalized vertical power distribution, and several intermediate neutronics variables.
	= 4	Only the convergence flags and eigenvalue are printed in the steady-state calculations.
	= 5	Only normalized horizontal and vertical power distributions for each power-void iteration are printed.

140000 ITYP,ICOUNT,ITEST,ITIP,IPB,IPLCTL (I6,4X,10I5)

ITYP defines the type of requested calculation: neutronics steady-state (NS), hydraulics steady-state (HS), neutronics transient (NT), hydraulics transient (HT), etc.

ITYP	= 0	Restart in transient (HT+NT). Data are read from file fort.39. Data for a consequent restart are stored on file fort.33. Plot file is stored on file fort.49.
	= 1	NS and HS calculations are performed and followed immediately by a transient calculation (HT+NT). The restart and plotting data are stored as in ITYP=0.
	= 2	Only neutronic and hydraulics steady-state calculations are performed (NS+HS); restart data are stored on file fort.39 if IPR(5)=2 on Card 150001.
	= 3	Restart after a previously run steady-state (i.e., run with ITYP=2) is performed. A transient calculation (HT+NT) follows. Restart and plotting data are stored as in ITYP=0.
	= 4	A neutronic and hydraulic steady-state calculation is followed by a neutronic transient calculation, (NS+NT). The hydraulic calculations are must be performed for steady state only.
	= 5	A hydraulic steady-state calculation is followed by a hydraulic transient, (HS+HT), bypassing the neutronic calculations. Reactor power is supplied on Card 600060. Axial power distributions in thermal hydraulic channels are supplied on Cards 500070.
	= 6	Neutronic steady-state calculation only (NS).
	= 7	Hydraulics steady-state calculation only (HS), see ITYP=5.
	= 8	Restart during a neutronic calculation (NT) under ITYP=4.
	= 9	Restart during a hydraulic calculation (HT) under ITYP=5.
	= 10	Run (HS+NS) to generate data files for consequent processing by the FRAM code. Data are stored on fort.44. (FRAM generates cross-sections sets for one dimensional neutronic calculations.) If ITYP=1, 2, 4, or 6, Card 550000 specifies the initial core average void fraction. If ITYP=4 or 6, Card 550000 defines the core average void fraction to be used in the neutronics calculations.
ICOUNT	= 0	Not used.
ITEST	= 1	Tests the consistency of some of the input data.
	= 0	No such test.
ITIP	> 0	Write (update) restart file every TMAX/NREST seconds of real time (default: NREST=5). TMAX is specified on Card 870000. NREST=0 prevents writing the restart file.
IPB	= 0	Recommended value.

4. Input Specifications

	= 1	"Peach Bottom Version" used for a particular test problem (Peach Bottom-2 Turbine Trip test 3). Not supported.
IPLOTL	= 0	Write only scalar variables for plotting at the end of every neutronic time step. BNL PAD plot file, file fort.49 is generated. See Appendix B for the list of plot variables.
	= 1	In addition to scalar variables, write 2-D and 3-D variables for plotting (file fort.49) at the end of every neutronic time step. See Appendix A for the list of plot variables.

150000 NEND,MEND,KSENON (I6,4X,10I5)

NEND		Total number of neutronic cells in the represented part of the core. Maximum value of NEND defined by code version (NEND=KAN*KMAX). See Card 200000.
MEND		The data stored in disk files are transferred in groups of MEND values. Restrictions: NEND/MEND must be an integer, MEND ≤ 200.
KSENON = 0		Not used.

150001 (IPR(I),I= 1,11) (I6,4X,14I5)

Steady-state output control.

IPR(1)		Not used.
IPR(2)	= 1	Data from the fuel temperature calculation are output every iteration.
	= 0	No fuel temperatures data are printed during iterations.
IPR(3)	= 1	The printout of power distribution is bypassed, i.e., IOU(3)=4 or 5 (Card 120000) is overridden.
	= 2	Power distribution is printed if IOU(3)=4 on Card 120000.
IPR(4)	= 0	Not used.
IPR(5)	= 1	The program proceeds with a dynamic calculation immediately following a steady-state calculation. Restart file from a steady-state calculation is not created .
	= 2	The program proceeds with a dynamic calculation immediately following a steady-state calculation. Restart file from a steady-state calculation is created and stored on file fort.39 .
IPR(6)	= 0	No data from the power distribution calculation are printed.
	= 1	Data from the power distribution relaxation calculation are printed every iteration.

160000 NWIND (I6,4X,I5)

NWIND Number of time windows where 2-D and 3-D plotting variables are written to the plot file (file fort.49). NWIND $\leq$ 30.

161000 (WINBEG(I),I=1,NWIND) (I6,4X,6E10.3)

As many cards as needed.

WINBEG(I) Array specifying the starting time of each time window (s).

162000 (WINEND(I),I=1,NWIND) (I6,4X,6E10.3)

As many cards as needed.

WINEND(I) Array specifying the ending time of each time window (s). NWIND values.

4.3.2 Card Type 2 - Geometry, Spacers, Loss Coefficients

200000 IMAX,JMAX,KMAX,ISYM,KANTOT,KAN,NBE (I6,4X,10I5)

IMAX Maximum number of cells in I (or X) direction (I) on the core map.

JMAX Maximum number of cells in J (or Y) direction (J) on the core map.

KMAX $\leq$ 24 Number of axial cells in the core (both for thermal hydraulic and neutronic calculations).

ISYM Core symmetry option (see Chapter 4, Section 4.1.1).

= 1 Full core, no symmetry restrictions.

= 2 Half core, rotational symmetry.

= 3 Half core, mirror symmetry.

= 4 Half core, half cell mirror symmetry.

= 5 Quarter core, mirror symmetry.

= 6 Quarter core, half cell mirror symmetry.

= 7 Quarter core, rotational symmetry.

= 8 Quarter core, half cell rotational symmetry.

= 9 1/8 core, mirror symmetry.

= 10 Rectangular region, reflecting boundary.

4. Input Specifications

- = 11 Rectangular region, half cell reflecting boundary.
- = 12 Half core, diagonal mirror symmetry (boundary cell 1 must be the cell 1 on the core map).
- = 13 Half core, diagonal, rotational symmetry (boundary cell 1 must be the cell 1 on the core map).

KANTOT = 0 Not used.

KAN Number of neutronic channels in the problem considered for the symmetry option chosen through ISYM.

NBE Number of neutronic channels at the core periphery in the represented part of the core. Channels facing the reflector with one or two sides or one corner may be counted as periphery channels (coordinates of the periphery channels are specified on Card 210000).

200001 (IHYDR(I),I=1,KAN) (16,4X,14I5)

IHYDR(I) Array relating the hydraulic channels to the neutronic channels: to each neutronic channel there is a corresponding hydraulic channel IHYDR(I). Several neutronic channels can "share" one hydraulic channel.

200010 (NSEC(I),I=1,6),NPC,NCC,N0,NP (16,4X,10I5)

Index k is associated with each hydraulic cell. This index is assigned serially, starting with number 2 at the entrance to section 1 (Downcomer 1) of the hydraulic loop (see Fig. 4.3). The range of index k for each loop section I , is given by NIN(I) and NOUT(I) for entrance and exit cells, respectively. Except in the core, the number of cells in each loop section is the number of subsections (i.e., NSEC). The core has NSEC(5)*NPC cells, where NPC is the number of parallel channels. The loop sections are:

- Loop section 1=Downcomer 1
- Loop section 2=Downcomer 2
- Loop section 3=Lower Plenum 1
- Loop section 4=Lower Plenum 2
- Loop section 5=Core
- Loop section 6=Riser
- Loop section 7=Steam Dome

NSEC(I) Number of subsections in the loop section I , $I=1,6$ (as defined above). $\sum_{I=1}^6 \text{NSEC}(I) \leq 55$, where
 NSEC(5)=KMAX on Card 200000.

NPC Total number of hydraulic channels (including one bypass channel).

NCC Number of coolant channels. If no bypass channel is present, NPC=NCC; otherwise, NPC=NCC+1. "Coolant" channel used here refers to the in-channel water surrounding the fuel rods. One bypass channel combines bypass flow from all core fuel bundles. Component 4+NPC is the bypass channel, if present. The number of coolant channels is less or equal to the number of neutronic channels, $\text{NCC} \leq \text{KAN}$, Card 200000.

4. Input Specifications

- N0 Feedwater inlet is located at cell N0. Note that $2 < N0 < NOUT(4)$, where $NOUT(4)$ is the exit cell of Lower Plenum 2.
- NP Jet pump is located at cell NP. Note that $2 < NP < NOUT(4)$. Feedwater Inlet and Jet Pump cannot be placed at a component junctions (i.e., N0 or NP $\neq$ NIN(I)).

200011 (A(I),I=1,6+NPC) (I6,4X,7E10.0)

- A(1) Flow area, Downcomer 1, (m²).
- A(2) Flow area, Downcomer 2, (m²).
- A(3) Flow area, Lower plenum 1, (m²).
- A(4) Flow area, Lower plenum 2, (m²).
- A(5) Flow area, Channel 1, (m²).
-
- A(4+NPC) Flow area, Channel NPC, (m²).
- A(5+NPC) Flow area, Riser, (m²).
- A(6+NPC) Flow area, Steam Dome, (m²).

200012 (DH(I),I=1,6+NPC) (I6,4X,7E10.0)

Hydraulic diameter is defined as four times the channel's flow area divided by the sum of its heated and wetted (non-heated) perimeters.

- DH(1) Hydraulic Diameter, Downcomer 1, (m).
- DH(2) Hydraulic Diameter, Downcomer 2, (m).
- DH(3) Hydraulic Diameter, Lower plenum 1, (m).
- DH(4) Hydraulic Diameter, Lower plenum 2, (m).
- DH(5) Hydraulic Diameter, Channel 1, (m).
-
- DH(4+NPC) Hydraulic Diameter, Channel NPC, (m).
- DH(5+NPC) Hydraulic Diameter, Riser, (m).
- DH(6+NPC) Hydraulic Diameter, Steam Dome (m). Not used.

4. Input Specifications

200013 (VH(I),I=1,5+2*NPC) (I6,4X,7E10.0)

Form Loss Coefficients. (This card is no longer used, replaced by Cards 200101 through 200106 for flow-dependent loss coefficients).

The definition for the form loss coefficient VH follows from the expression given in [Martinelli et al. 1948, Jones et al. 1962]: $\Delta p = \frac{1}{2} VH k_{2-\phi} w_m |w_m| / (\rho_f A^2)$, where $k_{2-\phi}$ is a two-phase multiplier [Ansari et al. 1981], w_m is the mixture mass flow rate, (kg/s), and A is the component's flow area, (m²).

VH(1) Inlet of Downcomer 1.

VH(2) Inlet of Downcomer 2.

VH(3) Inlet of Lower Plenum 1.

VH(4) Inlet of Lower Plenum 2.

VH(5) Inlet of Channel 1.

□

VH(4+NPC) Inlet of Channel NPC.

VH(5+NPC) Outlet of Channel 1.

□

VH(4+2*NPC) Outlet of Channel NPC.

VH(5+2*NPC) Outlet of Riser.

200014 (HEIGHT(I),I=1,7) (I6,4X,7E10.0)

HEIGHT(I) Height (length) of the loop's components, (m). Number of cells in each component is defined on Card 200010. All values of HEIGHT(I) must be positive. It is required that HEIGHT(5)=DZ*KMAX/100, where DZ is the height of a neutronic cell specified on Card 350000 and KMAX is the number of cells in axial direction that is specified on card 200000. Note that the latter expression is an exact conversion from centimeters to meters for HEIGHT(5). I=1 for upper downcomer, I=2 for lower downcomer, I=3 for lower plenum 1, I=4 for lower plenum 2, I=5 for reactor core, I=6 for riser, and I=7 for steam dome.

Note: HEIGHT(1)+HEIGHT(2) must equal HEIGHT(4)+HEIGHT(5) +HEIGHT(6).

200015 WLEVO,GRO,HTC,DELTA,DELTAM,RFCTR (I6,4X,6E10.0)

WLEVO Initial location of the mixture level in the Downcomer 1/Steam Dome region (m). WLEVO > 0 if the level is above the entrance to Downcomer 1; WLEVO < 0 if the level is below the entrance to Downcomer 1.

4. Input Specifications

GR0	Gravity acceleration, (m^2/s).
HTC	Heat transfer coefficient from the in-channel flow to bypass flow, ($\text{W}/\text{m}^2\text{C}$). Suggested value for a typical BWR is $3100 \text{ W}/\text{m}^2\text{C}$.
DELTA	Fraction of total reactor power deposited directly into the coolant and bypass channel liquid. Note that DELTA must equal QMF specified on Card 350000; also, in most circumstances, parameters CMPFRC and CMDFRC specified on Card 740000 are equal to DELTA.
DELTAM	Fraction of total reactor power deposited directly into the bypass channel; $\text{DELTAM} < \text{DELTA}$.
RFCTR	Not used.

200016 (PH(I),I=1,NCC) (I6,4X,7E10.0)

As many cards as necessary, same identifier.

PH(I)	Heated perimeter of Channel I, (m). PH(I) is a sum of the heated perimeters of all fuel rods contained in Channel I. Do not enter zero values to avoid zero divide in subroutine FUNCSS.
-------	--

200017 (PM(I),I=1,NCC) (I6,4X,7E10.0)

As many cards as necessary, same identifier.

PM(I)	Wetted, non-heated perimeter of Channel I, (m). PM(I) is a sum of the wetted perimeters of the walls of the fuel bundles contained in Channel I.
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200020 ISPAC,ISPAM,ISPAR (I6,4X,10I5)

Restrictions: $\text{ISPAC} + \text{ISPAM} + \text{ISPAR} \leq 25$; $\text{ISPAC} \leq 10$. Only one spacer per hydraulic cell can be specified.

ISPAC	Number of spacers in a fuel bundle (hydraulic channel). Used in calculation of form losses.
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ISPAM	Number of spacers in the bypass channel. Used in calculation of form losses.
-------	--

ISPAR	Number of spacers in the Riser. Used in calculation of form losses.
-------	---

Card 200020 must precede the following cards which specify spacers.

200021 (ZSP(I),I=1,ISPAC) (I6,4X,7E10.0)

These cards are not needed if $\text{ISPAC} = 0$. As many cards as necessary, same identifier.

ZSP(I)	Spacer I elevation in the core heated channels relative to the core inlet, (m).
--------	---

4. Input Specifications

200022 (VHSP(I),I=ISPAC) (I6,4X,7E10.0)

These cards are not needed if ISPAC=0. As many cards as necessary, same identifier.

VHSP(I) Form loss coefficient of spacer I. Definition of VHSP(I) is similar to that of VH, Card 200013.

200023 (ZSP(I),I=ISPAC+1,ISPAC+ISPAM) (I6,4X,7E10.0)

These cards are not needed if ISPAM=0. As many cards as necessary, same identifier.

ZSP(I) Spacer I elevation in the bypass channel relative to the core inlet, (m).

200024 (VHSP(I),I=ISPAC+1,ISPAC+ISPAM) (I6,4X,7E10.0)

These cards are not needed if ISPAM=0. As many cards as necessary, same identifier.

VHSP(I) Form loss coefficient of spacer I in the bypass channel. Definition of VHSP(I) is similar to that of VH, Card 200013.

200025 (ZSP(I),I=ISPAC+ISPAM+1,ISPAC+ISPAM+ISPAR) (I6,4X,7E10.0)

These cards are not needed if ISPAR=0. As many cards as necessary, same identifier.

ZSP(I) Spacer I elevation in the Riser relative to the core inlet, (m).

200026 (VHSP(I),I=ISPAC+ISPAM+1,ISPAC+ISPAM+ISPAR) (I6,4X,7E10.0)

These cards are not needed if ISPAR=0. As many cards as necessary, same identifier.

VHSP(I) Form loss coefficient of spacer I in the Riser. Definition of HSP(I) is similar to that of VH, Card 200013.

200101 ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

For Flow Dependent Loss Coefficient, $f = a + b \cdot Re^c$. These cards are for Downcomer 1.

ALOSI Constant 'a' at Inlet to Downcomer 1.

BLOSI Constant 'a' at Inlet to Downcomer 1.

CLOSI Constant 'c' at Inlet to Downcomer 1.

ALOSE Constant 'a' at Exit to Downcomer 1.

BLOSE Constant 'b' at Exit to Downcomer 1.

CLOSE Constant 'c' at Exit to Downcomer 1.

200102 ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

These cards are similar to those for Downcomer 1 and 2 but are for Lower Plenum 1 and 2.

ALOSI	Constant 'a' at Inlet of Downcomer 2.
BLOSI	Constant 'b' at Inlet of Downcomer 2.
CLOSI	Constant 'c' at Inlet to Downcomer 2.
ALOSE	Constant 'a' at Exit to Downcomer 2.
BLOSE	Constant 'b' at Exit to Downcomer 2.
CLOSE	Constant 'c' at Exit to Downcomer 2.

200103 ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

Constant 'a', 'b', & 'c' for Inlet & Exit to Lower Plenum 1

200104 ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

Constant 'a', 'b', & 'c' for Inlet & Exit to Lower Plenum 2

200105 ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

These cards are for core coolant channels, 1 through NCC. As many cards as necessary, same identifiers.

ALOSI	Constant 'a' for Inlet to Channel 1.
BLOSI	Constant 'b' for Inlet to Channel 1.
CLOSI	Constant 'c' for Inlet to Channel 1.
ALOSE	Constant 'a' for Exit to Channel 1.
BLOSE	Constant 'b' for Exit to Channel 1.
CLOSE	Constant 'c' for Exit to Channel 1.

Similarly, for the core bypass channel NPC.

ALOSI	Constant 'a' at Inlet to Bypass Channel.
BLOSI	Constant 'b' at Inlet to Bypass Channel.
CLOSI	Constant 'c' at Inlet to Bypass Channel.
ALOSE	Constant 'a' at Exit to Bypass Channel.

4. Input Specifications

BLOSE Constant 'b' at Exit to Bypass Channel.

CLOSE Constant 'c' at Exit to Bypass Channel.

200106 ALOSE,BLOSE,CLOSE,ALOSE,BLOSE,CLOSE (I6,4X,7E10.0)

These cards are for the riser.

ALOSE Constant 'a' for the inlet to riser.

BLOSE Constant 'b' for the inlet to riser.

CLOSE Constant 'c' for the inlet to riser.

ALOSE Constant 'a' for exit to riser.

BLOSE Constant 'b' for exit to riser.

CLOSE Constant 'c' for exit to riser.

200200 HRSBW,HRATIO,HRA,HRB (I6,4X,7E10.3)

HRSBW Chimney height excluding riser (m).

HRATIO Constant part of riser modifier.

HRA Coefficient 'a' in riser modifier.

HRB Coefficient 'b' in riser modifier.

Neutronic Input: Core Layout Information

210000 (IX(L)JY(L),L=1,NBE) (I6,4X,14I5)

IX(L) I-coordinate of the periphery channel, L.

JY(L) J-coordinate of the periphery channel, L.

These coordinates must be given for the core periphery channels in the order of increasing channel numbers. * The channels are numbered from 1 to KAN, Card 200000.

210001 Continuation, if necessary.

*With a reference to Figure 4.1, the correct order for entering the peripheral channel information on Card 210000 is:

IX	JY	Channel
1	5	5
2	4	9

3	4	13
4	3	16
5	2	18
6	1	19

It should be emphasized that for any given I (x-axis), the order of the input starts with the lowest value of J (y-axis).

4.3.3 Card Type 3 - Neutronic Core Configuration, Fuel Rod Model

330000 MJ1,MJ2,(IFM(I),NKNR(I),I=MJ1,MJ2) (I6,4X,2I5,4(2X,I5,I4,4X))

An absolute numbering system for the neutronic channels is used, as mentioned in Section 4.2.1 (from 1 to KAN; Card 200000). Starting from the top left corner of the core map, a fuel type and a control rod group are defined for each channel. For example, the first card contains the information on channels from 1 to 4 (MJ1=1, MJ2=4); the second card from 5 to 8 (MJ1=5, MJ2=8), etc. Note that MJ2=MJ1+3, i.e., one card contains data on four neutronic channels.

MJ1 Number of the first neutronic channel on this card.

MJ2 Number of the last neutronic channel on this card.

IFM(I) Identifier of a fuel type layout assigned to channel I: each identifier represents an array of KMAX fuel types. The identifiers are specified on Cards 441000, IFM(I) < IFCH_{max}. Several neutronic channels with identical axial fuel distribution can be assigned the same identifier.

NKNR(I) Identifier of the control rod group assigned to the neutronic channel I. Input zero for an un-controlled channel. Start numbering of the control rods with one and proceed consecutively to |KRR| specified on Card 470000: $NKNR(I)_{\max} \leq |KRR|$.

350000 QT,QMF,DX,DZ,RMOD,A2 (I6,4X,6E10.0)

QT Total reactor power, (W): it must be equal to QTH specified on Card 600000.

QMF Fraction of total power deposited directly into the coolant and bypass channels: it must be equal to DELTA specified on Card 200015.

DX Horizontal dimension of a neutronic cell, (cm).

DZ Vertical dimension of a neutronic cell, (cm). Note that the core height, HEIGHT(5) entered on Card 200014 must be equal to KMAX·DZ/100.

RMOD = 0 Not used.

A2 = 0 Not used.

4. Input Specifications

380000 NRODS,MM,MMC (I6,4X,3I5)

NRODS	Number of fuel rods in a fuel bundle.
MM	Number of radial regions in fuel, conduction calculation.
MMC	Number of radial regions in cladding, conduction calculation.

390000 PS,TSAT,RCA,DRCA (I6,4X,7E10.0)

PS	System pressure, (Pa). Also specified on Card 600061. Used for initialization of the Pressure Controller.
TSAT	Saturation temperature corresponding to the system pressure, PS, (°C).
RCA	Outer radius of cladding, (m).
DRCA	Thickness of cladding, (m).

391000 E1,E2,RLCA,GCAMAX,GCA0,GCA1,GCA2 (I6,4X,7E10.0)

E1	Constant in a correlation for the fuel thermal conductivity.
E2	Constant in a correlation for the fuel thermal conductivity.

Correlation for the fuel thermal conductivity can be found in [Wulff et al. 1984], Equation (3.4.15): $k_f = E_1 / (1 + E_2 T_f)$, (W/m°C), where T_f (°C), is the cell average fuel temperature. The suggested values for the constants are: $E_1 = 8.5$ W/m°C, $E_2 = 0.0021/°C$.

RLCA	Thermal conductivity of cladding, (W/m°C).
GCAMAX	Maximum value of the gap heat transfer coefficient, (W/m ² °C). Suggested value: 5678 W/m ² °C.
GCA0	Coefficient c_0 .
GCA1	Coefficient c_1 .
GCA2	Coefficients c_2 , c_0 , c_1 where c_2 are constants in polynomial expression for the gap heat transfer coefficient (variable GCA in RAMONA-4B): $h_{gap} = c_0 + c_1 \Delta_f + c_2 \Delta_f^2$ where Δ_f - cell average fuel temperature, (°C).

4.3.4 Card Type 4 - Neutronic Data

400000 CRITK,BG21,BG22,AB1,AB2,DREF (16,4X,7E10.3)

CRITK	Target value for k_{eff} in the criticality search. If CRITK is not equal to one, the code will adjust the reactor power in an attempt to achieve the target value through the feedback effects. If no criticality search is required, CRITK must be set to one.
BG21	Transverse leakage correction for the one-dimensional neutronic core model calculations, group 1, (cm^{-2}): $\delta\Sigma_{a1}=D_1 \cdot \text{BG21}$. (See Section 2.4.6 in [Wulff et al. 1984], $B_{1,2}^2$.) BG21 must be set to zero for three-dimensional neutronic calculations.
BG22	Transverse leakage correction for the one-dimensional neutronic core model calculations, group 2, (cm^{-2}): $\delta\Sigma_{a2}=D_2 \cdot \text{BG22}$. BG22 must be set to zero for three-dimensional neutronic calculations.
AB1	Gradient correction factor, group 1. (See Equation (6.2.68) in [Wulff et al. 1984]).
AB2	Gradient correction factor, group 2. AB1 and AB2 are the parameters a and a_i described in [Borresen, 1971].
DREF	Side reflector diffusion coefficient, group 1, (cm). (See Section 2.5.4 in [Wulff et al. 1984].)

401000 CREF,DAVER,SJ (5,4X,7E10.3)

CREF	Coefficient in the relationship between the albedo parameter BL, card 420000, diffusion coefficient D, and n, the number of missing neighbors (see Equation (2.3.35) in [Wulff et al. 1984]). CREF is defined in Equation (2.5.40).
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$$BL' = BL + CREF \cdot n \cdot (D - D_1^{\text{ref}}),$$

or

$$\frac{n}{\lambda_{\text{eff}}^s} = \left(\frac{n}{\lambda_{\text{eff}}^s} \right)_{\text{ref}} + \frac{\partial}{\partial D_1} \left(\frac{n}{\lambda_{\text{eff}}^s} \right)_{\text{ref}} (D_1 - D_1^{\text{ref}}),$$

where $D_1^{\text{ref}} = \text{DAVER}$.

DAVER	Average diffusion coefficient in the cells facing the side reflector in the plane where the albedos are calculated.
SJ	Energy (MeV) per fission generated in the fuel. Recommended value: 200 MeV per fission.

4. Input Specifications

410000 AVT,AVB,BET,BEB (I6,4X,7E10.3)

AVT Top reflector albedo, θ_T . Defined by Equations (2.3.32) and (2.5.34) in [Wulff et al. 1984].

AVB Bottom reflector albedo, θ_B . See Equations (2.3.37) and (2.5.34) in [Wulff et al. 1984].

BET Top reflector effective extrapolation length, (cm) (λ_{eff}^T , Defined by Equation (2.3.30) in [Wulff et al. 1984]).

BEB Bottom reflector effective extrapolation λ_{eff}^B , (cm). See Equation (2.3.37) in [Wulff et al. 1984].

If KMAX=1, the code sets BET=BEB= 10^{20} . For 1-D and 3-D cases, $\text{BET} < 10^{10}$.

420000 (BL(I),I=1,NBE) (I6,4X,7E10.3)

BL(I) Side reflector parameter, n/λ_{eff}^S where n-number of missing neighbors. See Equation (2.3.36) in [Wulff et al. 1984].

420001 Continuation for BL(I) above.

430000 (BE(I),I=1,NBE) (I6,4X,7E10.3)

BE(I) Side reflector parameter $\theta/\Delta x$. See Equation (2.3.36) in [Wulff et al. 1984].

Parameters BL and BE can be calculated using Equation (2.5.7) and Equation (2.5.36) in [Wulff et al. 1984], respectively. The values are entered in the same order as the channels' coordinates on Card 210000.

430001 Continuation for BE(I) above.

440000 TEK (6X,12A6,A2)

TEK Optional. Heading identifying the nuclear data.

441000 IFCH,(IAXTYP(IFCH,K),K=1,KMAX) (I6,4X,I5,14I4)

One card must be input for each unique IFM defined on card 330000.

IFCH Identifier of an array mapping cross-section sets in a neutronic channel.

IAXTYP Cross-section set identifier: this can be any of ITAB2 values of the fuel type identifiers. See Cards 470000 and 480000.

441001 IFCH,(IAXTYP(IFCH,K),K=15,KMAX) (I6,9X,14I4)

Continuation from above, if KMAX > 14.

442000 IFUEL,(CXENON(IFUEL,K),K=1,4) (I6,4X,I5,4E10.3)

IFUEL Each cross-section set belongs to one of twenty possible fuel types in terms of Xenon correction ($1 < \text{IFUEL} < 20$).

CXENON Coefficients used in the correction set. See Chapter 2.4.5, Equation (2.4.6) in [Wulff et al. 1984]).

CXENON(IFUEL,1) and CXENON(IFUEL,2) correspond to a_x and b_x for calculating corrections to Σ_{a2} , respectively; CXENON(IFUEL,3) and CXENON(IFUEL,4) correspond to a_x and b_x for calculating corrections to $v_2 \Sigma_p$, respectively.

460000 NAXIAL,INLOOP,WBINP,BCONC,WRATED (I6,4X,2I5,3E10.3)

This card is needed only if IOPTB=1 on Card 462000.

NAXIAL Cell number of INLOOP for boron injection (BWR only).

INLOOP Flow segment number where boron is injected:

INLOOP=1, upper downcomer (downcomer 1)

INLOOP=2, lower downcomer (downcomer 2)

INLOOP=3, lower plenum 1

INLOOP=4, lower plenum 2

INLOOP=5, reactor core

INLOOP=6, riser

WBINP Boron injection rate in kg/s (BWR only, IOPT(1)=1). For SBWR, it is calculated by SLCS model.

BCONC B_{10} concentration of injected boron in ppm (BWR only). For SBWR, it is input by SLCS model.

WRATED Rated total core inlet flow rate in kg/s.

461000 SIGA1B,SIGA2B,WETFRC,FACTR (I6,4X,4E10.3)

This card is needed only if IOPTB=1 on Card 462000.

SIGA1B Fast group absorption cross-section of B_{10} in barn.

SIGA2B Thermal group absorption cross-section of B_{10} in barn.

WETFRC Fraction of a neutronic cell occupied by the coolant.

FACTR Adjustment factor applied to boron cross-sections as $(1-\text{FACTR})$. Set it to zero if no correction needed.

462000 IOPTB,IPRNT,TSTR,T,TOFF,TDELAY (I6,4X,2I5,3E10.3)

This card is needed only if the boron calculation is requested.

IOPTB Option switch for boron calculation (0=No, 1=Yes).

4. Input Specifications

IPRNT Output printing switch for boron calculation:

 = 0 no print.

 = 1 print core average boron concentration, core inlet boron concentration, and riser inlet boron concentration.

≥ 2 print also local boron masses and boron concentrations in all hydraulic cells.

TSTRT Starting time for boron injection in (s).

TOFF Termination time for boron injection in (s).

TDELAY Delay time for boron injection in (s). Boron is injected only when the transient time is greater than (TSTRT+TDELAY) and less than TOFF.

463000 NBMIX1 (I6,4X,I5)

This card is needed only if IOPTB=1 on Card 462000.

NBMIX1 The number of pairs of entries (≤ 60) in the boron mixing efficiency table for downcomer that must follow on Cards 463000.

463000 (WBMIX1(I),I=1,NBMIX1),(EBMIX1(I),I=1,NBMIX1) (I6,4X,6E10.3)

This card is needed only if IOPTB=1 on Card 462000.

WBMIX1(I) Fractional flow with respect to the rated (WRATED), $-1 \leq \text{WBMIX1} \leq +1$, negative values for reverse flow.

EBMIX1(I) Boron mixing efficiency between 0 and 1. The code performs a linear interpolation using the table (EBMIX1 vs. WBMIX1).

464000 NBMIX2 (I6,4X,I5)

This card is needed only if IOPTB=1 on Card 462000.

NBMIX2 The number of pairs of entries (≤ 60) in the boron mixing efficiency table for lower plenum 1 that must follow on Cards 464000.

464000 (WBMIX2(I),I=1,NBMIX2),(EBMIX2(I),I=1,NBMIX2) (I6,4X,6E10.3)

This card is needed only if IOPTB=1 on Card 462000.

WBMIX2(I) Fractional flow with respect to the rated (WRATED), $-1 \leq \text{WBMIX2} \leq +1$, negative values for reverse flow.

EBMIX2(I) Boron mixing efficiency between 0 and 1. The code performs a linear interpolation using the table (EBMIX2 vs. WBMIX2).

465000 NBMIX3 (I6,4X,I5)

This card is needed only if IOPTB=1 on Card 462000.

NBMIX3 The number of pairs of entries (≤ 60) in the boron mixing efficiency table for lower plenum 2, core, and riser that must follow on Cards 465000.

465000 (WBMIX3(I),I=1,NBMIX3),(EBMIX3(I),I=1,NBMIX3) (I6,4X,6E10.3)

This card is needed only if IOPTB=1 on Card 462000.

WBMIX3(I) Fractional flow with respect to the rated (WRATED), $-1 \leq \text{WBMIX3} \leq +1$, negative values for reverse flow.

EBMIX3(I) Boron mixing efficiency between 0 and 1. The code performs a linear interpolation using the table (EBMIX3 vs. WBMIX3).

466000 LSC,IATWS,SCVOT,SCTL,SCPR,SCHT (10X,2I5,6E10.3)

Cards 466000 through 469000 are for inputting SLCS data.

LSC = 0 No boron injection.

 = 1 Boron injection upon violating pressure or water level limit.

 = 2 Manual initiation.

IATWS = 0 ATWS condition has not been met.

 = 1 ATWS condition has been met.

SCVOT Tank volume in (m^3).

SCTL Tank liquid temperature ($^{\circ}\text{C}$).

SCPR Tank gas pressure in (Pa).

SCHT Tank bottom elevation in (m).

467000 SC DIA,SCL,SCVOL,SCLEV,CPPM,DENSBOR (10X,7E10.3)

SC DIA Pipe diameter in (m).

SCL Pipe length in (m).

SCVOL Liquid volume in tank in (m^3).

SCLEV Liquid level in tank in (m).

4. Input Specifications

CPPM Boron concentration in ppm of pentaborate solution.

DENSBOR Boron density in (kg/m³).

468000 SCPHI,SCLOW,SCVEL,AKLOSS,AN,SCVIS (10X,7E10.3)

SCPHI High pressure setpoint in (Pa).

SCLOW Low level in vessel in (m).

SCVEL Assumed initial liquid velocity in (m/s).

AKLOSS Sudden contraction loss coefficient.

AN Isentropic expansion coefficient.

SCVIS Liquid viscosity in (Ns/m²).

469000 DELSC,DIVALS,DTSVAL,DATWS,TSLCS (10X,7E10.3)

DELS Signal transmission delay time (s).

DIVALS Valve diameter in (m).

DTSVAL Valve opening time in (s).

DATWS Signal initiation delay in ATWS in (s).

TSLCS Manual initiation time in (s) (valid if LSC=2 in 466000).

470000 ITAB2,ICONST,KRR (16,4X,10I5)

These cards are needed only when neutronic calculations are performed.

ITAB2 Number of cross-section sets to be read in Card 480000 series. Current limit is 1000 cross-section sets.

ICONST Number of coefficients in the RAMONA-4B cross-section format: 56 coefficients are used at present so enter 56.

KRR Number of the bottom entry control rod groups (use a negative sign for the top entry rods).

471000 (IFC(I),I=1,ITAB2) (16,4X,14I5)

These cards are needed only if IOPT(5)=0 on Card 110000.

IFC Maps the cross-section set number (in order of reading from Cards 480000) to its Xenon correction set. In other words, it relates each cross-section set to its fuel type for the Xenon correction. ITAB2 is read on Card 470000 and the Xenon correction coefficients are read from Card 442000.

480000 (WW(I),I=1,ICONST) (I6,4X,7E10.0)

These cards are for inputting cross-section data and their feedback coefficients. As many cards as necessary, same identifier. ITAB2 groups (sets) of polynomial coefficients. Note that the sequential order number of a set corresponds to its IAXTYP number on Card 441000.

WW(I) Polynomial coefficients. The interpretation depends on ICONST (see Section 4.1.2).

490000 KK ADDVO,ADDTF,ADDTM (I6,4X,3E10.3)

Perturbations to the cross-section independent variables.

Needed only if ITYP=10: generation of input files for the FRAM code is requested.

KK Axial plane number.

ADDVO Perturbation to void fraction.

ADDTF Perturbation to fuel temperature, (°C).

ADDTM Perturbation to coolant temperature, (°C).

If KK=0, the variables are incremented at every axial level to make a uniform perturbation.

493000 (CRAXY(I),I=1,KMAX) (I6,4X,7E10.3)

Needed only if IOPT(11)=3: 1-D neutronic calculation with the corresponding data from the FRAM input file being over-written.

CRAXY(I) Control density on level I. These values are calculated by the FRAM code.

493001 Continuation from above.

496000 (BUCK(I),I=1,KMAX) (I6,4X,7E10.3)

Needed only if IOPT(11)=3: 1-D neutronic calculation with the corresponding data from the FRAM input file being over-written.

BUCK(I) The buckling factor from the power buckling correction calculation. These values are calculated by the FRAM code.

4. Input Specifications

4.3.5 Card Type 5 - Thermal Hydraulics, Steam Separator, Recirculation Loop, Jet Pump, Recirculation Flow Controller, and Disturbance Specifications

500010 CNUSSF,DBARR,BPFR,DCGAP,STANT,ANFWE,DFWP (I6,4X,7E10.0)

CNUSSF	Stanton number for film condensation. Recommended value 0.0073.
DBARR	Diameter of the core barrel, in (m).
BPFR	Bypass flow fraction (ratio of bypass flow to total core flow).
DCGAP	Upper downcomer gap width, in (m).
STANT	Stanton number for condensation on a jet. Recommended value: STANT=0.02.
ANFWE	Total number of the feedwater sparger nozzles.
DFWP	Outlet diameter of a feedwater sparger nozzle, (m).

500030 CPB(1),CPB(2),CPB(3),CRT(1),CRT(2),CRT(3) (I6,4X,6E10.0)

CPB(1)	Coefficient C11 in the bulk vapor generation rate correlation, ($\text{Wm}^{-3}\text{C}^{-1}$). See Equation (4.4.57) in [Wulff et al. 1984].
CPB(2)	Coefficient C12 in the bulk vapor generation rate correlation, ($\text{Wm}^{-3}\text{C}^{-1}$).
CPB(3)	Coefficient C13 in the bulk vapor generation rate correlation.

Recommended values:

$$\begin{aligned}\text{CPB } 1 &= 5 \cdot 10^6 \text{ Wm}^{-3}\text{C}^{-1}, \\ \text{CPB } 2 &= 4 \cdot 10^7 \text{ Wm}^{-3}\text{C}^{-1}, \\ \text{CPB } 3 &= 0.3.\end{aligned}$$

CRT(1)	C_9 of the Becker's two phase friction multiplier, Equation (4.4.47) in [Wulff et al. 1984]. Recommended value 2400.
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(Coefficient C_9 in [Wulff et al. 1984] is given for the pressure expressed in Pascal (P). The code uses pressure in Bar).

CRT(2) = 0	drift velocity $\langle V_{gi} \rangle$, coefficient for core region (Default=1.54).
CRT(3) = 0	Coefficient for two-phase form loss multiplier (Default=1.2).

500040 IPUMP,IJPUMP (I6,4X,10I5)

IPUMP = 0	No recirculation pumps: BWR with a jet pump coolant recirculation system.
= 1	Recirculation pumps represented: BWR with an external pump coolant recirculation system. This option is not supported currently.

4. Input Specifications

- = 2 Natural circulation option (IJPUMP below must be zero).
- IJPUMP = 0 No jet pumps.
- = N Total number of jet pumps in the coolant recirculation system.

If IJPUMP $\neq$ 0, the total core flow rate, WCORIN (kg/s), must be specified on Card 600070; this value includes the bypass flow. Also, IPUMPD on Card 500083 must be zero. Note that the IPUMP=1 & IJPUMP=0 combination corresponds to an external pump driven coolant recirculation system, and the IPUMP=2 and IJPUMP=0 combination corresponds to a natural circulation system order as the SBWR.

500051 PH0,PH1,PH2 (I6,4X,7E10.0)

This card is needed only if IPUMP=1 and IJPUMP=0; it must be read after card 500040.

- PH0 First coefficient in the correlation for the forced circulation pump head ΔP_{head} (Pa).
- PH1 Second coefficient in the correlation for the forced circulation pump head ΔP_{head} (Pa).
- PH2 Third coefficient in the correlation for the forced circulation pump head ΔP_{head} (Pa).

$$\Delta P_{head} = PH0 + PH1 * V_{NP} + PH2 * V_{NP} | V_N$$

where V_{NP} is liquid velocity at the pump inlet, (m/s).

500052 NSEP,ASEP,HSEP,RLEFF0,DTSUBC (I6,4X,I10,6E10.0)

Steam separator data.

- NSEP Number of steam separators.
- ASEP Total steam separator area, (m²).
- HSEP Separator height, (m).
- RLEFF0 Effective L/A ratio for separators at zero quality, (m²). Recommended value: RLEFF0=120.0 m.
- DTSUBC Core inlet subcooling, (°C). DTSUBC is used in calculation of the steam carry-under coefficient, χ_{CU} .

500053 IDRL,ANOZ,ASCT,ATHR,RKDIF,RKSCT,RJJP (I6,4X,I10,6E10.0)

This card is present only if IJPUMP=1.

- IDRL Number of recirculation loops.
- ANOZ Jet pump nozzle flow area, (m²).
- ASCT Jet pump suction flow area, (m²).

4. Input Specifications

ATHR	Jet pump throat flow area, (m^2).
RKDIF	Jet pump diffuser loss coefficient, ($\text{m}^{-1}, \text{kg}^{-1}$).
RKSCT	Suction leg loss coefficient, ($\text{m}^{-1}, \text{kg}^{-1}$). Recommended value: $\text{RKSCT}=0.0006689 \text{ m}^{-1}, \text{kg}^{-1}$.
RJJP	Moment of inertia of a recirculation pump in the recirculation loop, (kg m^2).

500054 RLAD,PDR0,WDR0,TORQP0,OMGREF,OMGGIC,OMDMIC (I6,4X,7E10.0)

This card is needed if IJPUMP $\neq$ 0 - jet pumps represented.

RLAD	Total L/A ratio for a recirculation loop, m^{-1} . $\text{RLAD}=(\text{L/A})_{\text{Dc } 1,2}+(\text{L/A})_{\text{Drive Line}}$
PDR0	Recirculation pump rated pressure head (Pa).
WDR0	Total mass flow rate through the recirculation pump loops at steady state, (kg/s).
TORQP0	Recirculation pump rated torque (N.M).
OMGREF	Generator rated angular speed of Motor/Generator set (rad/s).
OMGGIC	Initial generator angular speed at steady state (rad/s).
OMDMIC	Initial drive motor angular speed at steady state (rad/s).

500055 TAUFPC,PUMPN,PUMPENR,RMCREF,RMDREF,RIGPC,RIDMPC (I6,4X,7E10.0)

This card is needed if IJPUMP $\neq$ 0 - jet pumps represented.

TAUFPC	Fluid coupler response time constant (s).
PUMPN	Recirculation pump angular speed at steady state, n_p , (s^{-1}).
PUMPENR	Recirculation pump rated angular speed, (s^{-1}).
RMCREF	Fluid coupler rated torque (N.M). Typical value: $\text{RMCREF} = 2.3304\text{E}+6 \text{ N.M}$.
RMDREF	Drive motor rated torque (N.M). Typical value: $\text{RMDREF} = 4.8634\text{E}+4 \text{ N.M}$.
RIGPC	Moment of inertia for generator-coupler assembly (kg m^2). Typical value: $\text{RIGPC} = 1359 \text{ kg m}^2$.
RIDMPC	Moment of inertia for drive motor-coupler assembly (kg m^2). Typical value: $\text{RIDMPC} = 1193 \text{ kg m}^2$.

500056 T1RC,T2RC,T3RC,T4RC,H2RC,H3RC,H4RC (I6,4X,7E10.0)

T1RC	Correlation constant 1 for hydraulic torque of recirculation pump. Typical value: $\text{T1RC}=0.8506 \text{ J s}^2$.
T2RC	Correlation constant 2 for hydraulic torque of recirculation pump. Typical value: $\text{T2RC}=0.0408 \text{ J s}^2 \text{ kg}^{-1}$.

4. Input Specifications

T3RC	Correlation constant 3 for hydraulic torque of recirculation pump. Typical value: $T3RC = -4.351E-3 \text{ J s}^2 \text{ kg}^{-2}$.
T4RC	Correlation constant 4 for hydraulic torque of recirculation pump. Typical value: $T4RC = -8.966 \text{ kg}$.
H2RC	Correlation constant 2 for recirculation pump head ($\text{m}^{-1} \text{ s}^{-2}$). Typical value: $H2RC = -32.67 \text{ m}^{-1} \text{ s}^{-2}$.
H3RC	Correlation constant 3 for recirculation pump head ($\text{m}^{-1} \text{ kg}^{-1}$). Typical value: $H3RC = -0.108 \text{ m}^{-1} \text{ kg}^{-1}$.
H4RC	Correlation constant 4 for recirculation pump head (kg s^{-1}). Typical value: $H4RC = 0.0$.

Note: The first correlation constant H1RC is determined automatically in the code at steady state such that the rate of change of drive flow rate is exactly zero at $t=0$.

500057 CKD1,CKD2,CKS1,CKS2,FMSC,FRDL,TRCCF (I6,4X,7E10.0)

This card is needed for recirculation flow control system (BWR only, not SBWR).

CKD1	P-constant for PI master flow controller. Typical value = 1.25.
CKD2	I-constant for PI master flow controller. Typical value = 0.01875.
CKS1	P-constant for recirculation speed controller. Typical value = 0.4.
CKS2	I-constant for recirculation speed controller. Typical value = 0.2.
FMSC	Manual speed control signal. $0.4 \leq FMSC \leq 1.025$. Set $FMSC = -1.0$ for automatic speed control.
FRDL	Runback demand limit. $0.0 \leq FRDL \leq 1.0$.
TRCCF	Time to activate recirculation control failure (s). Set to a large value (e.g., $1.0E+9$) to disable this feature.

500058 AFRCC,BFRCC,TAUCL,GCLMX,GRC,XCMAX,X0MAX (I6,4X,7E10.0)

This card is needed for recirculation flow control system (BWR only, not SBWR).

AFRCC	Correlation constant A of nonlinear function Y for speed control. $Y = \text{SQRT}(A * X / (B - X))$, where X is input signal.
BFRCC	Correlation constant B of nonlinear function Y for speed control.
TAUCL	Time lag for recirculation flow controller (s). Typical value = 0.5 s.
GCLMX	Gain factor for recirculation flow controller. Typical value = 1.0.
GRC	Actuator damping coefficient. Typical value = 0.6.
XCMAX	Maximum scoop tube position. Typical value = 1.75.
X0MAX	Maximum speed signal. Typical value = 0.20.

4. Input Specifications

500059 DEMAX,OMGCMX,TDMF,ETAG (I6,4X,4E10.0)

This card is needed for recirculation flow control system (BWR only, not SBWR).

DEMAX Maximum limit of steam demand error signal from pressure control system. Typical value = 0.20.

OMGCMX Maximum coupler actuator frequency (s^{-1}). Typical value = $2.0 s^{-1}$.

TDMF Time to activate drive motor failure (s). Set to a large value (e.g., $1.0E+9$) to disable this failure.

ETAG Generator efficiency of motor-generator set. Typical value = 0.96.

500060 IPDIST (I6,4X,10I5)

This card is needed only if ITYP=5 or ITYP=7 hydraulics-only calculations.

IPDIST Number of equidistant points where power distribution is specified (same axial cells for each hydraulic channel). Two of the points must correspond to the first and the last cell in the core.
 $2 < IPDIST \leq NSEC(5)$.

500070 (AUXQK(I),I= 1,IPDIST*NPC) (I6,4X,7E10.0)

This card is needed only if ITYP=5 or ITYP=7, hydraulics-only calculations and $IPDIST > 2$. As many cards as necessary, same identifier.

AUXQK(I) Normalized power distribution in equidistant points for each channel, starting at the core inlet and ending at the core outlet. The points refer to the midpoints of the cells. Channel power is specified on Card 600060.

500081 IPRES,RKP0 (I6,4X,I5,3E10.0)

IPRES = 0 Constant system pressure, system pressure remains constant at its steady-state value.

 = 1 Varying system pressure, system pressure is calculated by integrating p-dot equation.

RKP0 Main steam isolation valve coefficient. Required only if $IPRES=1$ and $NSTMOP=0$ (no steamline calculations, Card 880000); otherwise, set $RKP0=0.0$.

500082 SDTMAX,HMIN,ACCH (I6,4X,3E10.0)

SDTMAX Maximum hydraulic time step, (s). This is intended to guard against numerical instability due to explicit integration. Recommended value: 0.035.

HMIN Initial hydraulic time step, (s). Recommended value: $HMIN=0.01s$.

ACCH Maximum value of relative truncation error for determining the acceptable time step in the hydraulics calculation. If a constant hydraulic time step is wanted, set $ACCH=0$. Recommended value: $ACCH=0.02$.

500083 IPUMPD,IFWFLO,IFWTEM,ISTLOA,IQTOT (I6,4X,10I5)

These variables are used to impose various disturbances as boundary conditions. See Cards 500084-500088 for specific disturbance parameters.

IPUMPD = 1 Forced circulation flow disturbance.

 = 0 No forced circulation disturbance.

IPUMPD must be set to zero if IJPUMP $\neq$ 0 on Card 500040.

Similarly,

IFWFLO Feedwater flow disturbance.

IFWTEM Feedwater temperature disturbance.

ISTLOA Steam load disturbance. This option can be selected only if IPRES=1, Card 500081.

IQTOT Reactor power disturbance.

500084 THO,HRAM,HMAXR,DELTH,HSIN,OMEGAH (I6,4X,6E10.0)

This card is needed only if IPUMPD=1, Card 500083.

THO Starting time of the disturbance, (s).

HRAM Slope of the ramp (ramp coefficient): $HRAM = HMAXR / \Delta$, where Δ is the ramp's time window when the variable changes linearly in time, (s^{-1}).

HMAXR Maximum relative change of the disturbed variable in the course of one ramp.

DELTH Time interval between each new ramp, or end of sinusoidal disturbance, (s). Specify a large number if only one ramp is needed.

HSIN Relative amplitude of sinusoidal disturbance.

OMEGAH Angular frequency of sinusoidal oscillations, (s^{-1}).

The following conventions apply:

HSIN $< 10^{-6}$, ramp disturbance requested.

HMAXR $< 10^{-6}$, sinusoidal disturbance requested.

HSIN $> 10^{-6}$, and HMAXR $> 10^{-6}$, combined sinusoidal and ramp disturbance requested.

4. Input Specifications

The disturbance of a variable X is calculated according to the following correlations:

$$X(\text{TIME}) = X(\text{THO}) * [1 + \text{HRAM} * (\text{TIME} - \text{THO})],$$

or

$$X(\text{TIME}) = X(\text{THO}) * 1 + \text{HSIN} * \sin[\text{OMEGAH} * (\text{TIME} - \text{THO})],$$

where TIME is the transient time, (s).

500085 TWO,WFWRAM,WFWMAX,DELTW,WFSIN,OMEGAW (I6,4X,6E10.0)

This card is needed only if IFWFLO=1, Card 500083. A disturbance to the feedwater flow, WFW, is introduced. The variables are analogous to those on Card 500084.

500086 TTO,TFWRAM,TFWMAX,DELTT,TFWSIN,OMEGAT (I6,4X,6E10.0)

This card is needed only if IFWTEM=1, Card 500083. A disturbance to the feedwater temperature, TFW, is introduced. The variables are analogous to those on Card 500084.

500087 TKO,RKPRAM,RKPMAX,DELTK,RKPSIN,OMEGAK (I6,4X,6E10.0)

This card is needed only if ISTLOA=1, Card 500083. A disturbance to the steamline flow rate, WSL, is introduced. The variables are analogous to those on Card 500084.

500088 TQO,QRAM,QMAX,DELTO,QSIN,OMEGAQ (I6,4X,6E10.0)

This card is needed only if IQTOT=1, Card 500083. A disturbances to the total thermal power, QTOT, and the associated QJ's are introduced. The variables are analogous to those on Card 500084.

550000 VOCON (I6,4X,7E10.3),C0COF1,C0COF2,C0COF3,VFUP,SUBLIQ

VOCON	Initial core average void fraction for iterative neutronics calculations. Recommended value: VOCON=0.4 for IOPT(4)=0, Card 110000.
C0COF1	1 st coefficient for drift flux parameter C_o (Default=1.2).
C0COF2	2 nd coefficient for drift flux parameter C_o (Default=0.2).
C0COF3	3 rd coefficient for drift flux parameter C_o (Default=18).
VFUP	Estimated void fraction in the vapor space just above the mixture level.
SUBLIQ = 0	Subcooled RPV switch. SUBLIQ=1 means that the entire reactor pressure vessel (RPV) is subcooled. This is intended or a special case where the RPV is filled with subcooled liquid.

560000 IPSIT,IOPAFWR,TSUPER,TLIQMN,WWMIN,WWMAX,YIMMIN,YIMMAX (I6,4X,2I5,6E10.0)

This card is needed only if other than default values are desired.

IPSIT	Option switch for total vapor generation calculation. IPSIT=0, ignore vapor generation above water level (old model). IPSIT=1, include vapor generation above mixture level including steam dome.
IOPAFWR	Option switch for automatic feedwater runback. (0=No, 1=Yes). (Enter 0 for BWR and 1 for SBWR).
TSUPER	Maximum allowable liquid superheating ($^{\circ}\text{C}$).
TLIQMN	Minimum allowable liquid temperature ($^{\circ}\text{C}$).
WWMIN	Minimum allowable volumetric flow rate at downcomer entrance (m^3/s).
WWMAX	Maximum allowable volumetric flow rate at downcomer entrance (m^3/s).
YIMMIN	Minimum allowable integrated loop momentum ($\text{N}/\text{m}^2/\text{s}$).
YIMMAX	Maximum allowable integrated loop momentum ($\text{N}/\text{m}^2/\text{s}$).

570000 PRPSP,TPSP,RMLPSP,WRHR,TRHR,WSRW,AUCP,NRHR (I6,4X,7E10.0,I5)

This card is needed for pressure suppression pool dynamics using a simplistic model, option IPSP=1 on Card 625000.

PRPSP	Suppression pool pressure (N/m^2). Typical value = $1.0\text{E}+5 \text{ N}/\text{m}^2$.
TPSP	Initial suppression pool temperature ($^{\circ}\text{C}$). Typical value = 32°C .
RMLPSP	Initial suppression pool liquid mass (kg). Typical value = $3.6\text{E}6 \text{ kg}$.
WRHR	Mass flow rate of a single residual heat removal system (kg/s). Typical value = 631.4 kg/s .
WSRW	Service water mass flow rate of a single RHR system (kg/s). Typical value = 284.1 kg/s .
AUCP	Overall heat transfer coefficient of RHR heat exchanger times heat transfer area divided by specific heat (AU/Cp) (kg/s). Typical value = 181.13 kg/s .
NRHR	Number of RHR heat exchangers. Typically, NRHR = 4.

4. Input Specifications

4.3.6 Card Type 6 - Reactor Operation, Protection and Control

600000 HY,QTH,QCOOL (I6,4X,7E10.3)

HY Rated reactor power, (W).

QTH Initial reactor power, (W). Must be equal to QT on Card 350000.

QCOOL Not used.

600050 STEP1,HALT1,STEP2 (I6,4X,7E10.0)

This card specifies the frequency of printing of the hydraulics data during the transient calculation.

STEP1 Time interval between printouts in the period from $t=0$ to $t=HALT1$, (s).

HALT1 Time at which a new time interval may be introduced, (s).

STEP2 Time interval between printouts in the period $t > HALT1$, (s).

600060 (QJ(I),I=1,NPC) (I6,4X,7E10.0)

This card is needed only if ITYP=5 or ITYP=7, hydraulics-only calculation. As many cards as necessary, same identifier.

QJ(I) Total power in each channel, (W).

600061 IPLOC,TFW,P0,TMOD (I6,4X,I5,3E10.0)

IPLOC = 0 No local pressure dependence.

 = 1 Activate local pressure dependence. Applies only to thermo-physical properties calculation.

TFW Initial feedwater temperature ($^{\circ}\text{C}$).

P0 Initial system pressure (Pa). Specified also on Card 390000.

TMOD "Effective" bypass liquid temperature in cases where no bypass channel calculation is performed. Heat loss from the coolant channels through the surrounding channel box walls is taken into account by using TMOD ($^{\circ}\text{C}$), HTC on Card 200015, and PM on Card 200017.

600070 WCORIN,DVGUES,EPSP (I6,4X,3E10.0)

WCORIN Initial core inlet mass flow rate, (kg/s).

DVGUES Not used with the jet pump option.

EPSP Pressure drop convergence criterion.

If Jet pump model **is used**: the steady-state flow iteration is terminated when

$$|(\Delta P_{j,\max} - \Delta \tilde{P}_{core})| < \Delta \tilde{P}_{core} * EPSP ..$$

If Jet pump model **is not used**: the steady-state flow iteration is terminated when

$$|\Delta P_{ex} - \Delta P_j| < \Delta P_{ex} * EPSP, j=1, NPC,$$

where P_{ex} is the total pressure drop from the core exit around the loop to the core inlet, and ΔP_j is the pressure drop across the core channel j . Recommended value: $EPSP=0.001$.

600080 ITAB (I6,4X,10I5)

This card controls printing of the hydraulics data during steady-state calculation.

ITAB ITAB=100*ITAB2+10*ITAB1+ITAB0.

ITAB2 = 1 No printing output from iterations.

 = 2 Detailed printing output from iterations.

ITAB1 = 1 "Small" output.

 = 2 "Large" output.

ITAB0 Currently ITAB0=0.

600090 ITABD (I6,4X,3I5)

This card controls printing of the hydraulics data during transient calculation.

ITABD = 0 "Small" output is printed every STEP1 or STEP2 seconds, Card 600050. "Large" output is printed only at the beginning of the transient, $t=0$ (s).

 = k "Large" output is printed every k*STEP1 or k*STEP2 seconds, Card 600050. "Small" output is printed as for ITABD=0.

611000 (IFWTX(I),I=1,2) (I6,4X,2I5)

Feedwater Trip Data. If no feedwater trip is requested, Cards 611000 through 611300 are not needed.

IFWTX(1) = 0 Default; no test on time.

 = 1 Test on time.

IFWTX(2) = 0 Default; no test on high vessel water level.

4. Input Specifications

- = 1 Test on high vessel water level. The trip information time vs. feedwater flow rate is specified on Cards 611300. If any of the IFWTX(I), I=1,2 is non-zero, a corresponding Card 611100 should be present.

611100 TFWTP,TDELFW(1) (I6,4X,2E10.3)

TFWTP The time at which the feedwater trip should activate, (s).

TDELFW(1) Delay time for feedwater trip activation, (s): trip is activated at time TFWTP+TDELFW(1).

611200 WMAXFW,TDELFW(2) (I6,4X,2E10.3)

WMAXFW The maximum allowed elevation of the water level above the Downcomer 1 inlet. Specify negative value for the water level below the Downcomer 1 inlet. When the water level exceeds this value, the feedwater trip is activated if IFWTX(2)=1 on Card 611000.

TDELFW(2) Delay time for trip activation (s): the trip is activated TDELFW (2) seconds after reaching the condition on WMAXFW.

611300 NTRYFW (I6,4X,I5)

NTRYFW The number of pairs of entries in the feedwater flow rate table that must follow. The following 611300 card(s) first specify an array with the time points and then an array with the corresponding flow rates.

611300 (FWX(I),I=1,NTRYFW),(FWY(I),I=1,NTRYFW) (I6,4X,6E10.3)

As many cards as necessary, same identifier.

FWX(I) Time (s).

FWY(I) Flow rate as a fraction of flow rate just before the trip.

The code performs a linear interpolation on flow rate, FWY, using the [FWX vs. FWY] table.

611401 NFWT1,SLMN,SLMX,WFQFW,ZETA,RFWC (I6,4X,7E10.3)

NFWT1 Option switch for feedwater control (0=No, 1=Yes).

SLMN Lower limit for water level control in (m).

SLMX Upper limit for water level control in (m).

WFQFW Natural frequency of feedwater controller actuator.

ZETA Damping coefficient of feedwater controller actuator.

RFWC Minimum feedwater turbine valve position (fraction).

611402 TAUL,TAUS,TAU11,TAU12,TAUFW,TAU21,SFTV0 (I6,4X,7E10.3)

TAUL	Time constant for water level signal in (s).
TAUS	Time constant for steam flow signal in (s).
TAU11	Time lag for feedwater lead/lag compensator in (s).
TAU12	Time lead for feedwater lead/lag compensator in (s).
TAUFW	Feedwater flow adjustment constant (not used).
TAU21	Time lag for feedwater lag compensator in (s).
SFTV0	Initial feedwater turbine valve position (fraction).

611403 CKFW1,CKFW2,GFWLLG,GFWLAG,SFTVF,SFWCF (I6,4X,6E10.3)

CKFW1	P-constant for feedwater PI controller.
CKFW2	I-constant for feedwater PI controller.
GFWLLG	Gain factor for feedwater lead/lag compensator.
GFWLAG	Gain factor for feedwater lag compensator.
SFTVF	Feedwater turbine valve failure signal (0=No, 1=Yes).
SFWCF	Feedwater check valve failure signal (0=No, 1=Yes).

611501 IFHTX (I6,4X,2I5)

IFHTX	Option switch for feedwater heater trip.
= 0	no trip,
= 1	Test on time.

611502 TFHTP,TDELPH (I6,4X,2E10.3)

TFHTP	Time for feedwater heater trip activation, (s).
TDELPH	Time delay for feedwater heater trip, (s).

611503 NTRYFH

NTRYFH	Number of pairs of entries for feedwater heater trip.
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4. Input Specifications

611503 FHX(I),I=1,NTRYFH),(FHY(I),I=1,NTRYFH (I6,4X,6E10.3)

As many cards as necessary, same identifier.

FHX(I) Time(s)

FHY(I) Feedwater temperature as a fraction of the feedwater temperature just before the trip.

611601 ILSTX (I6,4X,I5)

This card is needed only for the new level setpoint vs. time option (ILSTX=1).

ILSTX Option switch.
ILSTX = 0, level setpoint is constant (default);
ILSTX = 1, level setpoint is a function of time.

611602 TLSTP,TDELLS (I6,4X,2E10.0)

This card is needed only for the new level setpoint vs. time option (ILSTX=1).

TLSTP Time to activate the level setpoint vs. time option (s).

TDELLS Delay time to activate the level setpoint vs. time option (s).

611603 NTRYLS (I6,4X,I5)

This card is needed only for the new level setpoint vs. time option (ILSTX=1).

NTRYLS Number of pairs of entries in the level setpoint vs. time table.

611603 (FLSX(I),I=1,NTRYLS), (FLSY(I),I=1,NTRYLS) (I6,4X,6E10.3)

This card is needed only for the new level setpoint vs. time option (ILSTX=1).

FLSX(I) Time (s).

FLSY(I) Level setpoint as a fraction of the collapsed liquid level in the downcomer at the time of interest.

The code performs a linear interpolation on the level setpoint, using the [FLSX vs. FLSY] table.

612000 VELSCR,(ISCRMX(I),I= 1,7) (I6,4X,E10.3,10I5)

This card specifies scram data (see also Card 770000 for TBEG and TEND).

VELSCR Velocity at which the control rods are inserted during scram (number of axial cells per second).

ISCRMX(1) = 1 Test on time.

ISCRMX(2) = 1 Test on closure of the turbine inlet valve.

4. Input Specifications

ISCRMX(3) = 1 Test on high power.

ISCRMX(4) = 1 Test on low reactor vessel water level.

ISCRMX(5) = 1 Test on high reactor vessel water level.

ISCRMX(6) = 1 Test on high system pressure.

ISCRMX(7) = 1 Test on the closure of the main steam isolation valve.

The rods' mapping and locations are specified on Cards 330000, 620000, and 760000. Scram activation is independent of the control rod disturbance specifications, IPERT on Card 750000. All the default values for ISCRMX(I), I=1,7 are zero: no testing. If ISCRMX(I) is non-zero, a corresponding 612100 card must be present.

612100 TSCRAM,TDELSC(1) (I6,4X,2E10.3)

TSCRAM Time at which the scram signal is generated, (s).

TDELSC(1) Scram delay time: control rods movement starts at time TSCRAM+TDELSC(1), (s).

612200 TDELSC(2) (I6,4X,E10.3)

TDELSC(2) Delay time: control rods movement starts TDELSC (2) seconds after the turbine valve closure signal had been generated, (s).

612300 ARSCRM,TDELSC(3) (I6,4X,2E10.3)

ARSCRM Scram on fission power: starts if the actual-to-rated total core power ratio (QTH/HY) exceeds ARSCRM.

TDELSC(3) Delay time: control rods movement starts TDELSC(3) seconds after the condition on ARSCRM had been met, (s).

612400 WMINSC,TDELSC(4) (I6,4X,2E10.3)

WMINSC Minimum allowed water level in the vessel relative to the Downcomer 1 inlet, (m) for scram.

TDELSC(4) Delay time: control rods movement starts TDELSC(4) seconds after the water level had dropped below WMINSC, (s).

612500 WMAXSC,TDELSC(5) (I6,4X,2E10.3)

WMAXSC Maximum allowed water level in the vessel relative to the Downcomer 1 inlet, (m) for scram.

TDELSC(5) Delay time: control rods movement starts TDELSC (5) seconds after the water level had risen above WMAXSC, (s).

4. Input Specifications

612600 PMAXSC,TDELSC(6) (I6,4X,2E10.3)

PMAXSC Maximum allowed system pressure (Pa) for scram.

TDELSC(6) Delay time: control rods movement starts TDELSC(6) seconds after the system pressure reached PMAXSC, (s).

612700 TDELSC(7) (I6,4X,E10.3)

TDELSC(7) Delay time: control rods movement starts TDELSC(7) seconds after the signal to close the main steam isolation valve has been generated, (s).

613000 (ITBX(I),I=1,5) (I6,4X,5I5)

Turbine trip Parameters. To test for a particular condition, set:

ITBX(1) = 1 Trip on time.

ITBX(2) = 1 Trip on low vessel water level.

ITBX(3) = 1 Trip on high vessel water level.

ITBX(4) = 1 Trip on low turbine inlet pressure.

ITBX(5) = 1 Trip on low system pressure.

This input is used for turbine trips and to control steam flow to the turbine if the pressure regulator model is not activated. All ITBX(I), I=1,5 are defaulted to zero: no tests.

If any of the ITBX(I), I=1,5 is non-zero, there must be a corresponding 613100 card present. If ITBX(5)=1, Card 613405 must be present. Turbine valve flow rate vs. time for this case is specified on Cards 613500.

613100 TIMETB,TDELTB(1) (I6,4X,2E10.3)

TIMETB Time of turbine trip, (s).

TDELTB(1) Delay time: turbine stop valve closure starts at time TIMETB+TDELTB(1), (s).

613200 WMINTB,TDELTB(2) (I6,4X,2E10.3)

WMINTB Minimum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for turbine trip.

TDELTB(2) Delay time: turbine stop valve closure starts TDELTB (2) seconds after the water level had dropped below WMINTB, (s).

613300 WMAXTB,TDELTB(3) (I6,4X,2E10.3)

WMAXTB Maximum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for turbine trip.

TDELTB(3) Delay time: turbine stop valve closure starts TDELTB (3) seconds after the water level had risen above WMAXTB, (s).

613400 PMINTB,TDELTB(4) (I6,4X,2E10.3)

PMINTB Minimum allowed turbine inlet pressure, (Pa) for turbine trip.

TDELTB(4) Delay time: turbine stop valve closure starts TDELTB(4) seconds after the turbine inlet pressure had dropped below PMINTB, (s).

613405 TBPSYS,TDELTB(5) (I6,4X,2E10.3)

TBPSYS Minimum system pressure, (Pa) for turbine trip.

TDELTB(5) Delay time: turbine stop valve closure starts TDELTB(5) seconds after the system pressure had dropped below TBPSYS, (s).

613500 NTRYTB (I6,4X,I5)

NTRYTB The number of pairs of entries in the turbine valve flow rate table that must follow on Card(s) 613500.

613500 (TTBX(I), I=1,NTRYTB), (WTBX(I), I=1,NTRYTB) (I6,4X,6E10.3)

These card(s) specify the arrays of the time points and of the corresponding flow rates. As many cards as necessary, same identifier.

TTBX(I) Time, (s).

WTBX(I) Turbine valve flow rate as a fraction of the flow rate just before the trip. The code performs a linear interpolation using the table [TTBX vs. WTBX].

614000 (ITQX(I),I=1,4) (I6,4X,4I5)

Recirculation Pump Trip Parameters. To test for a particular condition, set:

ITQX(1) = 1 Trip on time.

ITQX(2) = 1 Trip on turbine inlet valve closure.

ITQX(3) = 1 Trip on high system pressure.

ITQX(4) = 1 Trip on low vessel water level.

4. Input Specifications

All ITQX(I), I=1,4 are defaulted to zero: no tests. If any of the ITQX(I) is non-zero, a corresponding Card 614100 must be present. The trip shuts off the pump's electrical the motor by setting it torque equal to zero.

614100 TIMETQ,TDELRC(1) (I6,4X,2E10.3)

TIMETQ Time of recirculation pump trip, (s).

TDELRC(1) Delay time: recirculation pump is tripped at time TIMETQ+TDELRC(1), (s).

614200 TDELRC(2) (I6,4X,E10.3)

TDELRC(2) Delay time: recirculation pump is tripped TDELRC(2) seconds after the signal to close the turbine inlet valve had been generated, (s).

614300 PMAXRC,TDELRC(3) (I6,4X,2E10.3)

PMAXRC Maximum allowed system pressure (Pa) for recirculation pump trip.

TDELRC(3) Delay time: recirculation pump is tripped TDELRC(3) seconds after the maximum allowed system pressure had been reached, (s).

614400 WMINRC,TDELRC(4) (I6,4X,2E10.3)

WMINRC Minimum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for recirculation pump trip.

TDELRC(4) Delay time: recirculation pump is tripped TDELRC(4) seconds after the water level had dropped below WMINRC, (s).

615000 (ITBYX(I),I=1,2) (I6,4X,2I5)

Turbine Bypass Valve Trip Parameters. These cards are to be used to activate the bypass valve opening instead of activating the system pressure regulator. To test for a particular condition, set:

ITBYX(1) = 1 Trip on time.

ITBYX(2) = 1 Trip on closure of the turbine inlet valve.

All the ITBYX are defaulted to zero: no tests. If either of the ITBYX(I), I=1,2 is non-zero, a corresponding 615100 card must be present. The after-trip turbine bypass valve flow rate is specified on Cards 615000.

615100 TIMEBY,TDELBY(1) (I6,4X,2E10.3)

TIMEBY Time of opening of the bypass valve, (s).

TDELBY(1) Delay time: bypass valve starts to open at time TIMEBY+TDELBY(1), (s).

615200 TDELBY(2) (I6,4X,E10.3)

TDELBY(2) Delay time: bypass valve starts to open TDELBY(2) seconds after the signal to close the turbine inlet valve had been generated, (s).

615300 NTRYBY (I6,4X,I5)

NTRYBY The number of pairs of entries in the bypass valve flow rate table that must follow on Card(s) 615300.

615300 (TBYX(I),I=1,NTRYBY),(WTBYX(I),I=1,NTRYBY) (I6,4X,6E10.3)

These card(s) specify the arrays of the time points and of the corresponding flow rates. As many cards as necessary, same identifier.

TBYX(I) Time (s).

WTBYX(I) Bypass valve flow rate as a fraction of the maximum flow rate through the turbine bypass valve. See Card 880004 for the maximum flow rate. The code performs a linear interpolation using the table [TBYX vs. WTBYX].

616000 (ICIX(I),I=1,2) (I6,4X,2I5)

HPCI (High Pressure Coolant Injection) Parameters. To test for a particular condition, set:

ICIX(1) = 1 Test on time.

ICIX(2) = 1 Test on "low-high" vessel water level.

All ICIX(I), I=1,2 are defaulted to zero: no tests. If any of ICIX(I) is non-zero, corresponding 616100 cards must be present and the HPCI flow rate must be specified on Cards 616400 and 616600.

616100 TIMECI,TDELCI(1) (I6,4X,2E10.3)

TIMECI Time of HPCI activation, (s).

TDELCI(1) Delay time: HPCI is activated at time TIMECI+TDELCI(1),(s).

616200 WMINCI,TDELCI(2) (I6,4X,2E10.3)

WMINCI Minimum allowed vessel water level relative to the inlet to the Downcomer 1, (m).

TDELCI(2) Delay time (s). HPCI is activated TDELCI(2) seconds after the water level had dropped below WMINCI.

616300 WMAXCI,TDELCI(3) (I6,4X,2E10.3)

WMAXCI Maximum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for HPCI shutoff.

4. Input Specifications

TDELCI(3) Delay time (s). HPCI is shut off TDELCI(3) seconds after the water level had risen above WMAXCI.

616400 NTRYCI (I6,4X,I5)

NTRYCI ≤ 10 The number of pairs of entries in the HPCI flow rate table that must follow on Card(s) 616400.

616400 (TCIX(I),I=1,NTRYCI),(WCIX(I),I=1,NTRYCI) (I6,4X,6E10.3)

These card(s) specify the arrays of the time points and of the corresponding flow rates after HPCI activation. As many cards as necessary, same identifier.

TCIX(I) Time, (s).

WCIX(I) HPCI flow rate, (kg/s). The code performs a linear interpolation by using the table [TCIX vs. WCIX]. If the range of the time array, TCIX is exceeded, the last value of WCIX array is used.

616500 TCI,EPG,RLVTAF,WHPCIR (I6,4X,4E10.3)

TCI HPCI water temperature (°C).

EPG Option switch for automatic level control per emergency procedure guidelines (EPG). (0=No, 1=Yes).

RLVTAF Target level setpoint for the EPG level control (m). Relative to the downcomer entrance as the reference zero.

WHPCIR Rated HPCI flow capacity (kg/s). Typical value = 359.7 kg/s.

616600 NTRYCO (I6,4X,I5)

NTRYCO ≤ 10 The number of pairs of entries in the HPCI fractional flow rate table. Cards 616600 specify HPCI flow rate during the shutoff mode.

616600 (TCIO(I),I=1,NTRYCO),(WCIO(I),I=1,NTRYCO) (I6,4X,6E10.3)

As many cards as necessary, same identifier.

TCIO(I) Time array in the time vs. fractional HPCI flow rate table, (s).

WCIO(I) HPCI fractional flow rate array: fraction of flow rate just before the system shuts off. The code performs a linear interpolation by using the [TCIO*WCIO] table. If the range of TCIO is exceeded, the last value of WCIO is used.

617000 (IRCX(I),I=1,2) (I6,4X,2I5)

RCIC (Reactor Core Isolation Cooling) Parameters. To test for a particular condition, set:

IRCX(1) = 1 Test on time.

IRCX(2) = 1 Test for low and high vessel water level.

All IRCX(I), I=1,2 are defaulted to zero: no tests. If any of the IRCX(I), I=1,2 is non-zero, the corresponding 617100 cards must be present and the RCIC flow rate must be specified on Cards 617400 and 617600.

617100 TIMERC,TDLRC(1) (I6,4X,2E10.3)

TIMERC Time of RCIC activation, (s).

TDLRC(1) Delay time: RCIC is activated at time TIMERC+TDLRC(1).

617200 WMNRC,TDLRC(2) (I6,4X,2E10.3)

WMNRC Minimum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for RCIC activation.

TDLRC(2) Delay time: RCIC is activated TDLRC(2) seconds after the water level had dropped below WMNRC, (s).

617300 WMAXRC,TDLRC(3) (I6,4X,2E10.3)

WMAXRC Maximum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for RCIC shutoff.

TDLRC(3) Delay time (s). RCIC is shut off TDLRC(3) seconds after the water level had risen above WMAXRC.

617400 NTRYRC (I6,4X,I5)

NTRYRC <10 The number of pairs of entries in the RCIC flow rate table. Card(s) 617400 specify RCIC flow rate after activation.

617400 (TRCX(I),I=1,NTRYRC),(WRCX(I),I=1,NTRYRC) (I6,4X,6E10.3)

As many cards as necessary, same identifier.

TRCX(I) Time array in the time vs. RCIC flow rate table, (s).

WRCX(I) RCIC flow rate (kg/s). The code performs a linear interpolation by using the table [TRCX vs. WRCX]. If the range of the time array, TRCX, is exceeded, the last value of WRCX is used.

617500 TRC (I6,4X,E10.3)

TRC RCIC liquid temperature (°C).

617600 NTRYRO (I6,4X,E10.3)

NTRYRO ≤ 10 The number of pairs of entries in the RCIC fractional flow rate table. Cards 617600 specify flow rate during the shutoff mode.

4. Input Specifications

617600 (TRCO(I),I=1,NTRYRO),(WRCO(I),I=1,NTRYRO) (I6,4X,6E10.3)

As many cards as necessary, same identifier.

TRCO(I) The time array (s) in the time vs. RCIC fractional flow rate table.

WRCO(I) RCIC fractional flow rate array: fraction of flow rate just before the system shuts off. The code performs a linear interpolation by using the [TRCO vs. WRCO] table. If the range of TRCO is exceeded, the last value of WRCO is used.

618000 NSR,(ISRX(I),I=1,NSR) (I6,4X,6I5)

Safety and Relief Valves (S/Rvs) Parameters.

NSR ≤ 5 The number of S/RV banks represented.

ISRX(I) = 0 No test for bank I. Default: valve closed permanently, ISR(I)=0.

 = 1 Test on time. Cards 618100 and 618300 must be present.

 = 2 Test on pressure. Cards 618200, 618201, 618300, and 618301 must be present.

618100 (TIMESR(I),I=1,NSR) (I6,4X,5E10.3)

TIMESR(I) Time at which bank I is activated, (s).

618200 (PUP(I),I=1,NSR) (I6,4X,5E10.3)

PUP(I) High pressure setpoint for opening bank I, (Pa).

618201 (PDOWN(I),I=1,NSR) (I6,4X,5E10.3)

PDOWN(I) Low pressure setpoint for closing bank I, (Pa).

618300 (TDELSR(I),I=1,NSR) (I6,4X,5E10.3)

TDELSR(I) Delay time between reaching the opening setpoint and use of the opening characteristics, (s).

618301 (TDELRS(I),I=1,NSR) (I6,4X,5E10.3)

TDELRS(I) Delay time between reaching the closing setpoint and use of the closing characteristics, (s).

618400 (WSRMAX(I),I=1,NSR) (I6,4X,5E10.3)

WSRMAX(I) Rated flow capacity per steamline for bank I, (kg/s).

4. Input Specifications

Valve characteristics $f(t)$ and $g(p)$ are given on Cards 618501, $I=0,9$. These cards must be in the order given below. There must be NSR sets of 618501 cards. See Section 5.3 in [Wulff et al. 1984] for further discussion on the valve characteristics.

618500 NV (I6,4X,I5)

NV Valve bank ID: $NV \leq NSR$. Specifications for bank NV must follow on Cards 618501 through 618509.

618501 NTRYSR(NV),NTRYRS(NV),NTRYPS(NV),NTRYSP(NV) (I6,4X,4I5)

Not more than 10 pairs in each table are allowed.

NTRYSR(NV) Number of (f_p, t_i) ordered pairs in the table opening valve bank NV.

NTRYRS(NV) Number of (f_p, t_i) ordered pairs in the table closing the valve bank NV.

NTRYPS(NV) Number of (g_p, p_i) ordered pairs in the table opening the valve bank NV.

NTRYSP(NV) Number of (g_p, p_i) ordered pairs in the table closing the valve bank NV.

618502 (TSRX(I,NV),I=1,NTRYSR(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

TSRX(I,NV) Time values (seconds after opening starts) in the (f_p, t_i) table for opening valve bank NV.

618503 (WSRX(I,NV),I=1,NTRYSR(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

WSRX(I,NV) Fractional flow rate in the (f_p, t_i) table for opening valve bank NV.

618504 (XTSR(I,NV),I=1,NTRYRS(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

XTSR(I,NV) Time values (seconds after closing starts) in the (f_p, t_i) table for closing valve bank NV.

618505 (XWSR(I,NV),I=1,NTRYRS(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

XWSR(I,NV) Fractional flow rate in the (f_p, t_i) table for closing valve bank NV.

618506 (PSRXX(I,NV),I=1,NTRYPS(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

4. Input Specifications

PSRXX(I,NV) Pressure values (Pa) in the (g_p , p_i) table for opening valve bank NV.

618507 (WPSRXX(I,NV),I=1,NTRYPS(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

WPSRXX(I,NV) Fractional lift in the (g_p , p_i) table for opening valve bank NV.

618508 (PRXX(I,NV),I=1,NTRYSP(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

PRXX(I,NV) Pressure values (Pa) in the (g_p , p_i) table for closing valve bank NV.

618509 (WPRXX(I,NV),I=1,NTRYSP(NV)) (I6,4X,6E10.3)

As many cards as necessary; same identifier.

WPRXX(I,NV) Fractional lift in the (g_p , p_i) table for closing valve bank NV.

619000 (MSIVX(I),I=1,4) (I6,4X,4I5)

Main Steam Isolation Valve (MSIV) Closure Parameters. To test for a particular condition, set,

MSIVX(1) = 1 Test on time.

MSIVX(2) = 1 Test on low vessel water level.

MSIVX(3) = 1 Test on high steamline flow rate.

MSIVX(4) = 1 Test on low system pressure.

All MSIVX(I), I=1,4 are defaulted to zero: no tests. If any of MSIVX(I), I=1,4 is non-zero, a corresponding Card 619100 must be present. Table for MSIV flow rate vs. time is specified on Cards 619500.

619100 TIMEMS,TDELMS(1) (I6,4X,2E10.3)

TIMEMS Time at which the signal for MSIV closure is generated, (s).

TDELMS(1) Delay time: MSIV starts to close at time TIMEMS+TDELMS(1), (s).

619200 WMINMS,TDELMS(2) (I6,4X,2E10.3)

WMINMS Minimum allowed vessel water level relative to the inlet to the Downcomer 1, (m) for MSIV closure.

TDELMS(2) Delay time: MSIV closure starts TDELMS(2) seconds after the water level had dropped below WMINMS, (s).

619300 WSLMS,TDELMS(3) (I6,4X,2E10.3)

WSLMS Maximum allowed steamline flow rate-steam flow rate at the MSIV location, (kg/s) for MSIV closure.

TDELMS(3) Delay time: MSIV closure starts TDELMS(3) seconds after the steamline flow rate had exceeded WSLMS, (s).

619400 PMINMS,TDELMS(4) (I6,4X,2E10.3)

PMINMS Minimum system pressure, (Pa) for MSIV closure.

TDELMS(4) Delay time: MSIV closure starts TDELMS(4) seconds after the system pressure had dropped below PMINMS, (s).

619500 NTRYMS (I6,4X,I5)

NTRYMS ≤ 10 Number of pairs of entries in the MSIV closure steam flow rate table. The table must follow on Cards 619500.

619500(TMSIVT(I),I=1,NTRYMS),(WMSIVT(I),I=1,NTRYMS)(I6,4X,6E10.3)

As many cards as necessary; same identifier.

TMSIVT(I) The time array: seconds after initiation of MSIV closure, (s).

WMSIVT(I) The flow rate array: fraction of the value just before the MSIV closure had been initiated.

620000 NOR,RODINS,(IDUM(I),I=1,NOR) (I6,I3,1X,E10.3,12I5)

As many cards as necessary, same identifier. One card for each value of RODINS. These, cards specify the initial position of the control rods.

NOR Number of control rod groups with identical insertion RODINS.

RODINS Control rod insertion: distance between the rod's tip and the bottom of the core. The distance is measured in the units of axial cells; for example, RODINS=3.5 specifies the middle of cell 3.

IDUM(I) Control rod I identifier as was used on Card 330000 (i.e., NKNR).

The control rods which are not specified on these cards are assumed to have zero insertions.

621000 RRGCV,XKCV,TCMCV,TCDCV,TCRCV,TCVCV,WFQCV (I6,4X,7E10.3)

The pressure regulator input data are read from Cards 621000 through 621300.

RRGCV Gain factor for pressure setpoint adjustment (N/m^2).

XKCV Gain factor for a lead/lag compensator per (N/m^2).

4. Input Specifications

TCMCV	Time lag for pressure signal in (s).
TCDCV	Lead time for pressure regulator in (s).
TCRCV	Lag time for pressure regulator in (s).
TCVCV	Damping coefficient for turbine control/stop valve actuator.
WFQCV	Natural frequency for turbine control/stop valve actuator.

621100 PSRGCV,SVRGCV (I6,4X,2E10.3)

PSRGCV	Turbine control valve pressure setpoint in (N/m ²).
SVRGCV	Initial turbine control valve position (fraction).

621200 RRGBY,XKBY,TCMBY,TCDBY,TCRBY,TCVBY,WFQBY (I6,4X,7E10.3)

RRGBY	Generator load rejection signal (0=Yes, 1=No).
XKBY	Load setpoint ($0 \leq XKBY \leq 1$).
TCMBY	Load bias ($0 \leq TCMBY \leq 1$).
TCDBY	Turbine bypass valve bias ($0 \leq TCDBY \leq 1$).
TCRBY	Manual turbine bypass override ($0 \leq TCRBY \leq 1$).
TCVBY	Damping coefficient for bypass valve actuator.
WFQBY	Natural frequency for bypass valve actuator.

621300 SPRO,SPRC,FTEM,FTCOF (I6,4X,4E10.3)

SPRO	Turbine control valve stuck open signal (0=No, 1=Yes).
SPRC	Turbine control valve stuck closed signal (0=No, 1=Yes).
FTEM	Pressure drop across turbine control valve in (N/m ²).
FTCOF	Not used at present.

622000 DPTSV,DPHPT,PCRO,PC0,VLC,VC (I6,4X,6E10.3)

The BOP input data are read from Cards 622000 through 622800.

DPTSV	Pressure drop across turbine stop valve in (N/m ²).
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4. Input Specifications

DPHPT	Pressure drop across high-pressure turbine in (N/m ²).
PCRO	Cross-over pressure setpoint in (N/m ²).
PC0	Initial condenser pressure in (N/m ²).
VLC	Total liquid volume of condenser in (m ³).
VC	Total volume of condenser in (m ³).

622100 OMEGA0,PHFWP,PHCBP,FWSHS0,SA,SB,SC (I6,4X,7E10.3)

OMEGA0	Initial angular speed of feedwater pump in rad/s.
PHFWP	Feedwater pump head in (m).
PHCBP	Condensate booster pump head in (m).
FWSHS0	Fraction of extraction steam from high-pressure turbine.
SA	Feedwater pump head coefficient 1 (see Eq. (5.5.34))*.
SB	Feedwater pump head coefficient 2 (see Eq. (5.5.34))*.
SC	Feedwater pump head coefficient 3 (see Eq. (5.5.34))*.

622200 SP,SQ,SR,SS,RIFWP,SWFTV0,TCIR (I6,4X,7E10.3)

SP	Feedwater pump torque coefficient 1 (see Eq. (5.5.45))*.
SQ	Feedwater pump torque coefficient 2 (see Eq. (5.5.45))*.
SR	Feedwater pump torque coefficient 3 (see Eq. (5.5.45))*.
SS	Feedwater pump torque coefficient 4 (see Eq. (5.5.45))*.
* See the companion model description report [Rohatgi et al. 1996].	
RIFWP	Feedwater pump inertia in (kg m ²), (or Nm s ²).
SWFTV0	Initial feedwater turbine mass flow rate in (kg/s).
TCIR	Temperature of circulating water in condenser in (°C).

622300 TAUPL3,TAUHFW,TAUHTE,EFFFWT,RNUHPT0,RNULPT0,FBPV (I6,4X,7E10.3)

TAUPL3	Time constant for upstream pressure of low-pressure turbine, (s).
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4. Input Specifications

TAUHFV	Time constant for feedwater enthalpy in (s).
TAUHTF	Time constant for feedwater heater failure in (s).
EFFFWT	Feedwater turbine efficiency (fraction).
RNUHPT0	High-pressure turbine speed ratio at rated condition.
RNULPT0	Low-pressure turbine speed ratio at rated condition.
FBPV	Turbine bypass flow fraction.

622400 CFTV1,CFTV2,CFTV3,CFTV4,WFTVMX,RNUFWT0,FHTDC (I6,4X,7E10.3)

CFTV1	Feedwater turbine valve coefficient 1 (see Eq. (5.5.6))*.
CFTV2	Feedwater turbine valve coefficient 2 (see Eq. (5.5.6))*.
CFTV3	Feedwater turbine valve coefficient 3 (see Eq. (5.5.6))*.
CFTV4	Feedwater turbine valve coefficient 4 (see Eq. (5.5.6))*.
WFTVMX	Maximum feedwater turbine mass flow rate in kg/s.
RNUFWT0	Feedwater turbine speed ratio at rated condition.
FHTDC	Fraction of heat transfer in drain cooler of feedwater heaters.

* See the companion model description report [Rohatgi et al. 1996].

622500 NHTRBP,NHTF,RSTARHP,ALFAHP,RSTARLP,ALFALP,DTAFWR (I6,4X,2I10,5E10.3)

NHTRBP	Total number of feedwater heaters
NHTF	Number of feedwater heaters that are failed
RSTARHP	Theoretical degree of reaction for HP turbine
ALFAHP	Rotor entrance flow angle for HP turbine in radian
RSTARLP	Theoretical degree of reaction for LP turbine
ALFALP	Rotor entrance flow angle for LP turbine in radian
DTAFWR	Delay time for automatic feedwater runback (s). (For SBWR only).

622600 R2R1HP,PHIHP,PHIRHP,PSIHP,FRHHP,PHIEHP,VM21HP (I6,4X,7E10.3)

R2R1HP	Mean radius ratio for high-pressure (HP) turbine.
PHIHP	Velocity coefficient of stator loss for HP turbine.
PHIRHP	Carry-over coefficient for high-pressure turbine.
PSIHP	Velocity coefficient of rotor loss for HP turbine.
FRHHP	Reheat factor for high-pressure turbine.
PHIEHP	Exit kinetic energy recovery for HP turbine.
VM21HP	Meridian velocity ratio for high-pressure turbine.

622700 R2R1LP,PHILP,PHIRLP,PSILP,FRHLP,PHIELP,VM21LP (I6,4X,7E10.3)

R2R1LP	Mean radius ratio for low-pressure (LP) turbine.
PHILP	Velocity coefficient of stator loss for LP turbine.
PHIRLP	Carry-over coefficient for low-pressure turbine.
PSILP	Velocity coefficient of rotor loss for LP turbine.
FRHLP	Reheat factor for low-pressure turbine.
PHIELP	Exit kinetic energy recovery for low-pressure turbine.
VM21LP	Meridian velocity ratio for low-pressure turbine.

622800 SFWPT,SFWCV,SHTRF,DTFWPT,DTFWCV,DTHTRF,PAFWRB (I6,4X,7E10.3)

SFWPT	Feedwater pump trip signal (0=tripped, 1=No trip)
SFWCV	Feedwater check valve failure signal (0=Yes, 1=No)
SHTRF	Feedwater heater failure signal (0=No, 1=Yes)
DTFWPT	Delay time for feedwater pump trip in sec
DTFWCV	Delay time for feedwater check valve closure in sec
DTHTRF	Delay time for feedwater heater failure in sec
PAFWRB	Pressure setpoint for the automatic feedwater runback (N/m^2). (For SBWR only).

4. Input Specifications

623000 IRWCU,N1RWCU,N2RWCU (I6,4X,3I5)

This card is needed for the new reactor water cleanup (RWCU) system model if IRWCU=1.

IRWCU	Option switch for RWCU. (0=No, 1=Yes).
N1RWCU	Cell index number where RWCU system enters pressure vessel. Note: cell index = 2 at downcomer entrance.
N2RWCU	Cell index number where RWCU system leaves pressure vessel.

623100 WRWCU,TRWCU,CRWCU,TSRWCU,TERWCU (I6,4X,5E10.3)

This card is needed for the new reactor water cleanup (RWCU) system model if IRWCU=1.

WRWCU	RWCU flow capacity (kg/s). Typical value = 10.73 kg/s.
TRWCU	RWCU water temperature (°C).
CRWCU	Not used.
TSRWCU	Start time to activate the RWCU system (s).
TERWCU	End time to terminate the RWCU system (s).

623200 SLVMIN,SLVMAX,TRMN,FRWC,REKS,REKW,REKT (I6,4X,7E10.3)

This card is needed for the new reactor water cleanup (RWCU) system model if IRWCU=1.

SLVMIN	Minimum limit on the level error signal (m).
SLVMAX	Maximum limit on the level error signal (m).
TRMN	Minimum limit on the combined level and flow error signal (m).
FRWC	Multiplier for the maximum limit on the combined level and flow error signal, where $TRMX = FRWC * TRMN $.
REKS	Proportional constant of the PID controller for level error signal.
REKW	Multiplier for the flow error signal. Total Error = Level Error + REKW*(Flow error).
REKT	Proportional constant of the PID controller for combined level and flow error signal.

623300 TAULV,TAUSL,TAUIS,TAUDS,TAUFWF,TAUIT,TAUDT (I6,4X,7E10.3)

This card is needed for the new reactor water cleanup (RWCU) system model if IRWCU=1.

TAULV	Time lag for the sensed level (s).
TAUSL	Time lag for the sensed steam flow (s).
TAUIS	Time constant for the PID integrator for the level error signal (s).
TAUDS	Time constant for the PID differentiator for level error signal (s).
TAUFWF	Time lag for the sensed feedwater flow (s).
TAUIT	Time constant for the PID integrator for the combined level and flow error signal (s).
TAUDT	Time constant for the PID differentiator for the combined level and flow error signal (s).

624000 ISTAGE,NSEP (I6,4X,2I5)

This card is needed for the new mechanistic steam separator model if ISTAGE#0.

ISTAGE	Option switch for the new steam separator model. ISTAGE = 0, old simplistic model; ISTAGE = 2, 2-stage mechanistic steam separator model; ISTAGE = 3, 3-stage mechanistic steam separator model.
NSEP	Number of steam separators.

624100 RR1,AI,AN,RH,THETA,CWFCO,CWGCU (I6,4X,7E10.3)

This card is needed for the new mechanistic steam separator model if ISTAGE#0.

RR1	Radius of larger pickoff ring at 1st stage of 2-stage separator (m). Default = 0.0857208 m.
AI	Standpipe flow area (m ²). Default = 0.018637 m ² .
AN	Separator nozzle exit area (m ²). Default = 0.01441 m ² .
RH	Radius of separator hub at inlet (m). Default = 0.0809585 m.
THETA	Swirl vane angle relative to the horizontal (deg). Default = 48 deg.
CWFCO	Liquid carryover coefficient for upper separating stages. Default = 0.009 for 2-stage and 0.11 for 3-stage separator.
CWGCU	Vapor carryunder coefficient for upper separating stages. Default = 0.0004.

4. Input Specifications

624200 DPE,AAS(1),AAS(2),AAS(3),BBS(1),BBS(2),BBS(3) (I6,4X,7E10.3)

This card is needed for the new mechanistic steam separator model if ISTANCE#0.

DPE	Initial pressure drop across the separator (N/m^2).
AAS(1)	Liquid film void profile coefficient of 1st stage. Default = 110.
AAS(2)	Liquid film void profile coefficient of 2nd stage. Default = 20.
AAS(3)	Liquid film void profile coefficient of 3rd stage. Default = 20.
BBS(1)	Vapor core void profile coefficient of 1st stage. Default = 0.5.
BBS(2)	Vapor core void profile coefficient of 2nd stage. Default = 0.25.
BBS(3)	Vapor core void profile coefficient of 3rd stage. Default = 0.55.

624300 HSKS(1),HSKS(2),HSKS(3),RWS(1),RWS(2),RWS(3) (I6,4X,6E10.3)

This card is needed for the new mechanistic steam separator model if ISTANCE#0.

HSKS(1)	Axial distance between exit of 1st stage discharge passage and swirl vanes (m). Default = 0.2127 for 2-stage separator and 0.45083 for 3-stage separator.
HSKS(2)	Axial distance between exit of 1st stage discharge passage and swirl vanes (m). Default = 0.2127 for 2-stage separator and 0.45083 for 3-stage separator.
HSKS(3)	Axial distance between exit of 1st stage discharge passage and swirl vanes (m). Default = 0.2127 for 2-stage separator and 0.45083 for 3-stage separator.
RWS(1)	Separator wall inner radius of 1st stage (m). Default = 0.10794 m.
RWS(2)	Separator wall inner radius of 2nd stage (m). Default = 0.06985 m for 2-stage and 0.10794 m for 3-stage.
RWS(3)	Separator wall inner radius of 3rd stage (m). Default = 0.10794 m.

624400 RRS(1),RRS(2),RRS(3),ADS(1),ADS(2),ADS(3) (I6,4X,6E10.3)

This card is needed for the new mechanistic steam separator model if ISTANCE#0.

RRS(1)	Pickoff ring inner radius of 1st stage (m). Default = 0.069875 m for 2-stage and 0.0857208 m for 3-stage.
RRS(2)	Pickoff ring inner radius of 2nd stage (m). Default = 0.06032 m for 2-stage and 0.0952453 m for 3-stage.

4. Input Specifications

RRS(3) Pickoff ring innerradius of 3rd stage (m). Default = 0.0984201 m.

ADS(1) Discharge passage flow area of 1st stage (m^2).
Default = 0.041578 m^2 for 2-stage and 0.0096265 m^2 for 3-stage.

ADS(2) Discharge passage flow area of 2nd stage (m^2).
Default = 0.002913 m^2 for 2-stage and 0.0096265 m^2 for 3-stage.

ADS(3) Discharge passage flow area of 3rd stage (m^2). Default = 0.0096265 m^2 .

624500 DDS(1),DDS(2),DDS(3),HDS(1),HDS(2),HDS(3) (I6,4X,6E10.3)

This card is needed for the new mechanistic steam separator model if ISTAGE $\neq$ 0.

DDS(1) Discharge passage hydraulic diameter of 1st stage (m).
Default = 0.045558 m for 2-stage and 0.025399 m for 3-stage.

DDS(2) Discharge passage hydraulic diameter of 2nd stage (m).
Default = 0.0121699 m for 2-stage and 0.025399 m for 3-stage.

DDS(3) Discharge passage hydraulic diameter of 3rd stage (m). Default = 0.025399 m.

HDS(1) Separating barrel length of 1st stage (m).
Default = 0.877845 m for 2-stage and 1.0699 m for 3-stage.

HDS(2) Separating barrel length of 2nd stage (m).
Default = 0.16255 m for 2-stage and 0.384156 m for 3-stage.

HDS(3) Separating barrel length of 3rd stage (m). Default = 0.384156 m.

624600 CKS(1),CKS(2),CKS(3),ELA(1),ELA(2),ELA(3) (I6,4X,6E10.3)

This card is needed for the new mechanistic steam separator model if ISTAGE $\neq$ 0.

CKS(1) Discharge passage loss coefficient of 1st stage.
Default = 10.0 for 2-stage and 2.5 for 3-stage separator.

CKS(2) Discharge passage loss coefficient of 2nd stage.
Default = 0.5 for 2-stage and 1.429 for 3-stage separator.

CKS(3) Discharge passage loss coefficient of 3rd stage. Default = 2.563.

ELA(1) Discharge passage effective L/D coefficient of 1st stage, where L is length and D is diameter.
Default = 450.0 for 2-stage and 53.44 for 3-stage separator.

ELA(2) Discharge passage effective L/D coefficient of 2nd stage.
Default = 95.85 for 2-stage and 194.64 for 3-stage separator.

ELA(3) Discharge passage effective L/D coefficient of 3rd stage. Default = 424.96.

4. Input Specifications

Containment Model Input Cards: 625000 through 625900

625000 IPSP,IDFINP (I6,4X,2I5)

This card is needed for containment model option.

IPSP Option switch for containment model
 = 0, no containment calculation requested,
 = 1, simplistic model,
 = 2, detailed mechanistic model (recommended).

IDFINP Default input option switch
 = 0, input your own data,
 = 1, use built-in default data.

625100 PRPSP,TPSP,RMLPSP,WRHR,TRHR,WSRW,AUCP,NRHR (I6,4X,7E10.3,I5)

This card is for the simplistic model option IPSP=1.

PRPSP Suppression pool pressure (N/m^2)

TPSP Initial suppression pool temperature ($^{\circ}\text{C}$)

RMLPSP Initial suppression pool liquid mass (kg)

WRHR Flow capacity of Residual Heat Removal (RHR) system per pump (kg/s)

TRHR Inlet temperature of the RHR system (service water temperature) ($^{\circ}\text{C}$)

WSRW Mass flow rate of service water per pump (kg/s)

AUCP Overall heat transfer coefficient times heat transfer area over specific heat of the RHR system (kg/s)

NRHR Number of RHR pumps (typically, 4)

625200 RMAJOR,RMINOR,ACST,ABFW,ABRL,ABSL,TAU0 (I6,4X,7E10.3)

Cards 625200 through 625900 are for the detailed mechanistic containment model.

RMAJOR Major radius of wetwell torus (m)

RMINOR Minor radius of wetwell torus (m)

ACST Cross sectional area of condensate storage tank (m^2)

ABFW Break area of feedwater line break, if any (m^2)

4. Input Specifications

ABRL	Break area of recirculation line break, if any (m ²)
ABSL	Break area of steam line break, if any (m ²)
TAU0	Relaxation time constant for vapor condensation (s)

625300 AL1,AW1,TRHRON,TRHROF,SW1,SW2,T0 (I6,4X,7E10.3)

AL1	Cross sectional area of drywell (m ²)
AW1	Drywell wall surface area (m ²)
TRHRON	Time to turn on RHR cooling (s)
TRHROF	Time to turn off RHR cooling (s)
SW1	Drywell wall thickness (m)
SW2	Wetwell wall thickness (m)
T0	Initial drywell wall/liquid interface temperature (°C)

625400 CLPCI,CCSS,PLPCI,PCSS,RHOCS1,RHOCS2,URPV (I6,4X,7E10.3)

CLPCI	Volumetric flow capacity of Low Pressure Coolant Injection (LPCI) system (m ³ /s)
CCSS	Volumetric flow capacity of Core Spray System (CSS) (m ³ /s)
PLPCI	Pressure setpoint for LPCI system activation (N/m ²)
PCSS	Pressure setpoint for CSS activation (N/m ²)
RHOCS1	Heat capacity of drywell wall (W/°C)
RHOCS2	Heat capacity of wetwell wall (W/°C)
URPV	Overall heat transfer coefficient times heat transfer area between drywell and reactor pressure vessel (RPV) (W/°C)

625500 LSUMP,HUMC1,HUMC2,TSRW1,TSRWI,VCMPR,VCSTMX (I6,4X,7E10.3)

LSUMP	Initial drywell sump liquid level (m)
HUMC1	Initial drywell relative humidity (typically, 0.4)
HUMC2	Initial wetwell relative humidity (typically, 0.9999)

4. Input Specifications

TSRW1	Drywell service water temperature ($^{\circ}\text{C}$)
TSRWI	RHR cooler inlet temperature ($^{\circ}\text{C}$)
VCMPR	Volumetric flow capacity of wetwell compressor (m^3/s)
VCSTMX	Condensate storage tank volume (m^3)

625600 VOLC1,VOLC2,W12MAX,W21MAX,WCLR1,WCRDHS,WCSP0 (I6,4X,7E10.3)

VOLC1	Total volume of drywell (m^3)
VOLC2	Total volume of wetwell (m^3)
W12MAX	Maximum allowable flow rate from drywell to wetwell (kg/s)
W21MAX	Maximum allowable flow rate from wetwell to drywell (kg/s)
WCLR1	Total flow capacity of drywell coolers (kg/s)
WCRDHS	Total flow rate of control rod drive hydraulic system (kg/s)
WCSP0	Total flow capacity of core spray system pumps (kg/s)

625700 TWWSC,TCRDHS,WLKV0,WRHR0,WSPR20,WSRW1,WSRW2 (I6,4X,7E10.3)

TWWSC	Time to turn off wetwell spray cooling (s). (Spray cooling is automatically turned on).
TCRDHS	Time to turn off CRDHS flow (s). (CRDHS flow is normally always on).
WLKV0	Drywell leakage flow rate to reactor building, if any (kg/s)
WRHR0	Total flow capacity of all RHR pumps (kg/s)
WSPR20	Total flow capacity of wetwell spray system (kg/s)
WSRW1	Service water flow rate per drywell cooler (kg/s)
WSRW2	Service water flow rate per RHR pump (kg/s)

625800 NRHR,NLPCI,NCSP,NCLR1,TLPCI,TCSPS,TSLB,TRLB,TFWB (I6,4X,4I5,5E10.3)

NRHR	Number of active RHR cooling pumps (typically, 4)
NLPCI	Number of active LPCI cooling pumps (typically, 4)
NCSP	Number of active core spray system pumps (typically, 4)

4. Input Specifications

NCLR1	Number of active drywell coolers (typically, 10)
TLPCI	Time to turn off LPCI cooling (s) (LPCI cooling is turned on automatically via pressure setpoint)
TCSPS	Time to turn off core spray system cooling (s) (CSS cooling is turned on automatically via pressure setpoint)
TSLB	Time to initiate steam line break (s) (Set to a large number, say 1.0E+9, to indicate no break)
TRLB	Time to initiate recirculation line break (s) (Set to a large number, say 1.0E+9, to indicate no break)
TFWB	Time to initiate feedwater line break (s) (Set to a large number, say 1.0E+9, to indicate no break)

625900 PGC1,TGC1,PGC2,TGC2,TCPOOL,LPOOL,LCST (I6,4X,7E10.3)

PGC1	Initial drywell gas pressure (N/m ²)
TGC1	Initial drywell gas temperature (°C)
PGC2	Initial wetwell gas pressure (N/m ²)
TGC2	Initial wetwell gas temperature (°C)
TCPOOL	Initial suppression pool temperature (°C)
LPOOL	Initial suppression pool level (m) (Typically, 4 inches below torus midplane)
LCST	Initial liquid level of condensate storage tank (m)

631000 LHS (10X,I5)

LHS	= 0	No Heat Structure Calculation.
	= 1	Normal Heat Structure Calculation.

632000 (NSLAB(I),I=1,6) (10X,14I5)

NSLAB	Number of heat structure surfaces per component.
-------	--

4. Input Specifications

633000 (MATL(1,I),I=1,6) (10X,14I5)

MATL(1,I) Material of the first heat structure (per component).

MATL = 1 Stainless Steel.

 = 2 Zirconium.

634000 (MATL(2,I),I=1,6) (10X,14I5)

MATL(2,I) Material of the second heat structure.

635000 (THICK(1,I),I=1,6) (10X,10E10.3).

THICK(1,I) Thickness of first heat structure (m).

636000 (THICK(2,I),I=1,6) (10X,10E10.3)

THICK(2,I) Thickness of second heat structure (m).

637000 (SAREA(1,I),I=1,6) (10X,10E10.3)

SAREA(1,I) Surface area of first heat structure (m^2).

638000 (SAREA(2,I),I=1,6) (10X,10E10.3)

SAREA(2,I) Surface area of second heat structure (m^2).

639100 THICD,SAREAD1,SAREAD2,PERIM,THICB (10X,10E10.3)

THICD Thickness of the steam dome structure (m).

SAREAD1 Surface area of the upper dome (m^2).

SAREAD2 Surface area of the vertical section of the dome (m^2).

PERIM Perimeter of one fuel assembly (1 box) (m).

THICB Thickness of the bypass channel (m).

639200 TAIRHS,CONAT,TAIRD,TSD1,TSD2 (10X,10E10.3)

TAIRHS Temperature of surrounding air ($^{\circ}\text{C}$).

CONAT Coefficient in the natural convection equation for air.

TAIRD Temperature of air around the dome ($^{\circ}\text{C}$).

TSD1 Initial temperature of upper dome (°C).

TSD2 Initial temperature of vertical section of the dome (°C).

639300(TSO(I),I=1,6) (10X,10E10.3)

TSO Initial temperature of the outer structures in each component (°C).

639400(HCOFA(I),I=1,6) (10X,10E10.3)

HCOFA Heat transfer coefficient of air to structure. If this is equal to 0.0, the code uses a built in relation, (Watts/m²-°C).

639500(RNAKC(K),K=1,NCC) (10X,6E10.3)

RNAKC Number of assemblies per hydraulic channel.

661010 LIC,LID(I6,4X,I5)

LIC Logic for isolation condenser (IC) Operation.

- = 0 No IC,
- = 1 Normal IC,
- = 2 Abnormal IC (needs Card 661020).

LID Logic for Steam Line Connection.

- = 0 No Steam Line Connection to IC (BWR).
- = 1 Steam Line Connected to IC (SBWR).

661020 TZERO (I6,4X,E10.3)

TZERO Forced Valve Opening Time (for LIC=2).

661030 DIVAL,DTDEL,DTVAL (I6,4X,3E10.3)

DIVAL Valve Equivalent Diameter (m).

DTDEL Time Delay in Valve Activation (s).

DTVAL Time Delay in Valve Opening (s).

661100 VPOOL,PPOOL,TPOOL (I6,4X,3I0.3)

VPOOL IC Pool Volume (m³).

4. Input Specifications

PPOOL IC Pool Pressure (Pa).

TPOOL IC Pool Temperature (K).

661200 DTUBEI,DTUBE,CONTUBE,NTUBE,LTUBE (I6,4X,5I0.3)

DTUBEI Tube Inner Diameter (m) of IC tubes.

DTUBE Tube Outer Diameter (m) of IC tubes.

CONTUBE Tube Material Conductivity W/mK .

NTUBE Number of Tubes.

LTUBE Length of Tubes (m).

661300DD1,DD2,LDRUM (I6,3X,3I0.3)

DD1 Upper Drum Diameter (m) of IC.

DD2 Lower Drum Diameter (m) of IC.

LDRUM Drum Length (m) of IC.

661400 AKV,AKL,TAUICS,TAUICL,RFOUL(I6,4X,5E10.3)

AKV Flow Loss Coefficient in Steamline of IC.

AKL Flow Loss Coefficient in Liquid Line of IC.

TAUICS Time Lag for IC Steamline.

TAUICL Time Lag for IC Liquid Line.

RFOUL Resistance due to fouling W/Mk.

661500 DRETURN,LRETURN (I6,4X,2E10.3)

DRETURN Liquid Return Line Diameter (m).

LRETURN Liquid Return Line Elevation (m).

661600 ZMAX,ZO,DCEN,ZICEN,NIC (I6,4X,4E10.3)

ZMAX Maximum Height (m) of IC.

ZO Not used (Liquid Line Height) (m).

4. Input Specifications

DCEN Downcomer Entrance Elevation (m).
ZICEN Location of IC Return Line (m).
NIC Number of Operating ICS.

6610700 ASIN,AOUT,AREAC (I6,4X,3E10.3)

ASIN Steamline Pipe Area (m²) of IC.
AOUT Liquid Outlet Pipe area (m²) of IC.
AREAC Tube Surface Area (m²) of IC.

661800 DPRO,DPTO

DPRO Initial Steamline Pressure Drop (Pa) of IC.
DPTO Initial Liquid Line Pressure Drop (Pa) of IC.

661900 ITERMAX (I6,4X,I5)

ITERMAX Maximum Number of Iterations (For Initialization).

663100 QUALIC,QOLDIN (I6,4X,2E10.3)

QUALIC Initial Quality in IC.
QOLDIN Initial Heat Removal Rate (kJ/s) in IC.

663200 IGAS (I6,4X,I5)

IGAS Logic for Non-Condensiable Gas in IC.

663300 PMAXIC,ZSTEAM (I6,4X,2E10.3)

PMAXIC Maximum Pressure for IC Activation (Pa).
ZSTEAM Length of IC Steamline (m).

4. Input Specifications

663400 IPROF (I6,4X,E10.3)

IPROF Logic for Pool Heat Transfer Coefficient Profile.

IPROF = 0 Assume Constant Profile.

IPROF = 1 Use Given Radial Profile.

663500 NGC (I6,4X,I5)

NGC Number of Groups for Radoal Profile (if IPROF=1).

663600 HFRAC,NTC (1 to NGC) (I6,4X,6E10.3)

HFRAC Heat Transfer Coefficient Modifier for a Group.

NTC Number of Tubes in each Group.

4.3.7 Card Type 7 - Neutronics Time Step, Printing and Accuracy Control, Decay Heat Model, Control Rods Movement

710000 INTTYP,NG,IPMAX,(IPRD(I),I= 1,11) (I6,4X,14I5)

INTTYP = 0 Not used.

NG Number of delayed neutron groups, $NG \leq 6$. The delayed neutrons data are specified on Cards 741000 and 742000.

IPMAX Maximum number of inner iterations per neutronic time step in the fast flux calculation. Recommended value: IPMAX=100. This number is also used as a maximum number of iterations in the fuel conduction calculations.

IPRD(1) = 1 Subroutine DYNLST prints (a) average neutron flux and relative power every neutronic time step.

 = 2 In addition to (a): (b) core average and hot cell fuel temperatures are printed every time step.

 = 3 In addition to (a) and (b): (c) reactivity in pcm is printed every time step. Total reactivity is calculated by using the inverse in-hour (point kinetics) equation; the reactivity components are calculated from a perturbation theory.

 = 4 In addition to (a), (b), and (c): (d) the average delayed neutron precursor concentrations are printed every time step. If IPRD(1) > 0, print for every time step. If IPRD(1) < 0, print only IPRD(2) times per second of transient time.

4. Input Specifications

- IPRD(2) The requested information is printed IPRD(2) times per second of transient time.
- IPRD(3) = 0 No fuel conduction prediction in transient calculation.
- = 1 Fuel conduction prediction is performed in transient calculation.
- IPRD(4) = 0 No printed output of neutron flux or power distributions.
- = 1 Print data on normalized neutron flux for every cell.
- = 2 Print data on normalized fission power distribution for every cell, vertical and horizontal average power distributions, and control rod insertion positions.
- = 3 Same as 2 with the addition of the normalized flux distribution (i.e., options IPRD(4)=1 and IPRD(4)=2 combined).
- IPRD(5) = 1 No supplementary print upon beginning of the neutronic integration.
- = - 1 Supplementary print upon beginning of the neutronic integration: predictor-corrector error and integration step are printed.
- IPRD(6) > 0 Results are written to the summary file every neutronic time step.
- < 0 Results written to the summary file IPRD(2) times per second of real time. If $|\text{IPRD}(6)| > 1$, hydraulic data are not written to the summary file.
- IPRD(7) = 0 No printed output of the vertical and horizontal average power distributions and the control rod insertion positions.
- = 1 Print the vertical and horizontal average power distributions and the control rod insertion positions.
- = -1 Print the vertical and horizontal average power distributions IPRD(2) times per second of transient time along with the control rod insertion positions. Applies only if $|\text{IPRD}(4)|=0$ or 1. IPRD(4)=2 through 4 automatically sets IPRD(7)=1.
- IPRD(8) The transient calculation starts at a negative time $-\text{IPRD}(8) \cdot H$ (H is the time step). RAMONA-4B starts from a negative value of the transient time and marches to time zero. $\text{IPRD}(8) \geq 1$.

720000 H,HMAX,ACCF,DPJ,ROCF,RCCA (I6,4X,7E10.0)

H Initial neutronic time step, (s). Recommended value: $H=0.005\text{s}$.

HMAX Maximum neutronic time step, (s). Recommended value: $HMAX=0.3\text{ s}$. Minimum neutronic time step is set to $0.001 \cdot HMAX\text{ s}$.

4. Input Specifications

ACCF Time step size control for neutron flux. The relative error between the predicted and corrected core-averaged fast flux is compared with 2 X ACCF. The step size is then reduced or increased depending on the results of the comparison. The last step calculation results can be accepted or repeated according to criteria described in [Wulff et al. 1984], Equation (6.7.20). Recommended value: ACCF=0.01.

DPJ Accuracy test for the fast-flux inner iteration loop during transient calculations. See Chapter 6.7.1.1, Equation (6.7.2) in [Wulff et al. 1984]. Recommended value: DPJ=1.0E-3.

ROCF Volumetric heat capacity of fuel, $\rho_f C_{pf}$ (J/m³/°C).

RCCA Volumetric heat capacity of cladding, $\rho_c C_{p,c}$ (J/m³/°C).

730000 VEL1,VEL2,QUP,QUD,QMP,QMD (I6,4X,7E10.0)

VEL1 Velocity of fast neutrons, (cm/s). VEL1 < 0.0 sets infinite velocity for the fast neutrons (prompt-jump approximation).

VEL2 Velocity of thermal neutrons, (cm/s). See Chapter 2.6.1 in [Wulff et al. 1984].

QUP Variable not used.

QUD Variable not used.

QMP Variable not used.

QMD Variable not used.

740000 IOPTDY,IPRTDY,CMPFRC,CMDFRC,UPTIME,SSPOWR,FR239,FR238 (I6,4X,2I5,6E10.3)

IOPTDY Not used.

IPRTDY Not used.

CMPFRC Fraction of prompt heat deposited directly in moderator and coolant. Normally is set equal to DELTA, Card 200015.

CMDFRC Fraction of delayed heat deposited directly in moderator and coolant. Normally is set equal to DELTA and QMF, Cards 200015 and 350000, respectively.

UPTIME Exposure time, (s). This is h of Chapter 2.7.2 in [Wulff et al. 1984]. UPTIME=0.0 turns off the decay heat model.

SSPOWR This is a multiplier in front of the calculated nodal decay heat power, Equation (2.7.13) in [Wulff et al. 1984]. This is intended as a conservative factor. Recommended value: SSPOWR=1.0.

4. Input Specifications

FR239 Fraction of the decay heat from fissions in ^{239}Pu . Used in the decay heat calculation.

FR238 Fraction of the decay heat from fissions in ^{238}U . Used in the decay heat calculation.

741000 (B(I),I=1,NG)(I6,4X,6E10.0)

B(I) Delayed neutron fraction of the I-th delayed neutron group (i.e., λ_i in Chapter 2.6.2 in [Wulff et al. 1984]). $\text{NG} \leq 6$. Card 710000 must precede this card.

742000 (AL(I),I=1,NG) (I6,4X,6E10.0)

AL(I) Decay constant of the I-th delayed neutron group (s^{-1}), i.e., λ_i . See Chapter 2.6.2 in [Wulff et al. 1984]. $\text{NG} \leq 6$. Card 710000 must precede this card.

750000 IPERT(I6,4X,I5)

This card specifies perturbations and "manual" movement of the control rods.

IPERT = 0 No perturbation by control rod movement.

 = 1 Linear perturbation by control rod movement. Cards 760000 and 770000 must be present.

 = 2 Sinusoidal perturbation by control rod movement. Cards 760000 and 770000 must be present.

760000 (IMOV(I),I=1,KRR) (I6,4X,I4I5)

There are two options for moving the control rods:

- scram, specified on Card 612000, or
- manual movement of individual rods or banks of control rods, specified on Card 770000.

Both of these options require presence of Card 760000.

IMOV(I) = 0 No movement of control bank I.

 = 1 Movement of control bank I is allowed only during a scram condition, Card 612000.

 = 2 Control bank I can be moved "manually", Card 770000, and during scram condition.

 = 3 Movement of control bank I is allowed only by the manual option, Card 770000. A scram signal does not affect the specified control rod I.

770000 TBEG,TEND,CAMPL,CFREQ (I6,4X,7E10.0)

This card specifies the manual movement of the control rods. Applies only if IPERT=1 or 2.

TBEG Starting time of the control rod movement, (s).

4. Input Specifications

TEND	Stopping time of the control rod, (s).
CAMPL	Maximum amplitude for the control rod perturbation; measured in units of DZ. A positive value moves the control rod into the core while a negative value moves the control rods out of the core. Applies only if IPERT=1,2.
CFREQ	Angular frequency of the control rod oscillations. Applies only if IPERT=2.

4.3.8 Card Type 8 - Iteration Parameters, Run Time, Steamline Dynamics

800000 NSMAX,MEIT,NCMAX,NBMAX (I6,4X,14I5)

NSMAX	Number of inner iterations per eigenvalue iteration. Recommended value: NSMAX=20. See Chapter 6.6.1 in [Wulff et al. 1984].
MEIT	Maximum number of eigenvalue iterations per power-void (P-V) iteration in steady-state. See Chapter 6.6.1.2 in [Wulff et al. 1984].
NCMAX	Maximum number of P-V iterations. See Chapter 6.6.1.3 [Wulff et al. 1984]. Recommended value: NCMAX=30.
NBMAX	Not used.

810000 DLS,DLK,DPINP,DEC (I6,4X,7E10.3)

DLS	Convergence criterion for neutron flux and normalized power used in steady-state. Recommended value: DLS=1.0E-5.
DLK	Convergence criterion for eigenvalue in the steady-state calculation. Recommended value: DLK=1.0E-4. See Equation (6.6.27) [Wulff et al. 1984].
DPINP	Convergence criterion for local power density given as fraction of the core average power density in steady-state. Recommended value: DPINP=0.05. See Equation (6.6.30) in [Wulff et al. 1984].
DEC	Not used.

820000 A3,RELX,RELCY (I6,4X,7E10.3)

A3	Relaxation factor for inner iterations. Used as an under relaxation parameter with typical values varying from 0.1 to 0.2. See Equation(6.6.14) in [Wulff et al. 1984].
RELX	Relaxation factor for P-V iterations. Used as an under relaxation parameter with typical values varying from 0.4 to 0.5. See Chapter 6.6.13, Equation (6.6.29) in [Wulff et al. 1984].
RELCY	Not used.

4. Input Specifications

870000 IPRINT,CTMAX,TMAX (I6,4X,I5,3E10.0)

IPRINT = 1 Provides printed output of the static solution at the start of the dynamics in a restart from steady-state.

 = 0 No initial steady-state output.

CTMAX Maximum computer (CPU) time for transient calculation. If TMAX < 0, a restart file is created when |CTMAX| or |TMAX| is reached.

TMAX Maximum transient time, (s). TMAX is used to terminate the transient calculation. If TMAX < 0, a restart file is created when |TMAX| or |CTMAX| is reached. (CTMAX or TMAX < 0 defaults NREST to 5, if Card 140000 sets NREST to zero).

The following Cards (880000-880006) are used to provide the steamline data.

880000 NSTMOP,M2,NC,M1ST,M0,NLINE,IMSIV (I6,4X,I4I5)

NSTMOP = 0 No steamline.

 = 1 Include steamline.

M2 Number of computational cells in the main steamline.

NC Number of computational cells in the bypass line.

M1ST Bypass branch location in terms of cell number on the main steamline.

M0 Safety/Relief valves location (cell number, M0 < IMSIV).

NLINE Number of steamlines represented by the model.

IMSIV Main Steam Isolation Valve (MSIV) location (cell number).

880001 AM1,AM2,ASST,PLM1,PLM2,PLS,XKC (I6,4X,7E10.3)

AM1 Steamline cross-sectional area, (m²), between steam dome and bypass branch point.

AM2 Steamline cross-sectional area, (m²), between bypass branch point and turbine stop valve.

ASST Bypass line cross-sectional area, (m²).

PLM1 Length of steamline section, (m), between steam dome and bypass branch point.

PLM2 Length of steamline section, (m), between bypass branch point and turbine stop valve.

4. Input Specifications

PLS Bypass line length, (m).

XKC Steamline entrance contraction loss coefficient (dimensionless).

880003 LFR,ISTLPR (I6,4X,14I5)

LFR = 0 For friction factor as function of Reynolds Number. Recommended option.

 = 1 For computation with equivalent loss coefficients, XK.

 = 2 For computation with constant equivalent loss coefficient.

ISTLPR = 0 No steamline prints.

 = 1 Print steamline data every major hydraulic print.

880004 TAUPLN,TAUVLV,POLYTR,WMAX,ROUGH (I6,4X,7E10.3)

TAUPLN Not used.

TAUVLV Turbine valve closure rate, s^{-1} . Not used if the turbine trip data cards 613000 through 6135000 are present.

POLYTR Polytropic expansion coefficient (LFR=2 only).

WMAX Maximum bypass flow rate per steamline, kg/s.

ROUGH Normalized wall roughness of the steamline piping, ϵ/D .

880005 TDLY,TSTP (I6,4X,7E10.3)

This card is not used, if bypass trip option is chosen, Card 615000.

TDLY Bypass valve opening delay (s).

TSTP Bypass valve opening time (s).

880006 (XK(I),I=1,M2+NC) (I6,4X,7E103)

As many cards as needed.

XK(I) Steamline distributed form loss coefficient (one for each cell) used when LFR=1, Card 880003. The value for the first cell is overridden by the steamline entrance contraction loss coefficient XKC (Card 880001). See Chapter 4.5.5.2 in [Wulff et al. 1984] for further details XK(I) are dimensionless coefficients.

4.3.9 Card Type 9 End of Input Deck

900000 (I6,4X)

BLANK CARD except for the first six columns, which must be 900000, to designate the end of an input deck.

4.4 Sample Input Deck

This section provides a sample input deck as a guide for the user. The deck was prepared for a MSIV closure ATWS event simulation using a lot of comment cards (with an asterisk * at first column) to define the input parameters so that it becomes self-explanatory for the majority of the the input data.

The calculational model used for the input preparation is illustrated in Figures 4.5 and 4.3. It includes the reactor pressure vessel (RPV) with all important internal components, steam lines, balance of plant (BOP), control systems, and the SLCS for boron injection.

The reactor core was modeled with 101 neutronic channels and 25 hydraulic channels in a 1/8-core symmetry. Twenty four axial cells were used in each of the neutronic and hydraulic channels. Seven evenly distributed spacers were located along the axial height of each hydraulic channel (except for the bypass channel) to account for the local form losses due to the spacer grids.

The nuclear parameters for the 3D neutron kinetics were based on the Browns Ferry Unit 1 at the end of cycle 5. The two-group cross sections and their feedback coefficients were generated from the lattice physics data provided by TVA to BNL in early 1980.

The testing was performed for a MSIV closure ATWS event per EPG level control with boron injection. In this testing, the BOP, motor/generator set dynamics and control systems options in RAMONA-4B were all activated in order to produce realistic simulation results.

The transient for this testing was an ATWS event initiated by inadvertent closure of all MSIVs at 2 sec (This was done to make the initial power spike visible from the vertical axis). The normal scram system and alternate rod insertion (ARI) system were assumed to have failed, thus constituting an ATWS. Boron injection was initiated manually at 30 sec with 60-sec delay. The boron was injected by SLCS into the middle of lower plenum. (The code allows other injection points such as the downcomer, core and riser). The water level in the RPV was controlled by a EPG level controller using a time-dependent level setpoint specified by an input tabular function.

The initial condition was the hot full power and full flow condition. The key parameters calculated by RAMONA-4B for this case are given below:

4. Input Specifications

Core Thermal Power	3293 Mwt
System Pressure	6.962 Mpa
Feedwater Flow Rate	1685 kg/s
Core Flow Rate	13,040 kg/s
Core Inlet Subcooling	10.65 °C

For this input deck, the transient is set to run for 1200 seconds. The ATWS event is to be initiated from the full power condition at $t=2$ sec by a manual closure of all MSIVs in 4.5 seconds.

Table 4.3 lists the input deck for this sample problem.

RF = Recirculation Flow Controller FW = Feedwater Flow Controller PR = Pressure Regulator

Figure 4.5 Schematic of the BWR4 System

4. Input Specifications

```

1 *****
2 *****
3 *****
4 ***** BF1 MSIV 1/8 CORE INPUT DECK *****
5 *****
6 ***** BWR4 MSIV ATWS ANALYSIS *****
7 *****
8 *****
9 *****
10 *
11 * RAMONA-4B MODEL OF GE'S BWR4 FOR SAFETY ANALYSIS WITH BF1 CROSS SECTIONS *
12 *
13 * END OF CYCLE 5, AT RATED CONDITIONS, 1/8 CORE SYMMETRY UTILIZED *
14 *
15 * BROOKHAVEN NATIONAL LABORATORY *
16 *
17 * PREPARED BY: H. S. CHENG APRIL 12, 1995 *
18 *
19 *****
20 *
21 *****
22 * TITLE OPTIONS AND PRINTOUT SPECIFICATIONS *
23 *****
24 *
25 100000 MSIV Closure ATWS Per EPG Level Control and Boron Injection
26 *
27 ***** General option switches *****
28 ***** NOP,(IOPT(1),I=1,12)
29 ***** NOTE: IOPT(1)=0 for SBWR, IOPT(1)=1 for Regular BWR *****
30 ***** IOPT(2)=0 for original recirculation flow model
31 ***** IOPT(2)=1 for new recirculation flow model (EPA)
32 ***** IOPT(6)=1 activates BOP calculations.
33 ***** IOPT(6)=0 no BOP calculations.
34 * 1st no. is no. of options, 2nd no. is 1 for BWR (0 for SBWR), 7th no.
35 * is option for BOP (0=no BOP, 1=BOP calculations).
36 110000 12 1 1 1 0 0 1 0 1 2 1 0 0
37 *
38 ***** Transient output print option switches *****
39 120000 3 0 0 4
40 *
41 ***** Computational option switches *****
42 * restart = param1=0
43 ***** 1234123451234512345123451234512345
44 140000 1 1 1 1 0 100
45 150000 2424 101
46 *
47 ***** Steady state output control switches *****
48 150001 0 0 2 0 2 1
49 ***** Number of time windows for 3D plots *****
50 160000 1
51 ***** Arrays for time windows for 3D plots *****
52 161000 0.0
53 162000 0.1
54 *
55 *****
56 * SYSTEM GEOMETRY SPECIFICATIONS *
57 *****
58 *
59 ***** IMAX JMAX KMAX ISYM NONE KAN NBE
60 200000 11 15 24 9 0 101 15
61 ***** Hydraulic channel layout array *****
62 200001 1 1 2 1 1 6 19 6 8 8 11 8 15 12
63 200001 13 20 1 3 4 14 14 7 6 11 11 8 12
64 200001 13 2 4 17 5 2 6 7 11 11 15 11 12 13
65 200001 1 2 5 14 8 21 7 15 9 15 12 13 1 14
66 200001 22 8 8 8 10 9 9 18 13 2 6 11 8 23
67 200001 15 15 9 18 13 14 8 7 11 11 10 12 18 13
68 200001 8 8 7 10 10 18 16 8 10 10 12 16 12 12
69 200001 24 16 16
70 ***** Hydraulic diameters of flow segments and coolant channels *****

```

4. Input Specifications

71	200010	6	6	2	3	24	5	25	24	4	10
72	*****	Flow areas of flow segments and coolant channels *****									
73	200011	26.13	1.2502	18.154	16.444	.05659	.04115	.0102888			
74	200011	.02058	.02058	.05144	.05114	.12345	.04115	.06173			
75	200011	.10289	.07717	.07202	.04603	.07202	.03601	.0102888			
76	200011	.04115	.0102888	.0051444	.0102888	.0102888	.0102888	.0102888			
77	200011	.3175	10.57	26.32							
78	*****	Hydraulic diameters of flow segments and coolant channels *****									
79	200012	0.711	.2250	0.6379	0.5812	.01463	.01463	.01463			
80	200012	.01463	.01463	.01463	.01463	.01463	.01463	.01463			
81	200012	.01463	.01463	.01463	.01463	.01463	.01463	.01463			
82	200012	.01463	.01463	.01463	.01463	.01463	.01463	.01463			
83	200012	.01545	0.1540	4.9496							
84	*****	Original form loss coefficients (no longer used) *****									
85	200013	0.0	-.5	0.0	0.0	-30.	-30.	-30.			
86	200013	-30.	-30.	-30.	-30.	-30.	-30.	-30.			
87	200013	-30.	-30.	-230.	-30.	-30.	-230.	-30.			
88	200013	-30.	-30.	-30.	-30.	-30.	-30.	-230.			
89	200013	-700.	-1.340	-1.340	-1.340	-1.340	-1.340	-1.340			
90	200013	-1.340	-1.340	-1.340	-1.340	-1.340	-1.340	-1.340			
91	200013	-1.340	-1.340	-1.340	-1.340	-1.340	-1.340	-1.340			
92	200013	-1.340	-1.340	-1.340	-1.340	-8.0	-19.1				
93	*****	Component heights (nsec(i), i=1,7 where i=7 is steam dome) *****									
94	200014	6.018	5.062	3.188	2.306	3.810	4.9640	7.823			
95	*****	wlev0	gr0	htc	delta	deltam	rfctr				
96	200015	.6730	9.8067	3100.	.04	.015	1.1				
97	*****	Heated perimeters of coolant channels *****									
98	200016	13.145	9.560	2.390	4.780	4.780	11.950	11.950			
99	200016	28.680	9.560	14.340	23.900	17.925	16.730	10.753			
100	200016	16.730	8.365	2.390	9.560	2.390	1.195	2.390			
101	200016	2.390	2.390	2.390							
102	*****	Wetted non-heated perimeters of coolant channels *****									
103	200017	3.4680	2.5222	0.6306	1.2611	1.2611	3.1528	3.1528			
104	200017	7.5666	2.5222	3.7836	6.3056	5.0455	4.4139	2.8375			
105	200017	4.4139	2.2071	0.6306	2.5222	0.6306	0.3153	0.6306			
106	200017	0.6306	0.6306	0.6306							
107	*****	Spacer grids data, locations and loss coefficients *****									
108	200020	7	0	0							
109	200021	0.48	0.99	1.50	2.01	2.52	3.04	3.55			
110	200022	-1.300	-1.300	-1.300	-1.300	-1.300	-1.300	-1.300			
111	*****	New flow-dependent loss coefficients per inlet and exit *****									
112	200101	0.0	0.0	0.0	-0.50	0.0	0.0				
113	200102	0.0	0.0	0.0	0.0	0.0	0.0				
114	200103	0.0	0.0	0.0	0.0	0.0	0.0				
115	200104	0.0	0.0	0.0	0.0	0.0	0.0				
116	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
117	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
118	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
119	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
120	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
121	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
122	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
123	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
124	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
125	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
126	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
127	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
128	200105	-230.	0.0	0.0	-1.340	0.0	0.0				
129	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
130	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
131	200105	-230.	0.0	0.0	-1.340	0.0	0.0				
132	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
133	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
134	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
135	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
136	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
137	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
138	200105	-30.	0.0	0.0	-1.340	0.0	0.0				
139	200105	-230.	0.0	0.0	-1.340	0.0	0.0				
140	200105	-700.	0.0	0.0	-8.0	0.0	0.0				

4. Input Specifications

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141 ***** Riser form loss coefficients at inlet and exit *****
142 200106 0.0 0.0 0.0 -19.1 0.0 0.0
143 *
144 ***** Separator Model and Chimney Data *****
145 *
146 ***** HRSBW HRATIO HRA HRB
147 *****12341234567890123456789012345678901234567890
148 200200 0.0 120. 1357. 6561.
149 *
150 ***** Neutronic channel data *****
151 210000 1 15 2 15 3 15 4 15 5 15 6 15 7 14
152 210001 7 15 8 13 8 14 9 13 10 11 10 12 10 13
153 210001 11 11
154 ***** Neutronic channel id and control group id *****
155 330000 1 4 1 2 3 4
156 330000 5 8 5 6 7 8
157 330000 9 12 9 10 11 12
158 330000 13 16 13 14 15 16
159 330000 17 20 17 18 1 19 1 20
160 330000 21 24 21 22 23 24
161 330000 25 28 25 26 27 28
162 330000 29 32 29 30 31 1 32 1
163 330000 33 36 33 34 35 36
164 330000 37 40 37 38 39 40
165 330000 41 44 41 42 43 44
166 330000 45 48 45 46 47 48
167 330000 49 52 49 50 51 52
168 330000 53 56 53 54 55 56
169 330000 57 60 57 58 59 60
170 330000 61 64 61 62 63 64
171 330000 65 68 65 66 67 68
172 330000 69 72 69 70 71 72
173 330000 73 76 73 74 75 76
174 330000 77 80 77 78 79 80
175 330000 81 84 81 82 83 84
176 330000 85 88 85 86 87 88
177 330000 89 92 89 90 91 92
178 330000 93 96 93 94 95 96
179 330000 97 100 97 98 99 100
180 330000 101 101 101
181 ***** Thermal power, direct heating fraction, dx and dz *****
182 350000 3.2930E+9 0.04 15.240 15.875 0.0 0.0
183 ***** No. of fuel rods in a bundle, no. of nodes in pellet & clad ****
184 380000 62 4 2
185 ***** System pressure, saturation temperature, clad od & thickness ****
186 *****123412345678901234567890123456789012345678901234567890
187 390000 69.154E+5 286.00 0.006134 8.128E-04
188 ***** Correlation constants for fuel and clad thermal conductivity ****
189 391000 8.50 0.00200 13.85 5678. 5678. 0. 0.
190 *
191 ***** Neutronic calculation data (criticality, leakage correction) ***
192 *
193 400000 1.0 0. 0. 0.3 0.7 1.5
194 ***** Albedo boundary condition data *****
195 401000 -0.0667 1.652 200.
196 410000 0.3500 0.70 25.0 20.0
197 420000 0.05 0.05 0.05 0.05 0.05 0.05 0.00
198 420001 0.04 0.00 0.04 0.05 0.00 0.05 0.04
199 420001 0.04
200 430000 0.001 0.001 0.001 0.001 0.001 0.001 0.001
201 430001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
202 430001 0.001
203 *
204 440000 77 COMPOSITIONS BASED ON TVA EXPOSURE AND VOID HISTORY, D.Diamond
205 *
206 ***** Cross section set identification array *****
207 441000 1 1 2 2 2 3 3 3 4 4 4 5 5 5 5
208 441001 6 6 6 7 7 7 8 8 8 9
209 441000 2 1 10 10 10 11 11 11 12 12 12 13 13 13 13
210 441001 13 13 13 14 14 14 15 15 15 9

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4. Input Specifications

211	441000	3	16	17	17	17	18	18	18	19	19	19	20	20	20	20
212	441001		21	21	21	22	22	22	23	23	23	24				
213	441000	4	1	2	2	2	3	3	3	4	4	4	25	25	25	25
214	441001		6	6	6	7	7	7	26	26	26	9				
215	441000	5	1	27	27	27	28	28	28	25	25	25	25	25	25	25
216	441001		6	6	6	7	7	7	26	26	26	9				
217	441000	6	1	2	2	2	29	29	29	30	30	30	31	31	7	7
218	441001		7	7	7	14	14	14	15	15	15	9				
219	441000	7	16	17	17	17	18	18	18	19	19	19	20	20	20	20
220	441001		21	21	21	22	22	22	23	23	23	24				
221	441000	8	1	2	2	2	3	3	3	4	4	4	5	5	6	6
222	441001		31	31	31	13	13	13	8	8	8	9				
223	441000	9	1	27	27	27	28	28	28	25	25	25	25	25	25	25
224	441001		6	6	6	7	7	7	26	26	26	9				
225	441000	10	1	2	2	2	29	29	29	30	30	30	31	31	7	7
226	441001		7	7	7	14	14	14	15	15	15	9				
227	441000	11	16	32	32	32	33	33	33	19	19	19	20	20	20	20
228	441001		21	21	21	22	22	22	23	23	23	24				
229	441000	12	1	27	27	27	28	28	28	4	4	4	5	5	5	5
230	441001		31	31	31	13	13	13	8	8	8	9				
231	441000	13	1	10	10	10	34	34	34	12	12	12	31	31	13	13
232	441001		7	7	7	14	14	14	15	15	15	9				
233	441000	14	16	35	35	35	17	17	17	36	36	36	37	37	37	37
234	441001		38	38	38	38	38	38	39	39	39	40				
235	441000	15	1	2	2	2	3	3	3	5	5	5	31	31	31	31
236	441001		7	7	7	41	41	41	8	8	8	9				
237	441000	16	16	32	32	32	18	18	18	19	19	19	20	20	20	20
238	441001		21	21	21	22	22	22	23	23	23	24				
239	441000	17	1	2	2	2	3	3	3	30	30	30	6	6	6	6
240	441001		7	7	7	41	41	41	8	8	8	9				
241	441000	18	16	42	42	42	43	43	43	44	44	44	45	45	45	45
242	441001		45	45	45	46	46	46	47	47	47	24				
243	441000	19	48	49	49	49	50	50	50	51	51	51	52	52	52	52
244	441001		26	26	26	8	8	8	53	53	53	9				
245	441000	20	16	54	54	54	55	55	55	44	44	44	45	45	45	45
246	441001		45	45	45	46	46	46	47	47	47	24				
247	441000	21	1	2	2	2	3	3	3	30	30	30	6	6	31	31
248	441001		7	7	7	41	41	41	15	15	15	9				
249	441000	22	16	54	54	54	55	55	55	44	44	44	45	45	45	45
250	441001		45	45	45	46	46	46	47	47	47	24				
251	441000	23	48	56	56	56	57	57	57	51	51	51	52	52	52	52
252	441001		26	26	26	8	8	8	53	53	53	9				
253	441000	24	16	54	54	54	55	55	55	44	44	44	45	45	45	45
254	441001		45	45	45	46	46	46	47	47	47	24				
255	441000	25	1	56	56	56	57	57	57	51	51	51	52	52	52	52
256	441001		26	26	26	8	8	8	53	53	53	9				
257	441000	26	16	54	54	54	55	55	55	44	44	44	45	45	45	45
258	441001		45	45	45	46	46	46	47	47	47	24				
259	441000	27	48	49	49	49	50	50	50	58	58	58	58	58	58	58
260	441001		59	59	59	15	15	15	60	60	60	24				
261	441000	28	16	35	35	35	17	17	17	36	36	36	37	37	37	37
262	441001		38	38	38	38	38	38	39	39	39	40				
263	441000	29	1	27	27	27	3	3	3	5	5	5	6	6	6	6
264	441001		7	7	7	7	7	7	8	8	8	9				
265	441000	30	16	54	54	54	55	55	55	44	44	44	45	45	45	45
266	441001		45	45	45	46	46	46	47	47	47	24				
267	441000	31	1	10	10	10	34	34	34	30	30	30	31	31	7	7
268	441001		13	13	13	14	14	14	15	15	15	9				
269	441000	32	16	17	17	17	18	18	18	19	19	19	20	20	20	20
270	441001		21	21	21	22	22	22	23	23	23	24				
271	441000	33	48	56	56	56	57	57	57	51	51	51	14	14	14	14
272	441001		26	26	26	8	8	8	53	53	53	9				
273	441000	34	16	54	54	54	55	55	55	44	44	44	45	45	45	45
274	441001		61	61	61	46	46	46	47	47	47	24				
275	441000	35	1	10	10	10	34	34	34	12	12	12	13	13	13	13
276	441001		13	13	13	14	14	14	15	15	15	9				
277	441000	36	16	32	32	32	33	33	33	19	19	19	20	20	20	20
278	441001		21	21	21	22	22	22	23	23	23	24				
279	441000	37	1	27	27	27	3	3	3	30	30	30	31	31	7	7
280	441001		7	7	7	14	14	14	15	15	15	9				

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281	441000	38	16	32	32	32	33	33	33	20	20	20	20	20	20	20
282	441001	21	21	21	22	22	22	22	23	23	23	24				
283	441000	39	48	56	56	56	57	57	57	51	51	51	52	52	52	52
284	441001		26	26	26	8	8	8	53	53	53	9				
285	441000	40	16	17	17	17	18	18	18	19	19	19	62	62	62	62
286	441001		22	22	22	23	23	23	39	39	39	24				
287	441000	41	16	35	35	35	17	17	17	36	36	36	37	37	37	37
288	441001		38	38	38	38	38	38	39	39	39	40				
289	441000	42	1	2	2	2	3	3	3	5	5	5	5	5	6	6
290	441001		6	6	6	7	7	7	8	8	8	9				
291	441000	43	1	2	2	2	3	3	3	4	4	4	5	5	5	5
292	441001		6	6	6	7	7	7	8	8	8	9				
293	441000	44	1	27	27	27	28	28	28	25	25	25	25	25	25	25
294	441001		63	63	63	6	6	6	26	26	26	9				
295	441000	45	16	54	54	54	55	55	55	44	44	44	45	45	45	45
296	441001		45	45	45	46	46	46	47	47	47	24				
297	441000	46	48	56	56	56	57	57	57	51	51	51	14	14	14	14
298	441001		26	26	26	8	8	8	53	53	53	9				
299	441000	47	1	2	2	2	3	3	3	4	4	4	5	5	6	6
300	441001		31	31	31	13	13	13	8	8	8	9				
301	441000	48	1	27	27	27	28	28	28	25	25	25	25	25	25	25
302	441001		6	6	6	6	6	6	26	26	26	9				
303	441000	49	16	54	54	54	55	55	55	44	44	44	45	45	45	45
304	441001		45	45	45	46	46	46	47	47	47	24				
305	441000	50	48	56	56	56	57	57	57	51	51	51	52	52	52	52
306	441001		26	26	26	8	8	8	53	53	53	9				
307	441000	51	1	2	2	2	3	3	3	30	30	30	31	31	7	7
308	441001		7	7	7	14	14	14	15	15	15	9				
309	441000	52	1	10	10	10	34	34	34	12	12	12	13	13	13	13
310	441001		13	13	13	14	14	14	15	15	15	9				
311	441000	53	16	35	35	35	17	17	17	36	36	36	37	37	37	37
312	441001		38	38	38	38	38	38	39	39	39	40				
313	441000	54	1	2	2	2	3	3	3	5	5	5	6	6	31	31
314	441001		7	7	7	41	41	41	8	8	8	9				
315	441000	55	1	2	2	2	28	28	28	4	4	4	25	25	25	25
316	441001		6	6	6	7	7	7	26	26	26	9				
317	441000	56	48	56	56	56	57	57	57	51	51	51	14	14	14	14
318	441001		26	26	26	8	8	8	53	53	53	9				
319	441000	57	16	32	32	32	33	33	33	20	20	20	20	20	20	20
320	441001		21	21	21	22	22	22	23	23	23	24				
321	441000	58	1	27	27	27	28	28	28	25	25	25	25	25	25	25
322	441001		6	6	6	6	6	6	26	26	26	9				
323	441000	59	1	27	27	27	64	64	64	25	25	25	25	25	25	25
324	441001		6	6	6	6	6	6	26	26	26	9				
325	441000	60	48	56	56	56	57	57	57	51	51	51	52	52	52	52
326	441001		26	26	26	8	8	8	53	53	53	9				
327	441000	61	16	32	32	32	33	33	33	19	19	19	20	20	21	21
328	441001		21	21	21	22	22	22	23	23	23	24				
329	441000	62	1	27	27	27	28	28	28	25	25	25	25	25	25	25
330	441001		6	6	6	7	7	7	26	26	26	9				
331	441000	63	1	10	10	10	34	34	34	12	12	12	13	13	13	13
332	441001		13	13	13	14	14	14	15	15	15	9				
333	441000	64	16	35	35	35	17	17	17	36	36	36	37	37	37	37
334	441001		38	38	38	38	38	38	39	39	39	40				
335	441000	65	1	2	2	2	3	3	3	5	5	5	6	6	31	31
336	441001		7	7	7	41	41	41	8	8	8	9				
337	441000	66	16	54	54	54	55	55	55	44	44	44	45	45	45	45
338	441001		61	61	61	46	46	46	47	47	47	24				
339	441000	67	1	2	2	2	3	3	3	30	30	30	6	6	7	7
340	441001		7	7	7	14	14	14	8	8	8	9				
341	441000	68	16	54	54	54	55	55	55	44	44	44	45	45	45	45
342	441001		45	45	45	46	46	46	47	47	47	24				
343	441000	69	48	56	56	56	57	57	57	51	51	51	52	52	52	52
344	441001		26	26	26	8	8	8	53	53	53	9				
345	441000	70	16	54	54	54	55	55	55	44	44	44	45	45	45	45
346	441001		45	45	45	46	46	46	47	47	47	24				
347	441000	71	1	2	2	2	29	29	29	12	12	12	31	31	13	13
348	441001		13	13	13	14	14	14	15	15	15	9				
349	441000	72	16	54	54	54	43	43	43	44	44	44	65	65	65	65
350	441001		46	46	46	66	66	66	47	47	47	24				

4. Input Specifications

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351 441000 73 48 49 49 49 50 50 50 58 58 58 58 58 58 58
352 441001 59 59 59 15 15 15 60 60 60 24
353 441000 74 16 35 35 35 17 17 17 36 36 36 37 37 37 37
354 441001 38 38 38 38 38 38 39 39 39 40
355 441000 75 1 2 2 2 29 29 29 30 30 30 31 31 31 31
356 441001 7 7 7 14 14 14 15 15 15 9
357 441000 76 16 54 54 54 55 55 55 44 44 44 45 45 45 45
358 441001 45 45 45 46 46 46 47 47 47 24
359 441000 77 1 10 10 10 34 34 34 12 12 12 13 13 13 13
360 441001 14 14 14 52 52 52 15 15 15 9
361 441000 78 16 32 32 32 33 33 33 19 19 19 20 20 20 20
362 441001 21 21 21 22 22 22 23 23 23 24
363 441000 79 1 56 56 56 57 57 57 51 51 51 52 52 52 52
364 441001 26 26 26 8 8 8 53 53 53 9
365 441000 80 16 54 54 54 55 55 55 44 44 44 45 45 45 45
366 441001 46 46 46 66 66 66 47 47 47 24
367 441000 81 48 49 49 49 50 50 50 51 51 51 58 58 8 8
368 441001 8 8 8 15 15 15 60 60 60 24
369 441000 82 16 35 35 35 17 17 17 36 36 36 37 37 37 37
370 441001 38 38 38 38 38 38 39 39 39 40
371 441000 83 1 10 10 10 11 11 11 12 12 12 13 13 13 13
372 441001 14 14 14 26 26 26 15 15 15 9
373 441000 84 1 10 10 10 34 34 34 12 12 12 13 13 13 13
374 441001 13 13 13 14 14 14 15 15 15 9
375 441000 85 1 27 27 27 28 28 28 25 25 25 25 25 25 25
376 441001 6 6 6 7 7 7 26 26 26 9
377 441000 86 1 27 27 27 28 28 28 25 25 25 25 25 25 25
378 441001 6 6 6 7 7 7 8 8 8 9
379 441000 87 16 54 54 54 55 55 55 44 44 44 45 45 65 65
380 441001 46 46 46 66 66 66 47 47 47 24
381 441000 88 1 56 56 56 11 11 11 67 67 67 51 51 51 51
382 441001 52 52 52 8 8 8 53 53 53 68
383 441000 89 16 17 17 17 18 18 18 36 36 36 37 37 37 37
384 441001 38 38 38 38 38 38 39 39 39 40
385 441000 90 1 2 2 2 3 3 3 4 4 4 30 30 31 31
386 441001 7 7 7 41 41 41 15 15 15 9
387 441000 91 1 2 2 2 3 3 3 30 30 30 31 31 31 31
388 441001 7 7 7 41 41 41 8 8 8 9
389 441000 92 1 27 27 27 28 28 28 25 25 25 25 25 5 5
390 441001 6 6 6 7 7 7 26 26 26 9
391 441000 93 48 49 49 49 50 50 50 58 58 58 58 58 58 58
392 441001 8 8 8 15 15 15 60 60 60 24
393 441000 94 16 17 17 17 18 18 18 36 36 36 37 37 37 37
394 441001 38 38 38 38 38 38 39 39 39 40
395 441000 95 16 35 35 35 17 17 17 36 36 36 37 37 37 37
396 441001 38 38 38 38 38 38 39 39 39 40
397 441000 96 1 2 2 2 29 29 29 30 30 30 31 31 7 7
398 441001 7 7 7 41 41 41 15 15 15 9
399 441000 97 48 69 69 69 70 70 70 71 71 71 72 72 72 72
400 441001 73 73 73 74 74 74 60 60 60 24
401 441000 98 1 10 10 10 34 34 34 12 12 12 13 13 13 13
402 441001 13 13 13 14 14 14 15 15 15 9
403 441000 99 1 2 2 2 3 3 3 5 5 5 31 31 31 31
404 441001 7 7 7 14 14 14 15 15 15 9
405 441000 100 75 56 56 56 76 76 76 67 67 67 13 13 13 13
406 441001 14 14 14 14 14 14 15 15 15 77
407 441000 101 1 2 2 2 3 3 3 5 5 5 5 5 6 6
408 441001 6 6 6 7 7 7 8 8 8 9
409 *
410 ***** Correlation constants for xenon correction *****
411 *
412 442000 1 0.5773E-3 0.110198 0.1252E-3 0.134292
413 442000 2 .10121E-2 1.32739 0.6343E-3 .165516-1
414 442000 3 .10565E-2 0.948278 0.7264E-3 0.214806
415 442000 4 .10382E-2 1.50765 0.6525E-3 .137035-1
416 442000 5 .10689E-2 1.3629 0.6434E-3 .115243-1
417 *
418 *****
419 * BORON TRACKING INPUT DATA *
420 *****

```

4. Input Specifications

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421 *
422 ***** NAXIAL INLOOP WBINP BCONC WRATED TBINJ
423 460000 3 2 5.564 2.380E+4 1.367E+04 32.00
424 *
425 ***** SIGA1B SIGA2B WETFRS FACTR
426 461000 49.0 1500.0 1.00E+00 0.0
427 *
428 ***** IOPTB IPRNT TSTRT TOFF TDELAY
429 462000 1 1 30.0 1.00E+04 6.00E+01
430 *
431 ***** Boron Mixing Efficiency Tabular Input Data:
432 *
433 ***** For Downcomer (Down Flow):
434 *
435 ***** NBMIX1
436 463000 12
437 *
438 ***** (WBMIX1(I),I=1,NBMIX1), (EBMIX1(I),I=1,NBMIX1)
439 463000 -1.0 -0.95 -0.75 -0.25 -0.05 -0.02
440 463000 0.0 0.04 0.25 0.95 1.0 2.0
441 463000 1.0 1.00 0.87 0.75 0.0 0.0
442 463000 0.0 0.95 1.00 1.00 1.0 1.0
443 ***** Perfect mixing:
444 *463000 1.0 1.00 1.00 1.00 1.0 1.0
445 *463000 1.0 1.00 1.00 1.00 1.0 1.0
446 *
447 ***** For Lower Plenum 1 (Horizontal Flow):
448 *
449 ***** NBMIX2
450 464000 12
451 *
452 ***** (WBMIX2(I),I=1,NBMIX2), (EBMIX2(I),I=1,NBMIX2)
453 464000 -1.0 -0.95 -0.75 -0.25 -0.05 -0.02
454 464000 0.0 0.04 0.25 0.95 1.0 2.0
455 464000 1.0 1.00 1.00 0.75 0.0 0.0
456 464000 0.0 0.00 0.75 1.00 1.0 1.0
457 ***** Perfect mixing:
458 *464000 1.0 1.00 1.00 1.00 1.0 1.0
459 *464000 1.0 1.00 1.00 1.00 1.0 1.0
460 *
461 ***** For Lower Plenum 2, Core, Chimney, and Riser (Up Flow):
462 *
463 ***** NBMIX3
464 465000 12
465 *
466 ***** (WBMIX3(I),I=1,NBMIX3), (EBMIX3(I),I=1,NBMIX3)
467 465000 -1.0 -0.95 -0.75 -0.25 -0.05 -0.02
468 465000 0.0 0.04 0.25 0.95 1.0 2.0
469 465000 1.0 1.00 1.00 1.00 0.95 0.91
470 465000 0.0 0.00 0.75 1.00 1.0 1.0
471 ***** Perfect mixing:
472 *465000 1.0 1.00 1.00 1.00 1.00 1.00
473 *465000 1.0 1.00 1.00 1.00 1.00 1.0
474 *
475 *****
476 * INPUT DATA FOR SLCS (Hjk 6-9-93) *
477 *****
478 *
479 ***** LSC IATWS SCVOT SCTL SCPR SCHK
480 466000 0 0 20.5 30 14820000. 8.0
481 *
482 ***** SCDA SCL SCVOL SCLEV CPMH DENSBR
483 *****123412345678901234567890123456789012345678901234567890
484 467000 .0762 10.0 9.2 2.0 117500. 1070.
485 *
486 ***** SCPhi SCLOW SCVEL AKLOSS AN SCVIS
487 *****123412345678901234567890123456789012345678901234567890
488 468000 7760000. 7.1 10.0 120.0 1.278 .0008
489 *
490 ***** DELSC DIVALS DTSVAL DATWS TSLCS

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4. Input Specifications

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491 *****123412345678901234567890123456789012345678901234567890
492 469000      1.0      0.056      0.5      180.      20.0
493 *
494 *****
495 *      No. of Cross Section Sets (ITAB2), No. of Coefficients (ICONST), *
496 *      No. of Bottom Entry Control Rod Groups (KRR) *
497 *****
498 *
499 ***** no of xection sets, no of coefficients, no of control rod groups
500 ***** ITAB2 ICONST KRR
501 470000      77      56      30
502 ***** Map cross section sets to their xenon correction sets *****
503 471000      1      2      2      2      2      2      2      2      1      2      2      2      2      2
504 471000      2      1      3      3      3      3      3      3      3      1      2      2      2      2
505 471000      2      2      2      3      3      2      3      3      3      3      1      2      5
506 471000      5      5      4      4      4      1      2      2      2      2      5      5      2
507 471000      2      2      2      2      4      3      2      2      4      4      2      1      2      2
508 471000      2      2      2      2      1      2      1
509 *
510 *****
511 *      CROSS SECTIONS AND FEEDBACK COEFFICIENTS DATA *
512 *****
513 *
514 ***** Two-group cross section data at end of cycle 5 for BF1 (77 sets) *****
515 *
516 *      COMPOSITION 1
517 480000      .141032+1 .471998+0 .305096+0 .544701-3 .340390+0 .165150+0 .194954+0
518 480001      .308935-3 .212224-1 .157490-1 .672312-3 .212757-4 .130870-4 .281801-1
519 480001      -.164558-1 .401891-3 .222878-4 .661306-5 .363180-1 .483069-2 .656846-3
520 480001      -.147998-4 .267634-2 .321860-3 .278411-3 .509399-6 .119947-5 .365249-1
521 480001      -.657681-3 .102116-2 .179017-5 .548310+3 .120963+4 .276975+1 .274116+1
522 480002      .142568+1 .485081+0 .254036+0 .352531+0 .176742+0 .263081+0 .191460-1
523 480002      -.155521-1 .317751-4 .286832-1 .165981-1 .274692-3 .475819-1 .645865-2
524 480002      .623660-2 .266595-2 .345274-3 .415150-3 .404623-1 .197051-2 .709152-3
525 *      COMPOSITION 2
526 480000      .140254+1 .486439+0 .332123+0 .564474-3 .342239+0 .161795+0 .167750+0
527 480001      .316726-3 .197607-1 .151595-1 .927783-3 .190685-4 .117742-4 .278754-1
528 480001      -.160348-1 .397406-3 .202339-4 .736335-5 .500628-1 .594364-2 .166585-2
529 480001      -.153467-4 .353848-2 .367789-3 .411425-3 .578228-6 .195562-5 .595201-1
530 480001      -.295308-2 .296956-2 .479438-5 .548310+3 .120963+4 .271666+1 .269270+1
531 480002      .141019+1 .501927+0 .285130+0 .361546+0 .113629+0 .318916+0 .176217-1
532 480002      -.117913-1 .426321-2 .283706-1 .168678-1 .628550-3 .686256-1 .399146-1
533 480002      .506287-1 .355448-2 .359287-3 .620037-3 .713530-1 .244094-1 .230886-1
534 *      COMPOSITION 3
535 480000      .140490+1 .542354+0 .270623+0 .535042-3 .337601+0 .187319+0 .135241+0
536 480001      .343767-3 .196716-1 .149267-1 .727543-3 .151720-4 .106347-4 .280079-1
537 480001      -.160167-1 .397159-3 .162156-4 .705621-5 .503099-1 .665885-2 .108058-2
538 480001      -.126533-4 .341977-2 .458349-3 .324293-3 .538641-6 .198614-5 .579029-1
539 480001      -.428056-2 .186602-2 .291675-5 .548310+3 .120963+4 .274836+1 .274024+1
540 480002      .141036+1 .552614+0 .232205+0 .364214+0 .145503+0 .269764+0 .174128-1
541 480002      -.120653-1 .383075-2 .285055-1 .166752-1 .398156-3 .710098-1 .360119-1
542 480002      .444874-1 .342728-2 .457026-3 .511779-3 .711208-1 .236211-1 .212024-1
543 *      COMPOSITION 4
544 480000      .140555+1 .534526+0 .286375+0 .526531-3 .337239+0 .182979+0 .139779+0
545 480001      .355717-3 .195870-1 .149308-1 .809898-3 .133295-4 .104393-4 .279880-1
546 480001      -.160269-1 .409678-3 .143631-4 .687496-5 .515449-1 .642881-2 .128970-2
547 480001      -.106454-4 .346763-2 .430702-3 .354533-3 .520411-6 .199270-5 .598094-1
548 480001      -.377312-2 .227283-2 .338124-6 .548310+3 .120963+4 .275280+1 .274913+1
549 480002      .141262+1 .544984+0 .245100+0 .347848+0 .236124+0 .162399+0 .179474-1
550 480002      -.164866-1 .160029-2 .283513-1 .158335-1 .657819-3 .662161-1 .705789-2
551 480002      -.701233-2 .349068-2 .504139-3 .454312-3 .698865-1 .172950-2 .905441-2
552 *      COMPOSITION 5
553 480000      .141350+1 .508121+0 .287314+0 .518360-3 .341791+0 .169267+0 .140484+0
554 480001      .360334-3 .195316-1 .149924-1 .809279-3 .126807-4 .102548-4 .279028-1
555 480001      -.159827-1 .416501-3 .136891-4 .680437-5 .533729-1 .635140-2 .125790-2
556 480001      -.100244-4 .357757-2 .399801-3 .353623-3 .511374-6 .200366-5 .634077-1
557 480001      -.364101-2 .220676-2 .355839-6 .548310+3 .120963+4 .274807+1 .274642+1
558 480002      .142274+1 .517052+0 .247492+0 .355598+0 .226380+0 .115524+0 .174060-1
559 480002      -.163525-1 .371582-2 .283719-1 .158637-1 .100677-2 .724466-1 .618011-2
560 480002      -.273565-1 .360713-2 .486241-3 .401736-3 .765507-1 .117301-2 .205789-1

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4. Input Specifications

561	*	COMPOSITION	6
562	480000	.140675+1 .498824+0 .318030+0 .465186-3 .340092+0 .167251+0 .145548+0	
563	480001	.380059-3 .193884-1 .149564-1 .930666-3 .101545-4 .877650-5 .278003-1	
564	480001	-.159014-1-.423237-3-.109496-4 .658492-5 .558967-1-.641224-2-.199395-2	
565	480001	-.853654-5 .373980-2-.395056-3-.425752-3-.469659-6-.210335-5 .682834-1	
566	480001	-.381809-2-.360539-2 .789679-6 .548310+3 .120963+4 .274413+1 .274517+1	
567	480002	.141545+1 .497224+0 .293073+0 .354026+0 .147713+0 .256833+0 .173078-1	
568	480002	-.113364-1-.485030-2 .282792-1-.168257-1 .771367-3 .757409-1-.398903-1	
569	480002	.519654-1 .377551-2-.455044-3-.538762-3 .826442-1-.269358-1 .257423-1	
570	*	COMPOSITION	7
571	480000	.140059+1 .490278+0 .335767+0 .447967-3 .340157+0 .164310+0 .150582+0	
572	480001	.386963-3 .193474-1-.149656-1 .999144-3-.924721-5-.833819-5 .277241-1	
573	480001	-.158710-1-.439117-3-.997813-5 .649859-5 .569555-1-.637876-2-.224223-2	
574	480001	-.785926-5 .385758-2-.384760-3-.457421-3-.454955-6-.213529-5 .710743-1	
575	480001	-.377601-2-.406850-2 .128082-5 .548310+3 .120963+4 .273185+1 .273103+1	
576	480002	.140907+1 .490583+0 .306936+0 .354007+0 .129297+0 .291297+0 .173041-1	
577	480002	-.106963-1-.599606-2 .281987-1-.169437-1 .101050-2 .768234-1-.466280-1	
578	480002	.642056-1 .389427-2-.429814-3-.602532-3 .856835-1-.307769-1 .322206-1	
579	*	COMPOSITION	8
580	480000	.138945+1 .481383+0 .330242+0 .431677-3 .344418+0 .161506+0 .149074+0	
581	480001	.395238-3 .193466-1-.149297-1 .918882-3-.818774-5-.764955-5 .274509-1	
582	480001	-.157741-1-.412710-3-.882479-5 .662635-5 .588073-1-.656929-2-.222097-2	
583	480001	-.783804-5 .421275-2-.382740-3-.473485-3-.443777-6-.224867-5 .779620-1	
584	480001	-.428612-2-.414894-2-.131806-6 .548310+3 .120963+4 .268451+1 .267010+1	
585	480002	.139728+1 .488111+0 .294447+0 .358689+0 .183308+0 .195406+0 .173009-1	
586	480002	-.142460-1-.198110-3 .279716-1-.161305-1-.159401-3 .793322-1-.140172-1	
587	480002	.975661-2 .425563-2-.452423-3-.579766-3 .936390-1-.114971-1-.108430-2	
588	*	COMPOSITION	9
589	480000	.140942+1 .459325+0 .308885+0 .404809-3 .344779+0 .157430+0 .190275+0	
590	480001	.403806-3 .210889-1-.156617-1 .667094-3-.848090-5-.853556-5 .279268-1	
591	480001	-.163135-1-.380501-3-.900745-5 .620934-5 .390975-1-.486211-2-.820492-3	
592	480001	-.834702-5 .282062-2-.308217-3-.289280-3-.373382-6-.125873-5 .422662-1	
593	480001	-.751679-3-.138188-2-.614875-6 .548310+3 .120963+4 .275979+1 .273076+1	
594	480002	.142504+1 .467229+0 .266287+0 .356180+0 .191336+0 .218100+0 .189523-1	
595	480002	-.160562-1 .119286-2 .285073-1-.163686-1-.503571-3 .515552-1-.241731-2	
596	480002	-.206444-2 .280973-2-.373266-3-.350516-3 .471791-1-.116146-2-.316300-2	
597	*	COMPOSITION	10
598	480000	.139656+1 .481945+0 .330534+0 .570113-3 .342571+0 .160462+0 .165238+0	
599	480001	.313104-3 .197238-1-.151261-1 .898951-3-.194885-4-.115980-4 .277679-1	
600	480001	-.159734-1-.394753-3-.206536-4 .759166-5 .509008-1-.600472-2-.171453-2	
601	480001	-.160017-4 .366220-2-.369332-3-.413823-3-.591468-6-.202726-5 .620770-1	
602	480001	-.314835-2-.308929-2-.606329-5 .548310+3 .120963+4 .270157+1 .267226+1	
603	480002	.140410+1 .495614+0 .286343+0 .359764+0 .134820+0 .282372+0 .176354-1	
604	480002	-.126403-1-.286371-2 .282796-1-.166392-1 .343809-3 .693369-1-.312332-1	
605	480002	.364728-1 .368442-2-.383419-3-.591122-3 .743082-1-.199079-1 .150056-1	
606	*	COMPOSITION	11
607	480000	.140168+1 .495325+0 .317796+0 .539462-3 .341769+0 .165876+0 .157709+0	
608	480001	.340174-3 .196686-1-.150881-1 .883396-3-.156878-4-.105304-4 .278400-1	
609	480001	-.159574-1-.414263-3-.167257-4 .718878-5 .513683-1-.646155-2-.143423-2	
610	480001	-.135315-4 .359543-2-.406016-3-.389361-3-.548403-6-.200889-5 .616273-1	
611	480001	-.397810-2-.253831-2-.444007-5 .548310+3 .120963+4 .272137+1 .270352+1	
612	480002	.140774+1 .500411+0 .285565+0 .394967+0 .468140-1 .481740+0 .159175-1	
613	480002	-.270318-2-.141732-1 .286677-1-.186112-1 .258604-2 .861827-1-.125069+0	
614	480002	.142508+0 .358983-2-.304893-3-.690785-3 .832538-1-.758342-1 .782954-1	
615	*	COMPOSITION	12
616	480000	.139975+1 .515533+0 .297567+0 .526842-3 .339590+0 .174105+0 .144443+0	
617	480001	.356886-3 .195480-1-.149882-1 .852597-3-.131309-4-.104167-4 .278381-1	
618	480001	-.160032-1-.415732-3-.141655-4 .687650-5 .531094-1-.630906-2-.138778-2	
619	480001	-.104450-4 .365832-2-.405375-3-.371134-3-.519665-6-.200064-5 .642376-1	
620	480001	-.355931-2-.246087-2-.121271-6 .548310+3 .120963+4 .272910+1 .271932+1	
621	480002	.140783+1 .526367+0 .254975+0 .351711+0 .215468+0 .169048+0 .176790-1	
622	480002	-.157965-1 .151608-2 .282526-1-.159645-1-.622042-3 .698138-1 .437678-3	
623	480002	-.581724-2 .368420-2-.470605-3-.472426-3 .757231-1-.192271-2-.857198-2	
624	*	COMPOSITION	13
625	480000	.140124+1 .506096+0 .294796+0 .484897-3 .341106+0 .170422+0 .138924+0	
626	480001	.372842-3 .194349-1-.149350-1 .814247-3-.111208-4-.906125-5 .277116-1	
627	480001	-.158952-1-.400059-3-.119671-4 .677711-5 .558161-1-.654923-2-.169438-2	
628	480001	-.976884-5 .383363-2-.411131-3-.390864-3-.489081-6-.209790-5 .696037-1	
629	480001	-.412287-2-.306663-2-.980031-6 .548310+3 .120963+4 .272369+1 .271756+1	
630	480002	.141003+1 .502651+0 .274554+0 .355305+0 .191888+0 .173858+0 .173201-1	

4. Input Specifications

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631 480002 -.133091-1-.132381-2 .282186-1-.164541-1 .120046-3 .758779-1-.211243-1
632 480002 .172069-1 .387173-2-.513092-3-.427051-3 .840501-1-.167028-1 .660482-2
633 * COMPOSITION 14
634 480000 .139802+1 .476763+0 .341493+0 .452816-3 .342288+0 .159926+0 .153870+0
635 480001 .386063-3 .193693-1-.149929-1 .981348-3-.941109-5-.816939-5 .275896-1
636 480001 -.158176-1-.416138-3-.101276-4 .667402-5 .577211-1-.637968-2-.238827-2
637 480001 -.877947-5 .400801-2-.369524-3-.486726-3-.462451-6-.217561-5 .740826-1
638 480001 -.386954-2-.442309-2-.757317-6 .548310+3 .120963+4 .271037+1 .270333+1
639 480002 .140672+1 .474025+0 .318910+0 .356890+0 .129469+0 .281167+0 .172599-1
640 480002 -.106194-1-.591457-2 .281172-1-.169921-1 .112568-2 .784884-1-.477652-1
641 480002 .626911-1 .405041-2-.438250-3-.592812-3 .895191-1-.322142-1 .318643-1
642 * COMPOSITION 15
643 480000 .138931+1 .470356+0 .335736+0 .441604-3 .345948+0 .157773+0 .152983+0
644 480001 .391983-3 .193977-1-.149837-1 .916556-3-.871606-5-.767888-5 .273898-1
645 480001 -.157598-1-.404669-3-.936707-5 .667556-5 .588116-1-.653858-2-.231223-2
646 480001 -.902526-5 .428885-2-.371500-3-.485864-3-.453525-6-.220031-5 .788931-1
647 480001 -.425028-2-.431952-2-.209559-5 .548310+3 .120963+4 .267157+1 .265206+1
648 480002 .139805+1 .471510+0 .307857+0 .361035+0 .174116+0 .199566+0 .172699-1
649 480002 -.135085-1-.102666-2 .279562-1-.163455-1 .956849-4 .801680-1-.214704-1
650 480002 .168198-1 .433653-2-.462360-3-.558667-3 .949662-1-.165934-1 .396366-2
651 * COMPOSITION 16
652 480000 .139646+1 .465152+0 .304202+0 .548669-3 .341406+0 .164781+0 .205990+0
653 480001 .310892-3 .217652-1-.159568-1 .568373-3-.212030-4-.120553-4 .281099-1
654 480001 -.165756-1-.357349-3-.221091-4 .685318-5 .332115-1-.486588-2-.754019-3
655 480001 -.182297-4 .269936-2-.316374-3-.262944-3-.497606-6-.113625-5 .333405-1
656 480001 -.737604-3-.118313-2-.806285-5 .548310+3 .120963+4 .271530+1 .261043+1
657 480002 .141279+1 .479917+0 .251402+0 .352613+0 .185750+0 .254891+0 .197138-1
658 480002 -.161454-1 .677775-3 .286650-1-.165779-1-.395548-3 .437858-1-.381494-2
659 480002 .138509-2 .269030-2-.357707-3-.376139-3 .366617-1-.135051-2-.213876-2
660 * COMPOSITION 17
661 480000 .136816+1 .463535+0 .343866+0 .573328-3 .346442+0 .155926+0 .162866+0
662 480001 .315963-3 .194689-1-.150309-1 .825577-3-.189732-4-.969983-5 .272223-1
663 480001 -.157351-1-.418857-3-.200172-4 .775154-5 .588076-1-.674341-2-.282793-2
664 480001 -.192892-4 .472111-2-.382081-3-.529382-3-.628056-6-.213153-5 .812551-1
665 480001 -.483211-2-.498921-2-.139960-4 .548310+3 .120963+4 .260784+1 .254784+1
666 480002 .119431+1 .755116+0 .426644-1 .317135+0 .174099+0 .227865+0 .170054-1
667 480002 -.103893-1-.526652-2 .277394-1-.166825-1 .487246-3 .825891-1-.541063-1
668 480002 .579837-1 .475678-2-.393109-3-.747759-3 .974709-1-.353778-1 .257438-1
669 * COMPOSITION 18
670 480000 .136141+1 .532112+0 .280048+0 .541056-3 .340929+0 .185452+0 .132819+0
671 480001 .345864-3 .193506-1-.148645-1 .664018-3-.148046-4-.904289-5 .272848-1
672 480001 -.158489-1-.368307-3-.157443-4 .738283-5 .586709-1-.746058-2-.210383-2
673 480001 -.155396-4 .459379-2-.490070-3-.426014-3-.575280-6-.215917-5 .812237-1
674 480001 -.612624-2-.364899-2-.102521-4 .548310+3 .120963+4 .262723+1 .257934+1
675 480002 .119893+1 .732138+0 .517291-1 .318487+0 .194167+0 .200965+0 .169294-1
676 480002 -.116681-1-.413193-2 .277098-1-.164732-1 .279534-3 .821726-1-.409297-1
677 480002 .461459-1 .461204-2-.486174-3-.652345-3 .965309-1-.275510-1 .193054-1
678 * COMPOSITION 19
679 480000 .137151+1 .513228+0 .275208+0 .519078-3 .343570+0 .176564+0 .128861+0
680 480001 .363136-3 .193215-1-.148627-1 .667856-3-.123629-4-.844020-5 .272960-1
681 480001 -.157812-1-.351934-3-.132301-4 .720171-5 .601489-1-.745031-2-.197100-2
682 480001 -.135739-4 .462446-2-.465569-3-.415854-3-.547705-6-.222170-5 .833964-1
683 480001 -.598539-2-.353504-2-.807876-5 .548310+3 .120963+4 .263408+1 .259567+1
684 480002 .121785+1 .440780+0 .518376+0 .311668+0 .196741+0 .187339+0 .172390-1
685 480002 -.164971-1 .402180-2 .277491-1-.158766-1-.711457-3 .808257-1 .603133-2
686 480002 -.326347-1 .467522-2-.586510-3-.456263-3 .985083-1-.258712-2-.236360-1
687 * COMPOSITION 20
688 480000 .137379+1 .476929+0 .340943+0 .475290-3 .343929+0 .162137+0 .152432+0
689 480001 .380206-3 .193041-1-.149703-1 .878098-3-.102655-4-.775465-5 .273085-1
690 480001 -.157438-1-.421960-3-.109975-4 .685132-5 .613623-1-.699048-2-.302736-2
691 480001 -.118139-4 .467713-2-.397998-3-.549975-3-.500038-6-.222893-5 .853647-1
692 480001 -.523167-2-.529833-2-.629479-5 .548310+3 .120963+4 .263665+1 .260356+1
693 480002 .121485+1 .879602+0-.236962+0 .310890+0 .224277+0 .143703+0 .171259-1
694 480002 -.906354-2-.882918-2 .277661-1-.169551-1 .114903-2 .833116-1-.648741-1
695 480002 .901164-1 .473017-2-.490689-3-.653205-3 .101376+0-.448701-1 .489102-1
696 * COMPOSITION 21
697 480000 .137583+1 .473310+0 .338610+0 .444517-3 .345208+0 .160901+0 .150887+0
698 480001 .393224-3 .192971-1-.149529-1 .872683-3-.863220-5-.710629-5 .272714-1
699 480001 -.157112-1-.396702-3-.926163-5 .664679-5 .623803-1-.704451-2-.308485-2
700 480001 -.107480-4 .476360-2-.398826-3-.548324-3-.468328-6-.226489-5 .871738-1

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4. Input Specifications

701	480001	-.524246-2-.542384-2-.527739-5 .548310+3 .120963+4 .263241+1 .260012+1
702	480002	.121772+1 .613418+0 .216706+0 .312412+0 .188648+0 .200635+0 .171612-1
703	480002	-.129670-1-.200318-2 .277561-1-.163073-1 .811020-4 .844200-1-.280456-1
704	480002	.257731-1 .481743-2-.480445-3-.667642-3 .103494+0-.215675-1 .814840-2
705	*	COMPOSITION 22
706	480000	.137826+1 .470988+0 .332117+0 .434405-3 .347915+0 .160080+0 .148164+0
707	480001	.397749-3 .193248-1-.149363-1 .843086-3-.806091-5-.684716-5 .272374-1
708	480001	-.156826-1-.389492-3-.865448-5 .659270-5 .629344-1-.708595-2-.302884-2
709	480001	-.104684-4 .485084-2-.400052-3-.536291-3-.458182-6-.228498-5 .879454-1
710	480001	-.523749-2-.536534-2-.503974-5 .548310+3 .120963+4 .262317+1 .258755+1
711	480002	.121851+1 .478939+0 .401022+0 .314773+0 .175581+0 .213629+0 .171969-1
712	480002	-.150167-1 .963816-3 .277494-1-.159703-1-.372648-3 .851626-1-.842651-2
713	480002	-.274905-2 .490635-2-.489325-3-.640962-3 .104576+0-.965354-2-.906207-2
714	*	COMPOSITION 23
715	480000	.138583+1 .457817+0 .329817+0 .436796-3 .352899+0 .154389+0 .149474+0
716	480001	.397428-3 .195810-1-.150635-1 .783968-3-.829236-5-.677690-5 .273558-1
717	480001	-.157365-1-.420498-3-.888012-5 .654080-5 .642108-1-.696774-2-.329110-2
718	480001	-.115016-4 .501651-2-.378565-3-.552403-3-.462971-6-.218495-5 .866174-1
719	480001	-.532446-2-.545420-2-.695254-5 .548310+3 .120963+4 .260084+1 .255400+1
720	480002	.121887+1 .437568+0 .445882+0 .317835+0 .174755+0 .204096+0 .172788-1
721	480002	-.157119-1 .193400-2 .278507-1-.159760-1-.490685-3 .879792-1-.301322-2
722	480002	-.132507-1 .507577-2-.498912-3-.615442-3 .103431+0-.792508-2-.129192-1
723	*	COMPOSITION 24
724	480000	.140971+1 .443578+0 .308520+0 .409643-3 .353898+0 .148457+0 .200071+0
725	480001	.405764-3 .215704-1-.158209-1 .594296-3-.881255-5-.836607-5 .279510-1
726	480001	-.164022-1-.374853-3-.931787-5 .625715-5 .350306-1-.482762-2-.808131-3
727	480001	-.108343-4 .276017-2-.295932-3-.276669-3-.371726-6-.115698-5 .366167-1
728	480001	-.688399-3-.133153-2-.467980-5 .548310+3 .120963+4 .271733+1 .263296+1
729	480002	.142812+1 .453857+0 .264320+0 .364715+0 .198427+0 .202119+0 .193285-1
730	480002	-.169022-1 .218466-2 .286051-1-.162935-1-.768891-3 .473681-1 .115403-2
731	480002	-.807297-2 .275008-2-.391936-3-.287702-3 .409178-1-.662761-3-.390060-2
732	*	COMPOSITION 25
733	480000	.141473+1 .530988+0 .258599+0 .506256-3 .339761+0 .179506+0 .127761+0
734	480001	.363442-3 .195094-1-.148840-1 .681418-3-.123550-4-.979031-5 .279411-1
735	480001	-.159648-1-.391651-3-.132987-4 .681635-5 .532947-1-.667511-2-.109597-2
736	480001	-.103008-4 .352795-2-.441712-3-.318224-3-.505438-6-.203458-5 .625164-1
737	480001	-.428965-2-.191833-2-.701562-6 .548310+3 .120963+4 .275964+1 .276142+1
738	480002	.142327+1 .532460+0 .231583+0 .352996+0 .251016+0 .812723-1 .174908-1
739	480002	-.165222-1 .373451-2 .284032-1-.158076-1-.983067-3 .718583-1 .925912-2
740	480002	-.306054-1 .356023-2-.558693-3-.320378-3 .755325-1 .173476-2-.212590-1
741	*	COMPOSITION 26
742	480000	.138803+1 .491897+0 .326714+0 .426294-3 .341538+0 .165687+0 .147288+0
743	480001	.397240-3 .193182-1-.148880-1 .909376-3-.789655-5-.759001-5 .275033-1
744	480001	-.157847-1-.413026-3-.852123-5 .659625-5 .585812-1-.663583-2-.217539-2
745	480001	-.737417-5 .413941-2-.396711-3-.467260-3-.438526-6-.226662-5 .767308-1
746	480001	-.440595-2-.406792-2 .552162-6 .548310+3 .120963+4 .269617+1 .268522+1
747	480002	.139525+1 .502100+0 .284656+0 .355135+0 .183369+0 .202882+0 .173576-1
748	480002	-.143732-1-.941748-5 .279951-1-.160617-1-.264568-3 .782697-1-.128345-1
749	480002	.876515-2 .417967-2-.447067-3-.607586-3 .918677-1-.105420-1-.226228-2
750	*	COMPOSITION 27
751	480000	.140799+1 .486309+0 .325370+0 .566925-3 .342057+0 .160713+0 .166469+0
752	480001	.313045-3 .197955-1-.152126-1 .935837-3-.196830-4-.124693-4 .279679-1
753	480001	-.161052-1-.408051-3-.209015-4 .717245-5 .493318-1-.577035-2-.146715-2
754	480001	-.149225-4 .343669-2-.355712-3-.388792-3-.572790-6-.186986-5 .573348-1
755	480001	-.253436-2-.255429-2-.289442-5 .548310+3 .120963+4 .272943+1 .271010+1
756	480002	.141681+1 .500894+0 .278471+0 .358896+0 .135500+0 .282906+0 .176693-1
757	480002	-.127643-1-.276520-2 .284326-1-.167546-1 .330629-3 .669753-1-.303702-1
758	480002	.364353-1 .345158-2-.364936-3-.563568-3 .682474-1-.185835-1 .156679-1
759	*	COMPOSITION 28
760	480000	.140957+1 .563187+0 .242150+0 .535346-3 .336627+0 .197310+0 .122292+0
761	480001	.342176-3 .197043-1-.148517-1 .613838-3-.154326-4-.106708-4 .280985-1
762	480001	-.160115-1-.402457-3-.164764-4 .706626-5 .494362-1-.691898-2-.753003-3
763	480001	-.129147-4 .331703-2-.494775-3-.276818-3-.540179-6-.198031-5 .554518-1
764	480001	-.479407-2-.122285-2-.321378-5 .548310+3 .120963+4 .276193+1 .275806+1
765	480002	.141447+1 .575782+0 .201755+0 .364975+0 .161338+0 .244547+0 .174654-1
766	480002	-.129833-1-.254304-2 .285879-1-.164371-1 .784934-4 .701215-1-.283644-1
767	480002	.332072-1 .332095-2-.485686-3-.468325-3 .685677-1-.194532-1 .150561-1
768	*	COMPOSITION 29
769	480000	.139382+1 .590336+0 .217866+0 .534141-3 .334186+0 .210549+0 .109585+0
770	480001	.344896-3 .196246-1-.147374-1 .523267-3-.150020-4-.105092-4 .279546-1

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771	480001	-.160265-1-.370412-3-.160347-4 .707628-5 .508433-1-.702743-2-.742795-3
772	480001	-.126809-4 .349384-2-.524188-3-.257106-3-.538565-6-.199814-5 .594330-1
773	480001	-.497936-2-.124993-2-.319954-5 .548310+3 .120963+4 .274004+1 .272888+1
774	480002	-.139803+1 .607309+0 .171952+0 .340975+0 .308461+0 .861303-1 .185915-1
775	480002	-.202872-1 .544069-2 .282024-1-.149466-1-.153390-2 .604175-1 .409307-1
776	480002	-.423865-1 .351225-2-.598492-3-.359452-3 .661585-1 .211083-1-.294633-1
777	*	COMPOSITION 30
778	480000	.141030+1 .495855+0 .312814+0 .529553-3 .341953+0 .164448+0 .151264+0
779	480001	.356805-3 .195591-1-.150669-1 .924458-3-.130923-4-.106701-4 .278972-1
780	480001	-.160115-1-.430294-3-.141577-4 .680498-5 .529740-1-.607951-2-.147494-2
781	480001	-.993797-5 .358691-2-.371245-3-.389843-3-.517849-6-.197451-5 .631384-1
782	480001	-.308830-2-.261059-2 .106874-5 .548310+3 .120963+4 .274111+1 .273631+1
783	480002	.141957+1 .509495+0 .265045+0 .355383+0 .195802+0 .179601+0 .174785-1
784	480002	-.154301-1 .168058-2 .283434-1-.160739-1-.626688-3 .712917-1-.362435-2
785	480002	-.589676-2 .361256-2-.423716-3-.499426-3 .755745-1-.361997-2-.902336-2
786	*	COMPOSITION 31
787	480000	.140734+1 .501580+0 .301460+0 .491235-3 .341301+0 .168015+0 .142015+0
788	480001	.370148-3 .194528-1-.149718-1 .855772-3-.114594-4-.934728-5 .277899-1
789	480001	-.159223-1-.403425-3-.123423-4 .675562-5 .551405-1-.641052-2-.174346-2
790	480001	-.972264-5 .373044-2-.397913-3-.398035-3-.492724-6-.206971-5 .674337-1
791	480001	-.381849-2-.314845-2-.434959-6 .548310+3 .120963+4 .273674+1 .273409+1
792	480002	.141640+1 .497521+0 .282676+0 .355589+0 .168336+0 .215146+0 .172971-1
793	480002	-.121476-1-.345930-2 .282907-1-.166926-1 .524267-3 .752578-1-.317649-1
794	480002	.371382-1 .376648-2-.481763-3-.461350-3 .817282-1-.225016-1 .181833-1
795	*	COMPOSITION 32
796	480000	.136878+1 .471868+0 .337532+0 .575750-3 .345326+0 .159809+0 .159884+0
797	480001	.313394-3 .194047-1-.149932-1 .815667-3-.193085-4-.984771-5 .272245-1
798	480001	-.157330-1-.410431-3-.203716-4 .778282-5 .577978-1-.679051-2-.267755-2
799	480001	-.193696-4 .459098-2-.393770-3-.512377-3-.631120-6-.213969-5 .801249-1
800	480001	-.483927-2-.480382-2-.137003-4 .548310+3 .120963+4 .261887+1 .256318+1
801	480002	.121413+1 .637495+0 .177909+0 .316845+0 .169298+0 .236110+0 .172685-1
802	480002	-.123787-1-.302699-2 .277008-1-.163793-1 .160956-3 .783218-1-.346500-1
803	480002	.366677-1 .462940-2-.418634-3-.714535-3 .945450-1-.239613-1 .133419-1
804	*	COMPOSITION 33
805	480000	.135925+1 .556620+0 .257580+0 .533413-3 .337921+0 .196532+0 .121151+0
806	480001	.353218-3 .193145-1-.147654-1 .615093-3-.137153-4-.892381-5 .273422-1
807	480001	-.158531-1-.350912-3-.146403-4 .730680-5 .587722-1-.767609-2-.178631-2
808	480001	-.143436-4 .452822-2-.525563-3-.384810-3-.562516-6-.219415-5 .806531-1
809	480001	-.641512-2-.318325-2-.860357-5 .548310+3 .120963+4 .263728+1 .259526+1
810	480002	.125613+1 .384000+0 .449747+0 .316524+0 .196161+0 .199264+0 .179019-1
811	480002	-.177959-1 .286454-2 .276331-1-.156379-1-.636194-3 .726428-1 .187561-1
812	480002	-.210754-1 .456172-2-.611179-3-.500984-3 .907284-1 .615492-2-.182729-1
813	*	COMPOSITION 34
814	480000	.139319+1 .573592+0 .234219+0 .535593-3 .335680+0 .202874+0 .117404+0
815	480001	.343671-3 .196260-1-.147995-1 .581955-3-.151799-4-.104855-4 .279018-1
816	480001	-.160072-1-.376829-3-.162114-4 .711684-5 .511766-1-.696182-2-.850390-3
817	480001	-.129619-4 .354894-2-.506070-3-.278303-3-.541644-6-.200443-5 .606077-1
818	480001	-.488055-2-.145049-2-.366994-5 .548310+3 .120963+4 .273153+1 .271733+1
819	480002	.139772+1 .588304+0 .190959+0 .352338+0 .237909+0 .163119+0 .180312-1
820	480002	-.168218-1 .164175-2 .282691-1-.156418-1-.757098-3 .659962-1 .823696-2
821	480002	-.666158-2 .356197-2-.540701-3-.425260-3 .704259-1 .209137-2-.878350-2
822	*	COMPOSITION 35
823	480000	.136749+1 .483526+0 .326252+0 .581661-3 .345930+0 .166544+0 .155008+0
824	480001	.310024-3 .197163-1-.150943-1 .743850-3-.199998-4-.950643-5 .273947-1
825	480001	-.158364-1-.417207-3-.210245-4 .775670-5 .612714-1-.707010-2-.316294-2
826	480001	-.208813-4 .492803-2-.421885-3-.528995-3-.644746-6-.208709-5 .805883-1
827	480001	-.554897-2-.509985-2-.165953-4 .548310+3 .120963+4 .258854+1 .251831+1
828	480002	.122033+1 .494346+0 .373361+0 .316077+0 .166238+0 .245610+0 .176455-1
829	480002	-.149332-1 .229225-3 .278101-1-.160988-1-.335310-3 .814647-1-.115672-1
830	480002	.411531-2 .497333-2-.473061-3-.712800-3 .942044-1-.109637-1-.572076-2
831	*	COMPOSITION 36
832	480000	.135434+1 .547817+0 .267754+0 .537958-3 .339769+0 .194117+0 .125811+0
833	480001	.352493-3 .193961-1-.148121-1 .619854-3-.138514-4-.862939-5 .272533-1
834	480001	-.158344-1-.352058-3-.147576-4 .736445-5 .600077-1-.776340-2-.207358-2
835	480001	-.153432-4 .478488-2-.523005-3-.416131-3-.573134-6-.217919-5 .832786-1
836	480001	-.661589-2-.364276-2-.106405-4 .548310+3 .120963+4 .261156+1 .255749+1
837	480002	.125127+1 .350148+0 .488205+0 .318349+0 .184847+0 .216542+0 .179971-1
838	480002	-.181371-1 .313780-2 .275639-1-.155670-1-.714496-3 .739797-1 .214216-1
839	480002	-.240711-1 .481947-2-.594834-3-.563008-3 .933394-1 .788139-2-.212834-1
840	*	COMPOSITION 37

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841	480000	.136700+1 .499444+0 .298722+0 .527825-3 .345268+0 .171954+0 .139190+0
842	480001	.361514-3 .194413-1 .149095-1 .716024-3 .125683-4 .826760-5 .272598-1
843	480001	-.157525-1 .367382-3 .134387-4 .728736-5 .611693-1 .740449-2 .234679-2
844	480001	-.144480-4 .484873-2 .448843-3 .465755-3 .561619-6 .222115-5 .844169-1
845	480001	-.590889-2 .416929-2 .959510-5 .548310+3 .120963+4 .260861+1 .255703+1
846	480002	.121516+1 .433241+0 .504159+0 .313750+0 .183929+0 .211384+0 .174020-1
847	480002	-.163024-1 .319628-2 .277331-1 .158765-1 .636341-3 .816584-1 .334309-2
848	480002	-.241856-1 .489986-2 .550469-3 .550164-3 .993149-1 .363809-2 .200252-1
849	*	COMPOSITION 38
850	480000	.136701+1 .488788+0 .315906+0 .484636-3 .345302+0 .167716+0 .145227+0
851	480001	.378146-3 .195571-1 .150030-1 .743487-3 .106680-4 .758314-5 .273589-1
852	480001	-.157889-1 .413552-3 .113958-4 .690708-5 .629319-1 .729319-2 .293100-2
853	480001	-.133168-4 .498007-2 .431440-3 .518894-3 .513471-6 .215821-5 .850713-1
854	480001	-.597228-2 .486906-2 .918903-5 .548310+3 .120963+4 .259969+1 .254646+1
855	480002	.120963+1 .682446+0 .966555-1 .312295+0 .214087+0 .162902+0 .173736-1
856	480002	-.124066-1 .326650-2 .278111-1 .165157-1 .306784-3 .849903-1 .344463-1
857	480002	.364827-1 .503469-2 .547712-3 .595561-3 .100512+0 .269934-1 .168547-1
858	*	COMPOSITION 39
859	480000	.136573+1 .477332+0 .344050+0 .450572-3 .344047+0 .163650+0 .157819+0
860	480001	.392637-3 .198116-1 .150924-1 .772133-3 .902551-5 .690542-5 .275703-1
861	480001	-.158135-1 .472108-3 .963824-5 .660645-5 .654223-1 .715339-2 .364977-2
862	480001	-.127854-4 .517889-2 .411739-3 .593361-3 .478233-6 .209502-5 .826435-1
863	480001	-.592746-2 .581417-2 .934234-5 .548310+3 .120963+4 .257826+1 .250978+1
864	480002	.121740+1 .752800+0 .395884-1 .312655+0 .192841+0 .207353+0 .177167-1
865	480002	-.107741-1 .659290-2 .279783-1 .166921-1 .583587-3 .866863-1 .510904-1
866	480002	.683770-1 .523182-2 .456393-3 .815486-3 .970905-1 .343674-1 .305903-1
867	*	COMPOSITION 40
868	480000	.138519+1 .464486+0 .321915+0 .421137-3 .342464+0 .162195+0 .209952+0
869	480001	.402088-3 .217873-1 .157998-1 .614173-3 .947275-5 .851939-5 .280277-1
870	480001	-.164481-1 .386727-3 .999891-5 .631516-5 .324213-1 .487140-2 .857693-3
871	480001	-.120680-4 .273636-2 .314907-3 .287348-3 .377963-6 .111802-5 .325841-1
872	480001	-.756080-3 .140958-2 .630394-5 .548310+3 .120963+4 .269547+1 .256378+1
873	480002	.140303+1 .454471+0 .301960+0 .351523+0 .124375+0 .367050+0 .197995-1
874	480002	-.119984-1 .599469-2 .286310-1 .175451-1 .118061-2 .432496-1 .266630-1
875	480002	.384357-1 .272761-2 .264919-3 .554505-3 .362172-1 .769064-2 .746038-2
876	*	COMPOSITION 41
877	480000	.140372+1 .477429+0 .335707+0 .445736-3 .343295+0 .159285+0 .150629+0
878	480001	.388281-3 .193488-1 .149917-1 .981364-3 .909968-5 .815686-5 .276387-1
879	480001	-.158283-1 .435807-3 .980821-5 .654977-5 .579280-1 .637957-2 .224728-2
880	480001	-.811232-5 .396189-2 .371641-3 .463485-3 .454439-6 .215790-5 .736851-1
881	480001	-.383022-2 .410045-2 .485735-6 .548310+3 .120963+4 .272050+1 .271804+1
882	480002	.141266+1 .477525+0 .308558+0 .358021+0 .155254+0 .229512+0 .172058-1
883	480002	-.122120-1 .300894-2 .281545-1 .166643-1 .494810-3 .789892-1 .326640-1
884	480002	.356145-1 .400293-2 .449754-3 .548084-3 .892930-1 .228181-1 .156279-1
885	*	COMPOSITION 42
886	480000	.136769+1 .480103+0 .328420+0 .580432-3 .345101+0 .163337+0 .158044+0
887	480001	.308103-3 .195871-1 .149999-1 .806190-3 .200189-4 .100557-4 .272688-1
888	480001	-.157685-1 .371143-3 .211059-4 .782014-5 .569686-1 .681906-2 .234636-2
889	480001	-.197923-4 .458707-2 .402189-3 .483853-3 .641880-6 .212997-5 .773380-1
890	480001	-.482508-2 .429621-2 .137156-4 .548310+3 .120963+4 .261161+1 .255047+1
891	480002	.137442+1 .491435+0 .287700+0 .359454+0 .180705+0 .214629+0 .176516-1
892	480002	-.145184-1 .664420-4 .278236-1 .160450-1 .256707-3 .766206-1 .140728-1
893	480002	.863840-2 .464103-2 .461101-3 .628308-3 .920630-1 .120988-1 .232394-2
894	*	COMPOSITION 43
895	480000	.135600+1 .582450+0 .223527+0 .539739-3 .336872+0 .208869+0 .108374+0
896	480001	.345635-3 .194289-1 .147737-1 .500419-3 .148722-4 .920482-5 .273443-1
897	480001	-.159436-1 .318859-3 .158125-4 .731928-5 .569122-1 .777812-2 .138532-2
898	480001	-.153189-4 .445054-2 .560415-3 .322716-3 .569934-6 .211457-5 .774956-1
899	480001	-.656954-2 .242712-2 .968886-5 .548310+3 .120963+4 .263515+1 .258879+1
900	480002	.136009+1 .595659+0 .180831+0 .344440+0 .305566+0 .872608-1 .183804-1
901	480002	-.200778-1 .512323-2 .276294-1 .148805-1 .150687-2 .681371-1 .446101-1
902	480002	-.480289-1 .448337-2 .583299-3 .505904-3 .855488-1 .231949-1 .357641-1
903	*	COMPOSITION 44
904	480000	.137440+1 .515003+0 .270756+0 .515671-3 .343270+0 .176710+0 .129006+0
905	480001	.363722-3 .194131-1 .149033-1 .655206-3 .123171-4 .857717-5 .273498-1
906	480001	-.158299-1 .347761-3 .131808-4 .713143-5 .584136-1 .732657-2 .175663-2
907	480001	-.131933-4 .446583-2 .461245-3 .394218-3 .540055-6 .217820-5 .796733-1
908	480001	-.571047-2 .316408-2 .735068-5 .548310+3 .120963+4 .264342+1 .260798+1
909	480002	.138183+1 .519291+0 .260109+0 .357763+0 .267084+0 .788156-1 .173924-1
910	480002	-.166341-1 .420267-2 .279041-1 .157197-1 .106533-2 .798520-1 .884782-2

4. Input Specifications

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911 480002 -.378308-1 .452735-2 .577044-3 .440849-3 .954952-1 .808067-3 .262579-1
912 * COMPOSITION 45
913 480000 .137651+1 .472680+0 .344632+0 .462868-3 .343956+0 .159904+0 .156496+0
914 480001 .384923-3 .193785-1 .149977-1 .888006-3 .969371-5 .763092-5 .273194-1
915 480001 -.157542-1 .410951-3 .103870-4 .676148-5 .600539-1 .690190-2 .283036-2
916 480001 -.112792-4 .456727-2 .387276-3 .539881-3 .484434-6 .220284-5 .825537-1
917 480001 -.494145-2 .500386-2 .566282-5 .548310+3 .120963+4 .264260+1 .261193+1
918 480002 .121990+1 .816922+0 .116802+0 .317494+0 .201044+0 .176523+0 .169402-1
919 480002 -.913564-2 .832970-2 .277241-1 .166845-1 .858485-3 .831510-1 .610931-1
920 480002 .838136-1 .468212-2 .623338-3 .447588-3 .989096-1 .408691-1 .430033-1
921 * COMPOSITION 46
922 480000 .138005+1 .470534+0 .332187+0 .434286-3 .347384+0 .159131+0 .151108+0
923 480001 .397347-3 .193994-1 .149665-1 .839526-3 .813617-5 .697687-5 .272576-1
924 480001 -.157103-1 .386047-3 .873050-5 .658719-5 .611074-1 .702319-2 .272945-2
925 480001 -.103110-4 .469691-2 .392386-3 .522007-3 .455893-6 .224523-5 .844910-1
926 480001 -.509574-2 .487868-2 .487779-5 .548310+3 .120963+4 .263115+1 .259767+1
927 480002 .122208+1 .495188+0 .391767+0 .320500+0 .176343+0 .208306+0 .169995-1
928 480002 -.146277-1 .664408-3 .276940-1 .158874-1 .370946-3 .843086-1 .103519-1
929 480002 .474552-3 .481578-2 .511353-3 .618559-3 .101368+0 .104342-1 .684150-2
930 * COMPOSITION 47
931 480000 .138624+1 .455804+0 .329973+0 .435838-3 .352972+0 .152826+0 .153111+0
932 480001 .397913-3 .196387-1 .150850-1 .777594-3 .827642-5 .678283-5 .273088-1
933 480001 -.157470-1 .404295-3 .885563-5 .656088-5 .616648-1 .685221-2 .299977-2
934 480001 -.114879-4 .487242-2 .369880-3 .532030-3 .457272-6 .214990-5 .835578-1
935 480001 -.495661-2 .499781-2 .712466-5 .548310+3 .120963+4 .260524+1 .255733+1
936 480002 .122245+1 .437426+0 .455653+0 .325595+0 .175470+0 .196657+0 .170520-1
937 480002 -.156660-1 .214114-2 .277905-1 .157969-1 .617399-3 .871769-1 .870794-3
938 480002 -.157562-1 .500451-2 .506247-3 .616025-3 .100566+0 .691472-2 .133992-1
939 * COMPOSITION 48
940 480000 .140331+1 .469900+0 .303042+0 .547523-3 .340779+0 .164849+0 .195307+0
941 480001 .307186-3 .214284-1 .157861-1 .641529-3 .215435-4 .127754-4 .281212-1
942 480001 -.164660-1 .385186-3 .225320-4 .667469-5 .352050-1 .482873-2 .648146-3
943 480001 -.152769-4 .269085-2 .319178-3 .273860-3 .508180-6 .120868-5 .356709-1
944 480001 -.666589-3 .102183-2 .269586-5 .548310+3 .120963+4 .274647+1 .268964+1
945 480002 .141880+1 .483543+0 .250738+0 .352107+0 .186175+0 .246799+0 .193654-1
946 480002 -.160027-1 .732206-3 .286425-1 .165164-1 .412272-3 .462859-1 .379451-2
947 480002 .163096-2 .268148-2 .360043-3 .382721-3 .395072-1 .123531-2 .201400-2
948 * COMPOSITION 49
949 480000 .138443+1 .481151+0 .333654+0 .569878-3 .343273+0 .160854+0 .166439+0
950 480001 .314125-3 .196646-1 .151018-1 .880463-3 .193222-4 .112096-4 .275480-1
951 480001 -.159327-1 .387451-3 .204556-4 .765030-5 .525606-1 .611491-2 .186684-2
952 480001 -.165968-4 .393494-2 .374235-3 .431191-3 .595801-6 .203989-5 .673285-1
953 480001 -.340678-2 .339034-2 .765423-5 .548310+3 .120963+4 .267002+1 .262906+1
954 480002 .139155+1 .494783+0 .289910+0 .360891+0 .131262+0 .291221+0 .175978-1
955 480002 .125309-1 .311521-2 .280730-1 .166245-1 .401568-3 .711785-1 .324427-1
956 480002 .385304-1 .395981-2 .385199-3 .621033-3 .798253-1 .206856-1 .155046-1
957 * COMPOSITION 50
958 480000 .137569+1 .579735+0 .230789+0 .533905-3 .334969+0 .207206+0 .114273+0
959 480001 .347491-3 .195488-1 .147498-1 .554371-3 .145976-4 .992087-5 .276591-1
960 480001 -.159605-1 .339968-3 .155805-4 .724590-5 .532541-1 .711708-2 .106615-2
961 480001 -.133716-4 .385759-2 .522698-3 .292552-3 .544684-6 .206300-5 .669619-1
962 480001 -.525060-2 .191754-2 .541355-5 .548310+3 .120963+4 .269448+1 .266795+1
963 480002 .137998+1 .593031+0 .188859+0 .342439+0 .297522+0 .100036+0 .184387-1
964 480002 -.194427-1 .448619-2 .279468-1 .150116-1 .134440-2 .638268-1 .345080-1
965 480002 -.355648-1 .388037-2 .590715-3 .406933-3 .745626-1 .174727-1 .265355-1
966 * COMPOSITION 51
967 480000 .139525+1 .513920+0 .272143+0 .513934-3 .341918+0 .174179+0 .132293+0
968 480001 .362565-3 .194856-1 .149090-1 .704415-3 .124134-4 .946773-5 .276308-1
969 480001 -.158843-1 .374710-3 .133381-4 .707703-5 .552985-1 .669686-2 .133247-2
970 480001 -.111751-4 .390532-2 .431556-3 .348029-3 .518064-6 .211695-5 .700494-1
971 480001 -.445379-2 .243825-2 .289879-5 .548310+3 .120963+4 .270425+1 .268893+1
972 480002 .140340+1 .519772+0 .238814+0 .355922+0 .240037+0 .863770-1 .173962-1
973 480002 -.165318-1 .430089-2 .281557-1 .157189-1 .113824-2 .750338-1 .806308-2
974 480002 -.348130-1 .394442-2 .535529-3 .375611-3 .843158-1 .776506-3 .246764-1
975 * COMPOSITION 52
976 480000 .139018+1 .478302+0 .350356+0 .462549-3 .340677+0 .161298+0 .158372+0
977 480001 .382565-3 .193920-1 .149961-1 .998293-3 .987939-5 .828945-5 .275575-1
978 480001 -.158212-1 .408324-3 .106193-4 .677178-5 .572632-1 .635527-2 .254712-2
979 480001 -.941901-5 .404263-2 .369598-3 .509110-3 .472275-6 .217373-5 .739892-1
980 480001 -.384278-2 .474385-2 .171291-5 .548310+3 .120963+4 .270010+1 .268777+1

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4. Input Specifications

981	480002	.139856+1 .471880+0 .333718+0 .354899+0 .845956-1 .373721+0 .173388-1
982	480002	-.792254-2-.110268-1 .280824-1-.175761-1 .223475-2 .774190-1-.733659-1
983	480002	.110978+0 .408489-2-.419290-3-.655275-3 .889336-1-.480272-1 .611870-1
984	*	COMPOSITION 53
985	480000	.139607+1 .451542+0 .335075+0 .442343-3 .351474+0 .150208+0 .156857+0
986	480001	.393753-3 .194854-1-.150320-1 .847654-3-.868321-5-.736118-5 .272550-1
987	480001	-.157103-1-.373797-3-.929948-5 .665872-5 .592113-1-.654006-2-.239163-2
988	480001	-.104079-4 .444412-2-.353613-3-.496950-3-.454127-6-.214133-5 .812140-1
989	480001	-.431511-2-.451610-2-.504487-5 .548310+3 .120963+4 .265009+1 .262239+1
990	480002	.140535+1 .450975+0 .311959+0 .367795+0 .195204+0 .157287+0 .172355-1
991	480002	-.147858-1 .863223-3 .279009-1-.160432-1-.310518-3 .819211-1-.101167-1
992	480002	-.222296-2 .450049-2-.472387-3-.529945-3 .981878-1-.105121-1-.668198-2
993	*	COMPOSITION 54
994	480000	.137015+1 .474065+0 .333922+0 .576551-3 .344859+0 .160095+0 .160808+0
995	480001	.311516-3 .195066-1-.150280-1 .812774-3-.195684-4-.100333-4 .272658-1
996	480001	-.157758-1-.394589-3-.206431-4 .776097-5 .560298-1-.675301-2-.238613-2
997	480001	-.193146-4 .445408-2-.392218-3-.491081-3-.633564-6-.211926-5 .765399-1
998	480001	-.473211-2-.431121-2-.132557-4 .548310+3 .120963+4 .262461+1 .256945+1
999	480002	.137657+1 .485124+0 .294365+0 .361408+0 .149498+0 .256052+0 .174843-1
1000	480002	-.130793-1-.212043-2 .278268-1-.163598-1 .139078-3 .766673-1-.292837-1
1001	480002	.298279-1 .450545-2-.443351-3-.648325-3 .915401-1-.208820-1 .100446-1
1002	*	COMPOSITION 55
1003	480000	.136060+1 .560911+0 .251923+0 .533072-3 .337287+0 .198495+0 .120714+0
1004	480001	.352089-3 .194131-1-.148047-1 .592647-3-.139142-4-.908144-5 .273859-1
1005	480001	-.159048-1-.346063-3-.148417-4 .726058-5 .569826-1-.756574-2-.158827-2
1006	480001	-.142983-4 .438928-2-.524366-3-.363426-3-.559389-6-.214474-5 .770085-1
1007	480001	-.615835-2-.282815-2-.830728-5 .548310+3 .120963+4 .264389+1 .260300+1
1008	480002	.136552+1 .570198+0 .213350+0 .346610+0 .274831+0 .120158+0 .181098-1
1009	480002	-.180518-1 .298966-2 .277386-1-.153598-1-.952682-3 .707677-1 .237453-1
1010	480002	-.252721-1 .442851-2-.587027-3-.495373-3 .870642-1 .968266-2-.206378-1
1011	*	COMPOSITION 56
1012	480000	.139077+1 .475908+0 .329174+0 .572946-3 .343162+0 .157738+0 .164119+0
1013	480001	.311042-3 .196869-1-.151307-1 .889180-3-.197521-4-.115974-4 .276556-1
1014	480001	-.159531-1-.390545-3-.209228-4 .766694-5 .518306-1-.598318-2-.172838-2
1015	480001	-.162671-4 .379970-2-.362800-3-.413726-3-.596764-6-.204658-5 .648639-1
1016	480001	-.312869-2-.312857-2-.644711-5 .548310+3 .120963+4 .268594+1 .265135+1
1017	480002	.139836+1 .487601+0 .287999+0 .359357+0 .140576+0 .265664+0 .175812-1
1018	480002	-.127192-1-.251243-2 .281831-1-.166325-1 .304909-3 .705022-1-.301061-1
1019	480002	.325431-1 .382537-2-.392481-3-.567447-3 .774444-1-.197492-1 .132769-1
1020	*	COMPOSITION 57
1021	480000	.138262+1 .557671+0 .258440+0 .528429-3 .335725+0 .195896+0 .126488+0
1022	480001	.353083-3 .195395-1-.148121-1 .659996-3-.137557-4-.989149-5 .277210-1
1023	480001	-.159564-1-.364869-3-.147341-4 .715584-5 .531924-1-.687422-2-.124971-2
1024	480001	-.122762-4 .378264-2-.485154-3-.329429-3-.534102-6-.207343-5 .659451-1
1025	480001	-.476408-2-.226428-2-.385105-5 .548310+3 .120963+4 .270755+1 .268732+1
1026	480002	.138801+1 .567443+0 .219821+0 .344891+0 .266016+0 .132399+0 .181647-1
1027	480002	-.175917-1 .257183-2 .280655-1-.154771-1-.870412-3 .661108-1 .175509-1
1028	480002	-.174503-1 .380849-2-.564903-3-.426483-3 .751990-1 .699887-2-.151032-1
1029	*	COMPOSITION 58
1030	480000	.138799+1 .498871+0 .303066+0 .502718-3 .342283+0 .168954+0 .143592+0
1031	480001	.367865-3 .194687-1-.149437-1 .803556-3-.117347-4-.906563-5 .275209-1
1032	480001	-.158476-1-.383610-3-.126057-4 .705492-5 .562464-1-.658102-2-.181885-2
1033	480001	-.109930-4 .406429-2-.409107-3-.412122-3-.509146-6-.214567-5 .731325-1
1034	480001	-.428030-2-.336556-2-.327568-5 .548310+3 .120963+4 .268547+1 .266446+1
1035	480002	.139611+1 .498776+0 .278696+0 .356496+0 .189462+0 .185194+0 .173900-1
1036	480002	-.135616-1-.120830-2 .280599-1-.163803-1 .120174-3 .762206-1-.201147-1
1037	480002	.173217-1 .410591-2-.507586-3-.462552-3 .877338-1-.165193-1 .645365-2
1038	*	COMPOSITION 59
1039	480000	.138220+1 .476854+0 .347513+0 .456227-3 .341697+0 .161396+0 .157916+0
1040	480001	.385894-3 .194056-1-.149909-1 .963623-3-.950712-5-.797328-5 .274351-1
1041	480001	-.157866-1-.411374-3-.102065-4 .676234-5 .579343-1-.650723-2-.246060-2
1042	480001	-.970971-5 .422145-2-.377633-3-.504793-3-.467635-6-.217649-5 .769650-1
1043	480001	-.417931-2-.458090-2-.274794-5 .548310+3 .120963+4 .267580+1 .265515+1
1044	480002	.139075+1 .473600+0 .324165+0 .356164+0 .112709+0 .317492+0 .173579-1
1045	480002	-.980160-2-.734705-2 .279806-1-.171871-1 .148877-2 .783134-1-.567635-1
1046	480002	.772650-1 .426698-2-.442133-3-.629412-3 .921323-1-.381229-1 .404556-1
1047	*	COMPOSITION 60
1048	480000	.137072+1 .480883+0 .329210+0 .427788-3 .345074+0 .163936+0 .154218+0
1049	480001	.400589-3 .194532-1-.149091-1 .811964-3-.779441-5-.703674-5 .271727-1
1050	480001	-.156878-1-.372068-3-.835493-5 .654891-5 .585478-1-.682153-2-.225508-2

4. Input Specifications

1051	480001	-.973888-5 .456252-2 .401480-3 .487987-3 .439350-6 .216797-5 .813843-1
1052	480001	-.491873-2 .435950-2 .466424-5 .548310+3 .120963+4 .263172+1 .259007+1
1053	480002	.137763+1 .489767+0 .291136+0 .359184+0 .193326+0 .191376+0 .174994-1
1054	480002	-.149632-1 .745963-3 .277387-1 .158626-1 .400780-3 .782193-1 .806830-2
1055	480002	.117696-3 .461185-2 .463634-3 .619497-3 .965856-1 .844523-2 .774269-2
1056	*	COMPOSITION 61
1057	480000	.138341+1 .466708+0 .337468+0 .444259-3 .346649+0 .157086+0 .153118+0
1058	480001	.392697-3 .193741-1 .149946-1 .869030-3 .871105-5 .726830-5 .272998-1
1059	480001	-.157307-1 .394351-3 .934400-5 .663443-5 .608057-1 .691343-2 .276284-2
1060	480001	-.105155-4 .460083-2 .381062-3 .529146-3 .465401-6 .222584-5 .838337-1
1061	480001	-.493795-2 .491510-2 .489577-5 .548310+3 .120963+4 .264302+1 .261525+1
1062	480002	.122259+1 .582487+0 .276329+0 .319429+0 .184522+0 .194697+0 .168908-1
1063	480002	-.131122-1 .130326-2 .277240-1 .161122-1 .101294-3 .845494-1 .240989-1
1064	480002	.183263-1 .471943-2 .543152-3 .562601-3 .100876+0 .187124-1 .415990-2
1065	*	COMPOSITION 62
1066	480000	.136992+1 .491611+0 .311991+0 .492267-3 .344630+0 .168257+0 .142605+0
1067	480001	.374048-3 .193576-1 .149475-1 .764701-3 .110784-4 .789524-5 .272716-1
1068	480001	-.157665-1 .397773-3 .118499-4 .698410-5 .612114-1 .725228-2 .266934-2
1069	480001	-.129375-4 .476370-2 .430865-3 .497755-3 .519945-6 .220218-5 .855784-1
1070	480001	-.574129-2 .461307-2 .795323-5 .548310+3 .120963+4 .262360+1 .258264+1
1071	480002	.121040+1 .730990+0 .152614-1 .311355+0 .222939+0 .144684+0 .171731-1
1072	480002	-.117422-1 .428674-2 .277375-1 .166117-1 .525489-3 .831782-1 .397655-1
1073	480002	.462576-1 .481786-2 .552903-3 .551699-3 .101380+0 .305331-1 .237878-1
1074	*	COMPOSITION 63
1075	480000	.141194+1 .486611+0 .339246+0 .458811-3 .340051+0 .163331+0 .151750+0
1076	480001	.382243-3 .193684-1 .149990-1 .102342-2 .988728-5 .858976-5 .278290-1
1077	480001	-.158858-1 .428763-3 .106553-4 .656123-5 .560767-1 .626983-2 .235232-2
1078	480001	-.844006-5 .369988-2 .375132-3 .466820-3 .464952-6 .211314-5 .678590-1
1079	480001	-.355944-2 .427997-2 .700852-6 .548310+3 .120963+4 .275494+1 .275932+1
1080	480002	.142083+1 .480990+0 .319839+0 .354193+0 .100844+0 .334912+0 .172776-1
1081	480002	-.865681-2 .927114-2 .283155-1 .173894-1 .171578-2 .762253-1 .650592-1
1082	480002	.935327-1 .373706-2 .418608-3 .611223-3 .825258-1 .418507-1 .500471-1
1083	*	COMPOSITION 64
1084	480000	.140643+1 .601085+0 .201216+0 .532366-3 .333440+0 .215397+0 .102503+0
1085	480001	.344454-3 .196839-1 .147014-1 .455910-3 .151078-4 .105414-4 .281403-1
1086	480001	-.160310-1 .375092-3 .161377-4 .704977-5 .492516-1 .715102-2 .537357-3
1087	480001	-.127350-4 .328431-2 .542081-3 .228085-3 .537040-6 .198694-5 .546530-1
1088	480001	-.521276-2 .841237-3 .317134-5 .548310+3 .120963+4 .276931+1 .276804+1
1089	480002	.141039+1 .618073+0 .156284+0 .339796+0 .322060+0 .653908-1 .187175-1
1090	480002	-.208730-1 .620463-2 .283728-1 .148362-1 .168804-2 .582484-1 .460406-1
1091	480002	-.494189-1 .330195-2 .623957-3 .316750-3 .609755-1 .236417-1 .328506-1
1092	*	COMPOSITION 65
1093	480000	.137157+1 .488699+0 .320417+0 .477670-3 .343469+0 .166690+0 .148105+0
1094	480001	.379304-3 .194159-1 .149705-1 .795813-3 .104364-4 .779862-5 .273000-1
1095	480001	-.157806-1 .391838-3 .111674-4 .687400-5 .597158-1 .710483-2 .255376-2
1096	480001	-.122083-4 .461348-2 .417734-3 .496859-3 .500455-6 .217760-5 .823357-1
1097	480001	-.532696-2 .446081-2 .696133-5 .548310+3 .120963+4 .263356+1 .259680+1
1098	480002	.121649+1 .741404+0 .224316-1 .317335+0 .210420+0 .163619+0 .169887-1
1099	480002	-.109120-1 .522836-2 .277113-1 .165049-1 .494915-3 .827561-1 .446459-1
1100	480002	.542560-1 .472963-2 .647036-3 .423369-3 .983394-1 .321394-1 .270167-1
1101	*	COMPOSITION 66
1102	480000	.136937+1 .484442+0 .327504+0 .426275-3 .344956+0 .165428+0 .148697+0
1103	480001	.400747-3 .194060-1 .149012-1 .822976-3 .767443-5 .681460-5 .272433-1
1104	480001	-.156984-1 .383209-3 .824410-5 .654629-5 .611648-1 .718640-2 .264182-2
1105	480001	-.986694-5 .477561-2 .416906-3 .512426-3 .448094-6 .227528-5 .841864-1
1106	480001	-.533777-2 .479287-2 .429677-5 .548310+3 .120963+4 .262028+1 .257966+1
1107	480002	.121970+1 .476948+0 .426978+0 .319228+0 .171401+0 .226732+0 .171778-1
1108	480002	-.150309-1 .109965-2 .276595-1 .158140-1 .424828-3 .827452-1 .684937-2
1109	480002	-.232689-2 .488796-2 .497145-3 .667966-3 .100337+0 .808373-2 .929994-2
1110	*	COMPOSITION 67
1111	480000	.138811+1 .546384+0 .268196+0 .525909-3 .336493+0 .189831+0 .131061+0
1112	480001	.355128-3 .195389-1 .148562-1 .708909-3 .134525-4 .998815-5 .277694-1
1113	480001	-.159697-1 .379081-3 .144391-4 .706529-5 .531097-1 .672572-2 .127073-2
1114	480001	-.116704-4 .372805-2 .463645-3 .338921-3 .528016-6 .205603-5 .651389-1
1115	480001	-.444162-2 .228677-2 .273830-5 .548310+3 .120963+4 .271684+1 .270091+1
1116	480002	.139429+1 .555144+0 .230401+0 .346626+0 .250249+0 .142559+0 .180048-1
1117	480002	-.168463-1 .203575-2 .281402-1 .156718-1 .746592-3 .673266-1 .106783-1
1118	480002	-.122980-1 .375475-2 .543654-3 .430818-3 .752128-1 .305598-2 .119112-1
1119	*	COMPOSITION 68
1120	480000	.139243+1 .471927+0 .312924+0 .410147-3 .338481+0 .166156+0 .197995+0

4. Input Specifications

1121	480001	.402919-3 .213195-1-.157065-1 .639467-3-.880607-5-.854078-5 .279634-1
1122	480001	-.163884-1-.378252-3-.933452-5 .624211-5 .367620-1-.489262-2-.823357-3
1123	480001	-.939310-5 .279027-2-.320602-3-.286472-3-.375086-6-.122034-5 .389933-1
1124	480001	-.798433-3-.137352-2-.219794-5 .548310+3 .120963+4 .273795+1 .268109+1
1125	480002	.140757+1 .475940+0 .272407+0 .348202+0 .156450+0 .304224+0 .193558-1
1126	480002	-.139447-1-.242828-2 .285217-1-.169521-1 .329044-3 .478453-1-.155085-1
1127	480002	.196201-1 .278033-2-.310323-3-.482261-3 .430576-1-.472363-2 .255093-2
1128	*	COMPOSITION 69
1129	480000	.137828+1 .486917+0 .337832+0 .568110-3 .343484+0 .165266+0 .168230+0
1130	480001	.316621-3 .196496-1-.150452-1 .843601-3-.189544-4-.105127-4 .274357-1
1131	480001	-.158622-1-.388268-3-.200263-4 .766376-5 .532301-1-.642299-2-.204040-2
1132	480001	-.176628-4 .407876-2-.395087-3-.456812-3-.600911-6-.202616-5 .697472-1
1133	480001	-.407319-2-.373086-2-.104884-4 .548310+3 .120963+4 .265355+1 .260547-1
1134	480002	.138490+1 .501373+0 .292655+0 .361686+0 .131680+0 .305724+0 .176539-1
1135	480002	-.126763-1-.326534-2 .279688-1-.164841-1 .370961-3 .717102-1-.312918-1
1136	480002	.394111-1 .410705-2-.391761-3-.681458-3 .823234-1-.198932-1 .144365-1
1137	*	COMPOSITION 70
1138	480000	.139312+1 .442464+0 .372777+0 .544615-3 .346501+0 .142036+0 .184170+0
1139	480001	.337169-3 .196415-1-.152189-1 .101045-2-.161068-4-.101099-4 .275613-1
1140	480001	-.158727-1-.413082-3-.171144-4 .738240-5 .532149-1-.617896-2-.212574-2
1141	480001	-.149869-4 .392480-2-.338766-3-.490124-3-.562785-6-.204141-5 .680244-1
1142	480001	-.352830-2-.388642-2-.741736-5 .548310+3 .120963+4 .267772+1 .264393+1
1143	480002	.139908+1 .445274+0 .343632+0 .419122+0-.207246+0 .664249+0 .148061-1
1144	480002	.477498-2-.226457-1 .286864-1-.203657-1 .465757-2 .988848-1-.197950+0
1145	480002	.224141+0 .391824-2-.189279-3-.856203-3 .963717-1-.118992+0 .125578+0
1146	*	COMPOSITION 71
1147	480000	.137639+1 .523401+0 .294393+0 .529473-3 .339091+0 .180674+0 .141340+0
1148	480001	.356864-3 .195092-1-.148966-1 .778287-3-.131195-4-.964475-5 .275201-1
1149	480001	-.158961-1-.374640-3-.140829-4 .724313-5 .549187-1-.665591-2-.162687-2
1150	480001	-.119613-4 .405103-2-.440121-3-.388440-3-.534665-6-.213129-5 .713249-1
1151	480001	-.440554-2-.302258-2-.400669-5 .548310+3 .120963+4 .267616+1 .264620+1
1152	480002	.138276+1 .533163+0 .254573+0 .350362+0 .230148+0 .165003+0 .178390-1
1153	480002	-.161593-1 .145006-2 .279506-1-.157641-1-.591051-3 .707246-1 .394266-2
1154	480002	-.634194-2 .408301-2-.513626-3-.493963-3 .828196-1-.101446-2-.913370-2
1155	*	COMPOSITION 72
1156	480000	.138233+1 .520652+0 .260273+0 .507600-3 .342311+0 .178771+0 .127117+0
1157	480001	.365867-3 .194865-1-.148788-1 .641800-3-.120679-4-.896993-5 .274460-1
1158	480001	-.158479-1-.349455-3-.129340-4 .709283-5 .564465-1-.691238-2-.137939-2
1159	480001	-.119213-4 .416675-2-.453148-3-.342356-3-.516310-6-.211868-5 .745683-1
1160	480001	-.493041-2-.253353-2-.493514-5 .548310+3 .120963+4 .267050+1 .264312+1
1161	480002	.139017+1 .522782+0 .233229+0 .356392+0 .266560+0 .437697-1 .174258-1
1162	480002	-.173179-1 .560554-2 .279980-1-.155298-1-.140897-2 .763745-1 .155004-1
1163	480002	-.485195-1 .421159-2-.586858-3-.330353-3 .890993-1 .392291-2-.317559-1
1164	*	COMPOSITION 73
1165	480000	.137992+1 .466957+0 .359954+0 .476462-3 .342257+0 .157777+0 .166290+0
1166	480001	.378541-3 .194615-1-.150359-1 .956104-3-.105406-4-.818004-5 .273826-1
1167	480001	-.157785-1-.409095-3-.112858-4 .689065-5 .575763-1-.641650-2-.270407-2
1168	480001	-.113140-4 .427892-2-.364262-3-.533553-3-.487977-6-.212482-5 .771941-1
1169	480001	-.404349-2-.500515-2-.512235-5 .548310+3 .120963+4 .266328+1 .263587+1
1170	480002	.138844+1 .454934+0 .353346+0 .356984+0 .542493-1 .427170+0 .173746-1
1171	480002	-.602635-2-.144211-1 .279602-1-.181154-1 .319848-2 .782596-1-.927589-1
1172	480002	.143090+0 .432833-2-.442123-3-.641052-3 .923651-1-.609250-1 .817707-1
1173	*	COMPOSITION 74
1174	480000	.137684+1 .470131+0 .349505+0 .457348-3 .342691+0 .159235+0 .162950+0
1175	480001	.387229-3 .194611-1-.150080-1 .903012-3-.949219-5-.767805-5 .273100-1
1176	480001	-.157549-1-.384761-3-.101609-4 .676359-5 .581776-1-.659605-2-.254929-2
1177	480001	-.109395-4 .438727-2-.377169-3-.519184-3-.469326-6-.213055-5 .791135-1
1178	480001	-.439780-2-.478884-2-.536746-5 .548310+3 .120963+4 .265249+1 .262146+1
1179	480002	.138549+1 .465877+0 .328106+0 .357563+0 .118424+0 .306686+0 .174030-1
1180	480002	-.102297-1-.658950-2 .278954-1-.171154-1 .138501-2 .788192-1-.535553-1
1181	480002	.695472-1 .443796-2-.455212-3-.627916-3 .943821-1-.365369-1 .356662-1
1182	*	COMPOSITION 75
1183	480000	.142174+1 .475380+0 .301582+0 .543316-3 .339979+0 .165027+0 .188344+0
1184	480001	.307329-3 .209884-1-.156582-1 .727832-3-.214225-4-.141581-4 .282998-1
1185	480001	-.164261-1-.431069-3-.225182-4 .647549-5 .375001-1-.481803-2-.644378-3
1186	480001	-.136255-4 .265438-2-.326235-3-.282275-3-.520020-6-.118564-5 .368671-1
1187	480001	-.604153-3-.976560-3 .970253-6 .548310+3 .120963+4 .279991+1 .280373+1
1188	480002	.143704+1 .489212+0 .248693+0 .351833+0 .182368+0 .246294+0 .188863-1
1189	480002	-.156584-1 .489703-3 .287563-1-.165290-1-.375380-3 .491838-1-.501999-2
1190	480002	.391422-2 .264567-2-.357643-3-.406120-3 .411926-1-.144020-2-.135497-2

4. Input Specifications

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1191 * COMPOSITION 76
1192 480000 .140655+1 .447117+0 .368886+0 .541573-3 .345747+0 .143237+0 .182175+0
1193 480001 .338420-3 .196910-1 .152562-1 .105841-2 .159394-4 .104949-4 .277872-1
1194 480001 -.159177-1 .439272-3 .169760-4 .724416-5 .515927-1 .618406-2 .179165-2
1195 480001 -.139293-4 .364058-2 .345842-3 .458271-3 .552867-6 .201634-5 .625884-1
1196 480001 -.348322-2 .321164-2 .510228-5 .548310+3 .120963+4 .271314+1 .269237+1
1197 480002 .141334+1 .446872+0 .342818+0 .425339+0 .239958+0 .696114+0 .144360-1
1198 480002 .679200-2 .247211-1 .289449-1 .206422-1 .485889-2 .100571+0 .215520+0
1199 480002 .242816+0 .362204-2 .154235-3 .862340-3 .926393-1 .129067+0 .137164+0
1200 * COMPOSITION 77
1201 480000 .140947+1 .470822+0 .308885+0 .403456-3 .342311+0 .162192+0 .180910+0
1202 480001 .402130-3 .207607-1 .154982-1 .744717-3 .835405-5 .892243-5 .279282-1
1203 480001 -.162307-1 .406697-3 .891838-5 .616013-5 .412878-1 .494607-2 .894518-3
1204 480001 -.691537-5 .285893-2 .319996-3 .302305-3 .379731-6 .130740-5 .449544-1
1205 480001 -.883975-3 .151951-2 .217993-5 .548310+3 .120963+4 .278360+1 .277950+1
1206 480002 .142331+1 .478225+0 .265895+0 .354031+0 .187208+0 .223021+0 .186736-1
1207 480002 -.154739-1 .641552-3 .284459-1 .163891-1 .367785-3 .542944-1 .476143-2
1208 480002 .164287-2 .284959-2 .365722-3 .396954-3 .507366-1 .166900-2 .278419-2
1209 ***** End of Cross Section Data *****
1210 *
1211 *****
1212 * FEEDWATER SPARGER MODEL DATA AND BYPASS FLOW RATIO (BPFR) *
1213 *****
1214 *
1215 *** For BWR, core bypass flow fraction is 0.106 (typical) ***
1216 ***** CNUSSF DBARR BPFR DCGAP STANT ANFWE DFWP
1217 *****1234123456789012345678901234567890123456789012345678901234567890
1218 500010 0.0073 5.0 0.106 0.5 0.02 96. .04445
1219 500010 0.0365 5.0 0.106 0.5 0.10 96. .04445
1220 *
1221 *****
1222 * T/H MODEL PARAMETERS: (CPB(1),I=1,3) AND (CRT(1),I=1,3) *
1223 *****
1224 *
1225 ***** Vapor generation model coeff., Vgj and form loss multiplier coeff.
1226 ***** CPB(1) CPB(2) CPB(3) CRT(1) CRT(2) CRT(3)
1227 *****1234123456789012345678901234567890123456789012345678901234567890
1228 500030 5.0000E+6 4.0000E+7 0.3 2400. 1.54 1.2
1229 *
1230 *****
1231 * PUMP OPTIONS: FORCED CIRCULATION IN BWR4 (IPUMP=1) *
1232 *****
1233 *
1234 *** Recirculation pump and jet pump options and their data ***
1235 * Jet Pump Option Used
1236 *****12341234512345
1237 500040 1 1
1238 ***** Internal Pump Head Data (not used in this run)
1239 ***** PH0 PH1 PH2
1240 500051 -32.67 -0.1080 0.
1241 500051 0.0 0.0080 0.
1242 ***** Steam Separator Data and Core Inlet Subcooling (DTSUBC):
1243 ***** NSEP ASEP HSEP RLEFFO DTSUBC
1244 500052 211 19.04 3.67 120. 11.50
1245 ***** Jet Pump Data:
1246 ***** IDRL ANOZ ASCT ATHR RKDR RKSC RJJP
1247 *****1234123456789012345678901234567890123456789012345678901234567890
1248 500053 1 0.09992 0.57818 0.67810 0.08452 0.0006689 1013.
1249 ***** RLAD PDRO WDRO TORQPO OMGREF OMGIC OMDMIC
1250 *****1234123456789012345678901234567890123456789012345678901234567890
1251 500054 57.400 1.986E6 4368.000 29000.00 125.664 115.405 123.150
1252 ***** TAUFPC PUMPN PUMPNR RMCREF RMDREF RIGPC RIDMPC
1253 *****1234123456789012345678901234567890123456789012345678901234567890
1254 500055 0.10 169.65 169.65 2.3304E+6 4.8634E+4 1359.00 1193.00
1255 ***** T1RC T2RC T3RC T4RC H2RC H3RC H4RC
1256 *****1234123456789012345678901234567890123456789012345678901234567890
1257 500056 0.8506 0.0408 -4.351E-3 -8.9660 -32.67 -0.1080 0.0
1258 ***** Recirculation controller input:
1259 ***** CKD1 CKD2 CKS1 CKS2 FMSC FRDL TRCCF
1260 *****1234123456789012345678901234567890123456789012345678901234567890

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4. Input Specifications

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1261 *S00057      1.2500  0.01875  0.40  0.20  -1.0  1.0  1.0E+9
1262 500057      0.6000  0.01875  0.40  0.20  -1.0  1.0  1.0E+9
1263 *****      AFRCC  BFRCC  TAUCL  GCLMX  GRC  XCMAX  XOMAX
1264 *****1234123456789012345678901234567890123456789012345678901234567890
1265 500058      0.054330  1.021223  0.50  1.00  0.60  1.75  0.20
1266 *****      DEMAX  OMGCMX  TDMF  ETAG
1267 *****1234123456789012345678901234567890123456789012345678901234567890
1268 500059      0.200  2.0  1.E+9  0.96
1269 ***** 1st no. is IPRES, 1=dp/dt calculated, 0=dp/dt set to zero *****
1270 *****      IPRES  RKP0
1271 500081      1  0.0000
1272 *
1273 *****
1274 *      HYDRAULIC TIME INTEGRATION DATA      *
1275 *****
1276 *
1277 * Max hydraulic step size, initial hydraulic step, truncation error *
1278 *****      SDTMAX  HMIN  ACCH
1279 500082      0.0600  0.010  0.020
1280 *
1281 *
1282 *****
1283 *      SYSTEM DISTURBANCE DATA      *
1284 *****
1285 *
1286 * Option for various disturbances (pump, feedwater, steam and power) *
1287 *****      IPUMPD  IFWFLO  IFWTEN  ISTLOA  IQTOT
1288 *500083      0  1  1  0  0
1289 500083      0  0  0  0  0
1290 *
1291 *****      Feedwater Flow Disturbance Data      *****
1292 *****      TFO  WFWRAM  WFWMAX  DELTW  WFW SIN  OMEGAW
1293 500085      0.0  -0.025  -1.000  10000.00  0.0  0.0
1294 *
1295 *****      Feedwater Temperature Disturbance Data      *****
1296 *****      TFO  TFWRAM  TFWMAX  DELTT  TFW SIN  OMEGAT
1297 500086      0.0  -0.0250  -0.762  10000.00  0.0  0.0
1298 *
1299 *****      Drift Flux Parameters on card 550000      *****
1300 *****      VOCON  COCOF1  COCOF2  COCOF3  VFUP  SUBLIQ
1301 550000      0.4  1.200  0.200  18.00  0.95  0.0
1302 *
1303 *****      New Input for ipsit,iopafwr,Tuper,Tliqmn,wwmin,wwmax,yimmin,yimmax      *****
1304 *****      IPSIT IOPAFWR TSUPER TLIQMN WMIN WMAX YIMMIN YIMMAX
1305 *****123412345123456789012345678901234567890123456789012345678901234567890
1306 560000      1  0  10.0  20.0  -1.000  60.00  -5.0E+3  2.0E+5
1307 *
1308 ***** Rated reactor power, initial power, 3rd no. not used. *****
1309 *****      HY  QTH  QCOOL
1310 *****123412345678901234567890123456789012345678901234567890
1311 600000      3.2930E+9  3.293E+9  0.0
1312 *
1313 *** Parameters for controlling frequency of hydraulic output printing ***
1314 *****      STEP1  HALT1  STEP2
1315 *****12341234567890123456789012345678901234567890
1316 600050      50.00  200.  20.0
1317 *
1318 * 1st no. is IPLOC=0, no local pressure dependence, TFW, PO, TMOO *
1319 *****      IPLOC  TFW  PO  TMOO
1320 *****123412345123456789012345678901234567890
1321 600061      0  201.56  69.154E+5  286.00
1322 *
1323 * Initial core flow, DVGUES, and steady-state convergence criterion *
1324 *****      WCORIN  DVGUES  EPSP
1325 *****1234123456789012345678901234567890
1326 600070      13040.  130.4  0.002
1327 *
1328 * Steady state hydraulic data printing option switches *
1329 *****      ITAB
1330 600080      113

```

4. Input Specifications

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1331 *
1332 * Transient hydraulic data printing option switch *
1333 *****
1334         ITABD
1335         1
1336 *****
1337 * FEEDWATER TRIP DATA *
1338 *****
1339 *
1340 * No feedwater trip via input table
1341 ***** IFWTX(1) IFWTX(2)
1342 611000      0      0
1343 *
1344 ***** TFWTP      TDELFW
1345 611100      0.0      0.0
1346 *
1347 ***** NTRYFW
1348 611300      12
1349 *
1350 ***** FW Flow vs. Time: (FWX(I),I=1,NTRYFW), (FWY(I),I=1,NTRYFW)
1351 611300      0.      5.      10.      15.      20.      30.
1352 611300      40.     70.     100.     150.     180.     600.
1353 611300      1.00     0.996     0.70     0.56     0.50     0.51
1354 611300      0.52     0.524     0.528     0.52     0.522     0.53
1355 *
1356 *****
1357 * FEEDWATER CONTROL SYSTEM INPUT DATA *
1358 *****
1359 *
1360 ***** NFWT1=0, no FW controller,
1361 ***** NFWT1=1, EPA FW controller,
1362 ***** NFWT1=2, new FW controller.
1363 ***** NFWT1      SLMN      SLMX      WFQFW      ZETA      RFWC
1364 611401      1      -0.1778      1.5240      1.00      1.20      0.00
1365 ***** TAU1      TAUS      TAU11      TAU12      TAUFW      TAU21      SFTV0
1366 *****1234123456789012345678901234567890123456789012345678901234567890
1367 611402      0.25      0.25      1.00      5.00      0.60      1.00      0.257022
1368 ***** CKFW1      CKFW2      GFWLLG      GFWLAG      SFTVF      SFWCF
1369 611403      4.20      0.07      1.00      1.00      0.0      0.0
1370 *
1371 *****
1372 * FEEDWATER TEMPERATURE TRIP DATA *
1373 *****
1374 *
1375 ***** IFHTX
1376 611501      0
1377 *
1378 ***** IFHTP      TDELFW
1379 611502      0.0      0.0
1380 *
1381 ***** NTRYFH
1382 611503      18
1383 *
1384 ***** FW Temperature vs. Time: (FHX(I),I=1,NTRYFH), (FHY(I),I=1,NTRYFH)
1385 611503      0.0      10.      20.      40.      60.      80.
1386 611503      100.     120.     140.     160.     180.     200.
1387 611503      250.     300.     350.     400.     500.     600.
1388 611503      1.000     0.980     0.968     0.951     0.937     0.926
1389 611503      0.917     0.908     0.901     0.896     0.892     0.889
1390 611503      0.887     0.886     0.8856     0.885     0.8843     0.884
1391 *
1392 ***** optional level setpoint (fraction) vs. time input:
1393 611601      1
1394 611602      0.0      0.0
1395 611603      12
1396 *****1234123456789012345678901234567890123456789012345678901234567890
1397 ***** times in sec:
1398 611603      0.0      120.     180.     360.     420.     600.
1399 611603      660.     900.     960.     1260.     1320.     3600.
1400 ***** fractional level setpoints with respect to rlvtaf:

```

4. Input Specifications

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1401 *611603      0.5100    0.5100    0.8500    0.8500    1.00    1.00
1402 611603      0.7000    0.7000    0.9500    0.9500    1.00    1.00
1403 611603      1.00      1.00      0.60      0.60      0.62    0.62
1404 *
1405 *****
1406 *          SCRAM ACTIVATION DATA          *
1407 *****
1408 *
1409 *****      Scram option data      *****
1410 *****      VELSCR=Scram Velocity, ISCRMX(I)=Scram Test (0=No Scram)
1411 *****      VELSCR  ISCRMX(I),I=1,7
1412 612000          0.0      0      0      0      0      0      0
1413 *
1414 *****
1415 *          RECIRCULATION PUMP TRIP DATA          *
1416 *****
1417 *
1418 *****      ITQX(1),I=1,4: 1=Trip on Time, 2=Trip on Turbine Valve Closure,
1419 *****      3=Trip on High System Pressure, 4=Trip on Low Level
1420 *****      ITQX(1) (2) (3) (4)
1421 614000          0      0      1      0
1422 *
1423 *****      Trip on High Pressure (PMAHRC) with Time Delay (TDELRC(3))
1424 *****      PMAHRC      TDELRC(3)
1425 614300      7.9247E+6      0.53
1426 *
1427 *
1428 *****
1429 *          HPCI DATA          *
1430 *****
1431 *
1432 *****      ICIX(1) ICIX(2)
1433 616000          0      1.
1434 *
1435 *****      TIMECI      TDELCI(1)
1436 616100          0.0      25.
1437 *
1438 *****      WMINCI      TDELCI(2)
1439 616200      -1.485      0.0
1440 *
1441 *****      WMAXCI      TDELCI(3)
1442 616300      1.207      0.0
1443 *
1444 *****      NTRYCI
1445 616400          2
1446 *
1447 *****      HPCI Turn-on Flow vs. Time: (TCIX(I),I=1,NTRYCI), (WCIX(I),I=1,NTRYCI)
1448 *****12341234567890123456789012345678901234567890123456789012345678901234567890
1449 616400          0.0      25.0      0.0      359.72
1450 *
1451 *****      TCI      EPG      RLVTAF      WHPCIR
1452 *****12341234567890123456789012345678901234567890123456789012345678901234567890
1453 616500          32.2      1.0      -4.964      359.72
1454 *
1455 *****      NTRYCO
1456 616600          2
1457 *
1458 *****      HPCI Shut-off Flow vs. Time: (TCIO(I),I=1,NTRYCO), (WCIO(I),I=1,NTRYCO)
1459 616600          0.0      18.0      1.0      0.0
1460 *
1461 *****
1462 *          RCIC DATA          *
1463 *****
1464 *
1465 *****      IRCX(1) IRCX(2)
1466 617000          0      1
1467 *
1468 *****      TIMERC      TDELRC(1)
1469 617100          0.0      25.0
1470 *

```

4. Input Specifications

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1471 ***** WMINRC TDELRC(2)
1472 617200 -1.485 0.0
1473 *
1474 ***** WMAXRC TDELRC(3)
1475 617300 1.207 0.0
1476 *
1477 ***** NTRYRC
1478 617400 2
1479 *
1480 ***** RCIC Turn-on Flow vs. Time: (TRCX(I),I=1,NTRYRC), (WRCX(I),I=1,NTRYRC)
1481 617400 0.0 25.0 0.0 35.4
1482 *
1483 ***** TRC (CRD Water Temperature)
1484 617500 32.2
1485 *
1486 ***** NTRYRO
1487 617600 2
1488 *
1489 ***** RCIC Shut-off Flow vs. Time: (TRCO(I),I=1,NTRYRO), (WRCO(I),I=1,NTRYRO)
1490 617600 0.0 18.0 1.0 0.0
1491 *
1492 *****
1493 * SRV INPUT FOR BWR4 (4 BANKS, HSC 4-12-95) *
1494 *****
1495 *
1496 ***** Safety/Relief Valve (SRV) data *****
1497 *
1498 ***** 1st no. is number of SRV banks, rest are test on pressure option
1499 618000 4 2 2 2 2
1500 618200 7.72213E6 7.79108E6 7.86000E6 8.7219E6
1501 618201 7.37740E6 7.44630E6 7.51530E6 8.3772E6
1502 618300 0.0 0.0 0.0 0.0
1503 618301 0.0 0.0 0.0 0.0
1504 618400 108.64 108.64 81.48 54.32
1505 618500 1
1506 618501 4 4 2 2
1507 618502 0.0 0.4 0.65 1.0
1508 618504 0.0 0.4 0.65 1.0
1509 618503 0.0 0.4 0.65 1.0
1510 618505 1.0 0.6 0.35 0.0
1511 618506 7.72213E6 7.72410E6
1512 618507 0.0 1.0
1513 618508 7.3774E6 7.377E6
1514 618509 1.0 0.0
1515 618500 2
1516 618501 4 4 2 2
1517 618502 0.0 0.4 0.65 1.0
1518 618504 0.0 0.4 0.65 1.0
1519 618503 0.0 0.4 0.65 1.0
1520 618505 1.0 0.6 0.35 0.0
1521 618506 7.79108E6 7.793E6
1522 618507 0.0 1.0
1523 618508 7.4463E6 7.4459E6
1524 618509 1.0 0.0
1525 618500 3
1526 618501 4 4 2 2
1527 618502 0.0 0.4 0.65 1.0
1528 618504 0.0 0.4 0.65 1.0
1529 618503 0.0 0.4 0.65 1.0
1530 618505 1.0 0.6 0.35 0.0
1531 618506 7.86E6 7.862E6
1532 618507 0.0 1.0
1533 618508 7.5153E6 7.5149E6
1534 618509 1.0 0.0
1535 618500 4
1536 618501 4 4 2 2
1537 618502 0.0 0.4 0.65 1.0
1538 618504 0.0 0.4 0.65 1.0
1539 618503 0.0 0.4 0.65 1.0
1540 618505 1.0 0.6 0.35 0.0

```

4. Input Specifications

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1541 618506      8.7219E6 8.7239E6
1542 618507      0.0      1.0
1543 618508      8.3772E6 8.3768E6
1544 618509      1.0      0.0
1545 *
1546 *****
1547 ***** MSIV closure data (close on time) *****
1548 *****
1549 ***** MSIVX(J),J=1,4
1550 ***** msiv closes on time: MSIVX(1)=1
1551 619000      1      0      0      0
1552 ***** TIMEMS      TDELMs(1)
1553 *****123412345678901234567890
1554 619100      0.0      2.0
1555 ***** NTRYMS
1556 619500      7
1557 ***** MSIV Flow vs. Time: (TMSIVT(I),I=1,NTRYFW), (WMSIVT(I),I=1,NTRYFW)
1558 ***** Time array TMSIVT(I) in sec first, followed by
1559 ***** Flow array WMSIVT(I): fractional values
1560 *****123412345678901234567890123456789012345678901234567890
1561 619500      0.0      0.4      1.85      2.4      3.4      3.7
1562 619500      4.0      1.0      0.9      0.4      0.05      0.02
1563 619500      0.0005      0.0
1564 *
1565 ***** Control rod insertion data *****
1566 ***** NOR RODINS IDUM(I)
1567 *****123 12345678901234512345123451234512345123451234512345123451234512345
1568 620000 1 6.0      1
1569 *
1570 *****
1571 * Pressure regulator input data: *
1572 *****
1573 *
1574 ***** PRGCV      XKCV      TCMCV      TCDCV      TCRCV      TCVCV      WFOCV
1575 *****1234123456789012345678901234567890123456789012345678901234567890
1576 621000      2.00E+4      4.835E-6      0.10      2.0      5.0      0.919      1.414
1577 ***** PSRGCV      SVRGCV
1578 621100      64.206E+5      6.575E-1
1579 ***** RRGBY      XKBY      TCMBY      TCDBY      TCRBY      TCUBY      WFOBY
1580 *****1234123456789012345678901234567890123456789012345678901234567890
1581 621200      1.00      0.900000      0.09      0.018      0.0      1.000      2.750
1582 ***** SPRO      SPRC      FTEM      FTCAF
1583 621300      0.0      0.0      15.0E+5      0.0
1584 *
1585 *****
1586 * BOP INPUT DATA: CARDS 622000 to 622700 *
1587 *****
1588 *
1589 ***** DPTSV      DPHT      PCRO      PCO      VLC      VC      Not Used
1590 622000      8.773E+5      4.183E+6      1.121E+6      0.050E+5      400.0      1600.0      1.000
1591 *
1592 ***** OMEGA0      PHFWP      PHCBP      FWSH0      SA      SB      SC
1593 622100      565.490      704.090      384.050      0.34772      -0.50816      -0.191840      1.700
1594 *
1595 ***** SP      SQ      SR      SS      RIFWP      SWFTV0      TC1R
1596 *622200      -0.288660      0.265980      0.222680      8.000E-1      200.0      9.5923      27.00
1597 622200      -0.288660      0.265980      0.222680      8.000E-1      1000.0      9.5923      27.00
1598 *
1599 ***** TAUPL3      TAUHFV      TAUHTF      EFFFWT      RNUHPT0      RNULPT0      FBPV
1600 622300      4.000E+0      2.400E+2      1.840E+0      0.816540      0.691      0.812      0.260
1601 *
1602 ***** CFTV1      CFTV2      CFTV3      CFTV4      WFTVMX      RNUFWT0      FHTDC
1603 622400      2.000E+0      0.000E+0      1.000E+0      5.000E-1      15.00      0.812      0.241
1604 *
1605 ***** NHTRBP      NHTF      RSTARHP      ALFAHP      RSTARLP      ALFALP      DTAFWR
1606 622500      15      0      4.000E-1      1.309      0.500      1.309      3.0E+01
1607 *
1608 ***** R2R1HP      PHIHP      PHIRHP      PSIHP      FRHHP      PHIEHP      VM21HP
1609 622600      1.000E+0      0.970E+0      0.980E+0      9.500E-1      0.089      1.000      1.200
1610 *

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4. Input Specifications

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1611 ***** R2R1LP PHILP PHIRLP PSILP FRHLP PHIELP VM21LP
1612 622700 1.033E+0 0.960E+0 0.950E+0 9.480E-1 0.025 0.950 1.200
1613 *
1614 ***** SFWPT SFWCV SHTRF DTFWPT DTFWCV DTHTRF PAFWRB
1615 622800 1.0 1.0 1.0 4.5E+6 1.0E+8 1.0E+5 1.000E+9
1616 *
1617 *****
1618 * NEW RWCU INPUT DATA: CARDS 623000 to 623100 *
1619 *****
1620 *
1621 ***** IRWCU N1RWCU N2RWCU
1622 *623000 1 4 17
1623 623000 0 4 17
1624 *****1234123456789012345678901234567890123456789012345678901234567890
1625 ***** WRWCU TRWCU CRWCU TSRWCU TERWCU
1626 623100 10.73 80.00 250.0 0.0 1.0E+6
1627 ***** SLVMIN SLVMAX TRMN FRWC REKS REKW REKT
1628 623200 -100. 100. -100. 3.5 25.0 0.00 4.2
1629 ***** TAULV TAUSL TAUIS TAUDS TAUFWF TAUIT TAUDT
1630 623300 0.10 0.250 60.00 0.0 0.25 1.E+8 0.0
1631 *
1632 *****
1633 * New Steam Separator Input Data *
1634 *****
1635 *
1636 ***** istage=0, use old simple model for steam separator
1637 ***** =2, use new 2-stage steam separator model
1638 ***** =3, use new 3-stage steam separator model
1639 *
1640 ***** istage nsep
1641 *****12341234512345
1642 624000 2 211
1643 *
1644 ***** rr1 ai an rh theta cwfco cwgcu
1645 *****1234123456789012345678901234567890123456789012345678901234567890
1646 624100 0.0857208 0.018637 0.01441 0.0809585 48.00 0.009 0.0004
1647 *
1648 ***** dpe aas(1) aas(2) aas(3) bbs(1) bbs(2) bbs(3)
1649 *****1234123456789012345678901234567890123456789012345678901234567890
1650 624200 0.506e+5 110.0 20.0 20.0 0.5 0.25 0.55
1651 *
1652 ***** hsk(1) hsk(2) hsk(3) rws(1) rws(2) rws(3)
1653 *****1234123456789012345678901234567890123456789012345678901234567890
1654 624300 0.2127 0.2127 0.45083 0.10794 0.06985 0.10794
1655 *
1656 ***** rrs(1) rrs(2) rrs(3) ads(1) ads(2) ads(3)
1657 *****1234123456789012345678901234567890123456789012345678901234567890
1658 624400 0.069875 0.060320 0.098420 0.0415776 0.0029133 0.0096265
1659 *
1660 ***** dds(1) dds(2) dds(3) hds(1) hds(2) hds(3)
1661 *****1234123456789012345678901234567890123456789012345678901234567890
1662 624500 0.045558 0.0121699 0.025399 0.877845 0.16255 0.384156
1663 *
1664 ***** cks(1) cks(2) cks(3) ela(1) ela(2) ela(3)
1665 624600 10.0 0.50 2.563 450.0 95.85 424.96
1666 *
1667 *
1668 ***** New Mark1 Containment Model Input Data:
1669 *
1670 *
1671 ***** IPSP = 0, no containment calculation,
1672 ***** = 1, simple model for suppression pool dynamics,
1673 ***** = 2, Mark1 containment model of EPA.
1674 *
1675 ***** IDFINP = 0, input your own data,
1676 ***** = 1, use built-in default input data.
1677 *
1678 ***** IPSP IDFINP
1679 *****12341234512345123451234512345
1680 625000 2 0

```

4. Input Specifications

```

1681 *
1682 ***** New input for PSP dynamics: prpsp,tpsp,rmlpsp,wrhr,trhr,wsrw,aucp,nrhr
1683 ***** PRPSP TPSP RMLPSP WRHR TRHR WSRW AUCP NRHR
1684 *****123412345678901234567890123456789012345678901234567890123456789012345
1685 *625100 1.0000E+5 32.22 3.5390E+6 631.4 25.0 284.1 181.134 4
1686 625100 1.0000E+5 32.22 3.6400E+6 631.4 25.0 284.1 362.00 4
1687 *
1688 ***** New input for Mark1 Containment Model of EPA:
1689 *
1690 ***** RMAJOR RMINOR ACST ABFW ABRL ABSL TAUO
1691 *****1234123456789012345678901234567890123456789012345678901234567890
1692 625200 18.288 4.572 9.00 0.00263 0.00263 0.00263 0.25
1693 *
1694 ***** AL1 AW1 TRHRON TRHROF SW1 SW2 TG1SPT
1695 *****1234123456789012345678901234567890123456789012345678901234567890
1696 625300 502.41 1737.3 1.0E+9 1.0E+9 0.01905 0.01905 63.00
1697 *
1698 ***** CLPCI CCSS PLPCI PCSS TAUWC21 TAUWC12 URPV
1699 *****1234123456789012345678901234567890123456789012345678901234567890
1700 625400 0.6508385 0.2447269 2.2828E+6 2.3586E+6 10.0 10.0 3456.7
1701 *
1702 ***** LSUMP HUMC1 HUMC2 TSRW1 TSRW1 VCMRPR VCSTMX
1703 *****1234123456789012345678901234567890123456789012345678901234567890
1704 625500 0.004026 0.400 1.000 32.00 32.00 0.07079 1371.0
1705 *
1706 ***** VOLC1 VOLC2 W12MAX W21MAX WCLR1 WCRDHS WCSP0
1707 *****1234123456789012345678901234567890123456789012345678901234567890
1708 625600 4502.4 7561.0 276.20 220.97 86.10 0.9600 982.1
1709 *
1710 ***** TG2SPT TL2SPT WLKVO WRHRO WSPR20 WSRW1 WSRW2
1711 *****1234123456789012345678901234567890123456789012345678901234567890
1712 625700 55.000 35.000 0.301 2591.10 3.60 65.1800 284.10
1713 *
1714 ***** NRHR NLPCI NCSP NCLR1 TLPCI TCSPS TSLB TRLB TFWB
1715 *****123412345123451234512345678901234567890123456789012345678901234567890
1716 625800 4 4 4 10 1.0E+9 1.0E+9 1.0E+9 1.0E+9 1.0E+9
1717 *
1718 ***** PGC1 TGC1 PGC2 TGC2 TCPPOOL LPOOL LCST
1719 *****1234123456789012345678901234567890123456789012345678901234567890
1720 625900 1.08248E+5 62.80 0.99560E+5 32.22 32.22 -0.1017 152.30
1721 *
1722 *****
1723 * NEUTRONIC SOLUTION METHOD DATA *
1724 *****
1725 *
1726 ***** INTTYP NG IPMAX (IPRD(I),I=1,8)
1727 710000 0 6 100 -3 1 1 0 1 -1 0 1
1728 *
1729 ***** H HMAX ACCF DPJ ROCF RCCA
1730 720000 0.01 0.3 0.050 1.00E-3 3.157+6 2.127+6
1731 *
1732 ***** VEL1 VEL2 VFBK
1733 730000 0.0 3.67000E+5 1.00
1734 *
1735 ***** IOPTDY IPRDY CMPFRC CMDFRC UPTIME SSPower FR239 FR238
1736 *****1234123456789012345678901234567890123456789012345678901234567890
1737 740000 1 1 0.04 0.04 4.0E+07 1.00 0.4 0.1
1738 *
1739 ***** Delayed Neutron Fractions: (B(I),I=1,NG)
1740 *****1234123456789012345678901234567890123456789012345678901234567890
1741 741000 0.2075E-3 0.1163E-2 0.1027E-2 0.2222E-2 0.6989E-3 0.142E-03
1742 *
1743 ***** Delayed Precursor Decay Constants: (AL(I),I=1,NG)
1744 742000 0.127 E-1 0.317 E-1 0.115 0.311 0.140 E+1 0.387E+01
1745 *
1746 ***** IPERT (Control Rod Movement or Perturbation switch)
1747 750000 0
1748 *
1749 ***** Control Rod Movement Options: (IMOV(I),I=1,KRR), KRR=30 for BWR4 1/8 Core
1750 * Manual control rod movement data, cards 750000 to 770000 *

```

4. Input Specifications

```

1751 750000      0
1752 760000      3  0  0  0  0  0  0  0  0  0  0  0  0  0
1753 760000      0  0  0  0  0  0  0  0  0  0  0  0  0
1754 760000      0  0
1755 *
1756 ***** TBEG      TEND      CAMPL      CFREQ
1757 770000 10000.    1.E+06    0.00      0.0
1758 *
1759 ***** Inner Iteration No., Eigenvalue Iteration No., Power/Void Iteration No.
1760 *
1761 ***** NSMAX MEIT NCMAX
1762 800000      20  1  30
1763 *
1764 ***** Flux Convergence (DLS), Eigenvalue Convergence (DLK), Power Convergence (DPINP)
1765 *
1766 ***** DLS      DLK      DPINP
1767 810000 1.0000E-4 1.0000E-4 0.050
1768 *
1769 ***** Inner Iteration Relaxation (A3), Power/Void Iteration Relaxation (RELX)
1770 *
1771 ***** A3      RELX
1772 820000 0.1      0.4
1773 *
1774 ***** Transient Termination Time (TMAX), Maximum Computer Time (CTMAX) *****
1775 *
1776 ***** IPRINT CTMAX      TMAX
1777 *****123412345123456789012345678901234567890
1778 870000      0 99999999. 1200.0
1779 *
1780 *****
1781 * STEAM LINE DYNAMICS DATA *
1782 *****
1783 *
1784 ***** For SBWR 2 Steam Lines *****
1785 *
1786 ***** NSTMOP M2 NC M1ST M0 NLINE IMSIV
1787 880000      1  6  2  5  2  4  3
1788 *
1789 ***** Steam Line Geometric Data *****
1790 *
1791 ***** AM1      AM2      ASST      PLM1      PLN2      PLS      XKC
1792 880001 .24850 .23550 .07015 79.2392 4.179 21.192 0.5
1793 *
1794 ***** The card below is no longer used *****
1795 ***** PSETU      PSETL      WMAXSR      CFF      CFB      SLP1      SLP2
1796 880002 0.      0.      0.      0.      0.      0.      0.
1797 *
1798 ***** LFR ISTLPR
1799 880003 0 0
1800 *
1801 ***** Polytropic Expansion Coeff.(POLYTR), Max. Bypass Flow (WMAX),
1802 ***** Steamline Wall Roughness (ROUGH)
1803 *
1804 ***** TAUPLN      TAUVLV      POLYTR      WMAX      ROUGH
1805 880004 0.      10.5 1.2783 110.54 0.28E-03
1806 *
1807 ***** Steamline Form Loss Coefficients: (XK(I),I=1,M2+NC)
1808 880006 0.75 1.0 1.7 0.3 0.3 0.3 1.7
1809 880006 0.0
1810 *
1811 ***** 900000 is a blank card to indicate the end of input deck *****
1812 900000
1813 *
1814 *****
1815 * END OF INPUT DATA FOR RAMONA-4B *
1816 *****

```


4. Input Specifications

4.5 Input Card Identification Numbers

For the user's convenience, a listing of the cards' IDs is provided below along with the corresponding variables names.

100000	ITITLE
110000	NOP,IOPT(I); I=1,NOP
120000	NOP,IOUT(I); I=1,NOP
140000	ITYP,ICOUNT,ITEST,ITIP,IPB,IPLOTL
150000	NEND,MEND,KSENON
150001	IPR(I); I=1,6
160000	NWIND
161000	WINBEG(I); I=1,NWIND
162000	WINEND(I); I=1,NWIND
200000	IMAX,JMAX,KMAX,ISYM,KANTOT,KAN,NBE
200001	IHYDR(I); I=1,KAN
200010	(NSEC(I); I=1,6),NPC,NCC,N0,NP
200011	A(I); I=1,6+NPC
200012	DH(I); I=6+NPC
200013	VH(I); I=1,5+2*NPC
200014	HEIGHT(I); I=1,7
200015	WLEV0,GR0,HTC,DELTA,DELTAM,RFCTR
200016	PH(I); I=1,NCC
200017	PM(I); I=1,NCC
200020	ISPAC,ISPAM,ISPAR
200021	ZSP(I); I=1,ISPAC
200022	VHSP(I); I=1,ISPAC
200023	ZSP(I); I=ISPAC+1,ISPAC+ISPAM
200024	VHSP(I); I=ISPAC1,ISPAC+ISPAM
200025	ZSP(I); I=ISPAC+ISPAM+1,ISPAC+ISPAM+ISPAR
200026	VHSP(I); I=ISPAC+ISPAM+1,ISPAC+ISPAM+ISPAR
200101	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Downcomer 1
200102	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Downcomer 2
200103	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Lower Plenum 1
200104	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Lower Plenum 2
200105	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Core Coolant Channels
200106	ALOSI,BLOSI,CLOSI,ALOSE,BLOSE,CLOSE for Riser
200200	HRSBW,HRATIO,HRA,HRB
210000	IX(L),JY(L); L=1,NBE
330000	MJ1,MJ2,IFM(I),NKNR(I); I=MJ1,MJ2
350000	QT,QMF,DX,DZ,RMOD,A2
380000	NRODS,MM,MMC
390000	PS,TSAT,RCA,DRCA
391000	E1,E2,RLCA,GCAMAX,GCA0,GCA1,GCA2
400000	CRITK,BG21,BG22,AB1,AB2,DREF
401000	CREF,DAVER,SJ
410000	AVT,AVB,BET,BEB

4. Input Specifications

420000 BL(I); I=1,NBE
 430000 BE(I); I=1,NBE
 440000 TEK
 441000 IFCH,IAXTYP(IFCH,K); K=1,KMAX
 442000 IFUEL,CXENON(IFUEL,K); K=1,4
 460000 NAXIAL,INLOOP,WBINP,BCONC,WRATED
 461000 SIGA1B,SIGA2B,WETFRC,FACTR
 462000 IOPTB,IPRNT,TSTRT,TOFF,TDELAY
 463000 NBMIX1
 463000 WBMIX1(I),EBMIX1(I); I=1,NBMIX1
 464000 NBMIX2
 464000 WBMIX2(I),EBMIX2(I); I=1,NBMIX2
 465000 NBMIX3
 465000 WBMIX3(I),EBMIX3(I); I=1,NBMIX3
 466000 LSC,IATWS,SCVOT,SCTL,SCPR,SCHT
 467000 SCDIA,SCL,SCVOL,SCLEV,CPPM,DENSBOR
 468000 SCPhi,SCLOW,SCVEL,AKLOSS,AN,SCVIS
 469000 DELSC,DIVALS,DTSVAl,DATWS,TSLCS
 469000 SLCS
 470000 ITAB2,ICONST,KRR
 471000 IFC(I); I=1,ITAB2
 480000 WW(I); 1,ICONST
 490000 KK,ADDVO,ADDTF,ADDTM
 493000 CRAXY(I); I=1,KMAX
 496000 BUCK(I); I=1,KMAX
 500010 CNUSFF,DBARR,BPFR,DCGAP,STANT,ANFWE,DFWP
 500030 CPB(I),CRT(I); I=1,3
 500040 IPUMP,IJPUMP
 500051 PH0,PH1,PH2
 500052 NSEP,ASEP,HSEP,RLEFF0,DTSUBC
 500053 IDRL,ANOZ,ASCT,ATHR,RKDIF,RKSCT,RJJP
 500054 RLAD,PDR0,WDR0,TORQP0,OMGREF,OMGGIC,OMDMIC
 500055 TAUFCP,PUMPn,PUMPnR,RMCREF,RMDREF,RIGPC,RIDMPC
 500056 T1RC,T2RC,T3RC,T4RC,H2RC,H3RC,H4RC
 500057 CKD1,CKD2,CKS1,CKS2,FMSC,FDRL,TRCCF,
 500058 AFRCC,BFRCC,TAUCL,GCLMX,GRC,XCMAX,X0MAX
 500059 DEMAX,OMGCMX,TDMF,ETAG
 500060 IPDIST
 500070 AUXQK(I); I=1,IPDIST*NPC
 500081 IPRES,RKP0
 500082 SDTMAX,HMIN,ACCH
 500083 IPUMPD,IFWFLO,IFWTEM,ISTLOA,IQTOT
 500084 THO,HRAM,HMAXR,DELTH,HSIN,OMEGAH
 500085 TWO,WFWRAM,WFWMAX,DELTW,WFSIN,OMEGAW
 500086 TTO,TFWRAM,TFWMAX,DELTT,TFSIN,OMEGAT
 500087 TKO,RKPRAM,RKPmax,DELTK,RKPSIN,OMEGAK

4. Input Specifications

500088	TQO, QRAM, QMAX, DELTQ, QSIN, OMEGAQ
550000	VOCON, C0COF1, C0COF2, C0COF3, VFUP, SUBLIQ
560000	IPSIT, IOPAFWR, TSUPER, TLIQMN, WWMIN, WWMAX, YIMMIN, YIMMAX
570000	PRPSP, TPSP, RMLPSP, WRHR, WSRW, AUCP, NRHR
600000	HY, QTH, QCOOL
600050	STEP1, HALT1, STEP2
600060	QJ(I); I=1, NPC
600061	IPLOC, TFW, P0, TMOD
600070	WCORIN, DVGUES, EPSP
600080	ITAB
600090	ITABD
611000	IFWTX(I); I=1, 2
611100	TFWTP, TDELFW(1)
611200	WMAXFW, TDELFW(2)
611300	NTRYFW
611300	FWX(I), FWY(I); I=1, NTRYFW
611401	NFWT1, SLMN, SLMX, WFQFW, ZETA, RFWC
611402	TAUL, TAUS, TAU11, TAU12, TAUFW, TAU21, SFTV0
611403	CKFW1, CKFW2, GFWLLG, GFWLAG, SFTVF, SFWCF
611501	IFHTX
611502	TFHTP, TDELFH
611503	NTRYFH
611503	FHX(I), FHY(I); I=1, NTRYFH
611601	ILSTX
611602	TLSTP, TDELLS
611603	NTRYLS
611603	FLSX(I), FLSY(I); I=1, NTRYLS
612000	VELSCR, ISCRMX(I); I=1, 7
612100	TSCRAM, TDELSC(1)
612200	TDELSC(2)
612300	ARSCRM, TDELSC(3)
612400	WMINSC, TDELSC(4)
612500	WMAXSC, TDELSC(5)
612600	PMAXSC, TDELSC(6)
612700	TDELSC(7)
613000	ITBX(I); I=1, 5
613100	TIMETB, TDELTB(1)
613200	WMINTB, TDELTB(2)
613300	WMAXTB, TDELTB(3)
613400	PMINTB, TDELTB(4)
613405	TBPSYS, TDELTB(5)
613500	NTRYTB
613500	TTBX(I), WTBX(I); I=1, NTRYTB
614000	ITQX(I); I=1, 4
614100	TIMETQ, TDELRC(1)
614200	TDELRC(2)

4. Input Specifications

614300	PMAXRC,TDELRC(3)
614400	WMINRC,TDELRC(4)
615000	ITBYX(I); I=1,2
615100	TIMEBY,TDELBY(1)
615200	TDELBY(2)
615300	NTRYBY
615300	TBYX(I),WTBYX(I); I=1,NTRYBY
616000	ICIX(I); I=1,2
616100	TIMECI,TDELCI(1)
616200	WMINCI,TDELCI(2)
616300	WMAXCI,TDELCI(3)
616400	NTRYCI
616400	TCIX(I),WCIX(I); I=1,NTRYCI
616500	TCI,EPG,RLVTAF,WHPCIR
616600	NTRYCO
616600	TCIO(I),WCIO(I); I=1,NTRYCO
617000	IRCX(I); I=1,2
617100	TIMERC,TDLRC(1)
617200	WMNRC,TDLRC(2)
617300	WMAXRC,TDLRC(3)
617400	NTRYRC
617400	TRCX(I),WRCX(I); I=1,NTRYRC
617500	TRC
617600	NTRYRO
617600	TRCO(I),WRCO(I); I=1,NTRYRO
618000	NSR,ISRX(I); I=1,NSR
618100	TIMESR(I); I=1,NSR
618200	PUP(I); I=1,NSR
618201	PDOWN(I); I=1,NSR
618300	TDELSR(I); I=1,NSR
618301	TDELRS(I); I=1,NSR
618400	WSRMAX(I); I=1,NSR
618500	NV
618501	NTRYSR(NV),NTRYRS(NV),NTRYPS(NV),NTRYSP(NV)
618502	TSRX(I,NV); I=1,NTRYSR(NV)
618503	WSRX(I,NV); I=1,NTRYSR(NV)
618504	XTSR(I,NV); I=1,NTRYRS(NV)
618505	XWSR(I,NV); I=1,NTRYRS(NV)
618506	PSRXX(I,NV); I=1,NTRYPS(NV)
618507	WPSRXX(I,NV); I=1,NTRYPS(NV)
618508	PRSXX(I,NV); I=1,NTRYSP(NV)
618509	WPRSXX(I,NV); I=1,NTRYSP(NV)
619000	MSIVX(I); I=1,4
619100	TIMEMS,TDELMS(1)
619200	WMINMS,TDELMS(2)
619300	WSLMS,TDELMS(3)

4. Input Specifications

619400 PMINMS,TDELMs(4)
 619500 NTRYMS
 619500 TMSIVT(I),WMSIVT(I); I=1,NTRYMS
 620000 NOR,RODINS,IDUM(I); I=1,NOR
 621000 RRGCV,XKCV,TCMCV,TCDCV,TCRCV,TCVCV,WFQCV
 621100 PSRGCv,SVRGCv
 621200 RRGBY,XKBY,TCMBY,TCDBY,TCRBY,TCVBY,WFQBY
 621300 SPRO,SPRC,FTEM,FTCOF
 622000 DPTSV,DPHPT,PCRO,PCO,VLC,VC
 622100 OMEGA0,PHFWP,PHCBP,FWSHS0,SA,SB,SC
 622100 OMEGA0,PHFWP,PHCBP,FWSHS0,SA,SB,SC
 622200 SP,SQ,SR,SS,RIFWP,SWFTV0,TCIR
 622300 TAUPL3,TAUHFw,TAUHTF,EFFFWT,RNUHPT0,RNULPT0,FBPV
 622400 CFTV1,CFTV2,CFTV3,CFTV4,WFTVMX,RNUFWT0,FHTDC
 622500 NHTRBP,NHTF,RSTARHP,ALFAHP,RSTARLP,ALFALP,DTAFWR
 622600 R2R1HP,PHIHP,PHIRHP,PSIHP,FRHHP,PHIEHP,VM21HP
 622700 R2R1LP,PHILP,PHIRLP,PSILP,FRHLP,PHIELP,VM21LP
 622800 SFWPT,SFWCV,SHTRF,DTFWPT,DTFWCV,DTHTRF,PAFWRB
 623000 IRWCU,N1RWCU,N2RWCU
 623100 WRWCU,TRWCU,CRWCU,TSRWCU,TERWCU
 623200 SLVMIN,SLVMAX,TRMN,FRWC,REKS,REKW,REKT
 623300 TAULV,TAUSL,TAUIS,TAUDS,TAUFWF,TAUIT,TAUDT
 624000 ISTAGE,NSEP
 624100 RR1,Al,AN,RH,THETA,CWFCO,CWGCU

 624200 DPE,AAS(1),AAS(2),AAS(3),BBS(1),BBS(2),BBS(3)
 624300 HSKS(1),HSKS(2),HSKS(3),RWS(1),RWS(2),RWS(3)
 624400 RRS(1),RRS(2),RRS(3),ADS(1),ADS(2),ADS(3)
 624500 DDS(1),DDS(2),DDS(3),HDS(1),HDS(2),HDS(3)
 624600 CKS(1),CKS(2),CKS(3),ELA(1),ELA(2),ELA(3)
 625000 IPSP,IDFINP
 625100 PRPSP,TPSP,RMLPSP,WRHR,TRHR,WSRW,AUCP,NRHR
 625200 RMAJOR,RMINOR,ACST,ABFW,ABRL,ABSL,TAU0
 625300 AL1,AW1,TRHRON,TRHROF,SW1,SW2,T0
 625400 CLPCI,CCSS,PLPCI,PCSS,RHOCS1,RHOCS2,URPV
 625500 LSUMP,HUMC1,HUMC2,TSRW1,TSRWI,VCMPR,VCSTMX
 625600 VOL1,VOL2,W12MAX,W21MAX,WCLR1,WCRHDS,WCSPO
 625700 TWWSC,TCRHDS,WLKV0,WRHR0,WSPR20,WSRW1,WSRW2
 625800 NRHR,NLPCI,NCSP,NCLR1,TLPCI,TCSPS,TSLB,TRLB,TFWB
 625900 PGC1,TGC1,PGC2,TGC2,TCPOOL,LPOOL,LCST
 631000 LHS
 632000 NSLAB
 633000 MATL(1,I); I=1,6
 634000 MATL(2,I); I=1,6
 635000 THICK(1,I); I=1,6
 636000 THICK(2,I); I=1,6

4. Input Specifications

637000	SAREA(1,I); I=1,6
638000	SAREA(2,I); I=1,6
639100	THICD,SAREAD1,SAREAD2,PERIM,THICB
639200	TAIRHS,CONAT,TAIRD,TSD1,TSD2
639300	TSO(I); I=1,6
639400	HCOFA(I); I=1,6
639500	RNAKC(K); K=1,NCC
661010	LIC,LID
661020	TZERO
661030	DIVAL,DTDEL,DTVAL
661100	VPOOL,PPOOL,TPOOL
661200	DTUBEI,DTUBE,CONTUBE,NTUBE,LTUBE
661300	DD1,DD2,LDRUM
661400	AKV,AKL,TAUICS,TAUICL,RFOUL
661500	DRETURN,LRETURN
661600	ZMAX,ZO,DCEN,ZICEN,NIC
661070	ASIN,AOUT,AREAC
661800	DPRO,DPTO
661900	ITERMAX
663100	QUALIC,QOLDIN
663200	IGAS
663300	PMAXIC,ZSTEAM
663400	I PROF
663500	NGC
663600	HFRAC,NTC
710000	INTTYP,NG,IPMAX,IPRD(I); I=1,11
720000	H,HMAX,ACCF,DPI,ROCF,RCCA
730000	VEL1,VEL2,QUP,QUD,QMP,QMD
740000	IOPTDY,IPRTDY,CMPFRC,CMDFRC,UPTIME,SSPOWR,FR239,FR238
741000	B(I); I=1,NG
742000	AL(I); I=1,NG
750000	IPERT
760000	IMOV(I); I=1,KRR
770000	TBEG,TEND,CAMPL,CFREQ
800000	NSMAX,MEIT,NCMAX,NBMAX
810000	DLS,DLK,DPINP,DEC
820000	A3,RELF,RELCY
870000	IPRINT,CTMAX,TMAX
880000	NSTMOP,M2,NC,M1ST,M0,NLINE,IMSIV
880001	AM1,AM2,ASST,PLM1,PLM2,PLS,XKC
880003	LFR,ISTLPR
880004	TAUPLN,TAUVLV,POLYTR,WMAX,ROUGH
880005	TDLY,TSTP
880006	XK(I); I=1,M2+NC
900000	Blank Card (End of Input Deck)

Table 4.3 lists the input card numbers corresponding to the input variables for further convenience.

4. Input Specifications

Table 4.3 Input Card Numbers Corresponding to Input Variables

A	200011	AL1	625300	BEB	410000
A2	350000	ALOSI	200101	BET	410000
A3	820000	AM1	880001	BFRCC	500058
AAS(I); I=1,3	624200	AM2	880001	BG21	400000
AB1	400000	AN	468000	BG22	40000
AB2	400000	ANFWE	500010	BL	420000
ABFW	625200	ANOZ	500053	BLOSE	200101
ABRL	625200	AOUT	661070	BLOSI	200101
ABSL	625200	AREAC	661070	BPFR	500010
ACCF	720000	ARSCRM	612300	BUCK1	496000
ACCH	500082	ASCT	500053	C0COF1	550000
ADDTF	490000	ASEP	500052	C0COF2	550000
ADDTM	490000	ASIN	661070	C0COF3	550000
ADDVO	490000	ASST	880001	CCSS	625400
ADS(I); I=1,3	624400	ATHR	500053	CFREQ	770000
AFRCC	500058	AUCP	625100	CFTV1	622400
AI	624100	AUXQK	500070	CFTV2	622400
AKL	661400	AVB	410000	CFTV3	622400
AKLOSS	468000	AVT	41000	CFTV4	622400
AKV	661400	AW1	625300	CKD1	500057
AL	742000	B	741000	CKD2	500057
ALFAHP	622500	BBS(I); I=1,3	624200	CKFW1	611403
ALFALP	622500	BCONC.	460000	CKFW2	611403
ALOSE	200101	BE	430000	CKS(I); I=1,3	624600

4. Input Specifications

Table 4.3 (Cont'd.)

CKS1	500057
CKS2	500057
CLOSE	200101
CLOSI	200101
CLPCI	625400
CMDFRC	740000
CMPFRC	740000
CNUSSF	500010
COMPEL	770000
CONAT	639200
CONTUBE	661200
CPB	500030
CPPM	467000
CREF	401000
CRITK	400000
CRT	500030
CRXY	493000
CTMAX	870000
CWFCO	624100
CWGCU	624100
CXENON	442000
DATWS	469000
DAVER	401000
DBARR	500010
DCEN	661600

DCGAP	500010
DD1	661400
DD2	661300
DDS(I); I=1,3	624500
DEC	810000
DELSC	469000
DELTA	200015
DELTAM	200015
DELTH	500084
DELTK	500087
DELTQ	500088
DELTT	500086
DELTW	500085
DEMAX	500059
DENSBOR	467000
DFWP	500010
DH	200012
DIVAL	661030
DIVALS	469000
DLK	810000
DLS	810000
DPE	624200
DPHPT	622000
DPINP	810000
DPJ	720000

DPRO	661800
DPTO	661800
DPTSV	622000
DRCA	390000
DREF	400000
DRETURN	661500
DTDEL	661030
DTFWCV	622800
DTFWPT	622800
DTHTRF	622800
DTSUBC	500052
DTSVL	469000
DTUBE	661200
DTUBEI	661200
DTVAL	661030
DUM	600070
DVGUES	600070
DX	350000
DZ	350000
E1.	391000
E2	391000
EBMIX2	464000
EBMIX3	465000
EFFFWT	622300
ELA(I); I=1,3	624600

4. Input Specifications

Table 4.3 (Cont'd.)

EPSP	600070
ETAG	500059
FACTOR	461000
FBPV	622300
FHTDC	622400
FHX	611503
FHY	611503
FLSX	611603
FLSY	611603
FMSC	500057
FRDL	500057
FR238	740000
FR239	740000
FRHHP	622600
FRHLP	622700
FRWC	623200
FTCOF	621300
FTEM	621300
FWSHS0	622100
FWSHSO	622100
FWX	611300
FWY	611300
GCA0	391000
GCA1	391000
GCA2	391000

GCAMAX	391000
GCLMX	500058
GFWLAG	611403
GFWLLG	611403
GR0	200015
GRC	500058
H	720000
H2RC	500056
H3RC	500056
H4RC	500056
HALT1	600050
HCOFA	639400
HDS(I); I=1,3	624500
HEIGHT	200014
HFRAC	663600
HMAX	720000
HMAXR	500084
HMIN	500082
HRA	200200
HRAM	500084
HRATIO	200200
HRB	200200
HRSBW	200200
HSEP	500052
HSIN	500084

HSKS(I); I=1,3	624300
HTC	200015
HUMC1	625500
HUMC2	625500
HY.	600000
IATWS	466000
IAXTYP	441000
ICIX	616000
ICONST	470000
ICOUNT	140000
IDFINP	625000
IDRL	500053
IDUM	620000
IFC	471000
IFCH	441000
IFHTX	611501
IFM	330000
IFUEL	442000
IFWFLO	500083
IFWTEM	500083
IFWTX	611000
IGAS	663200
IHYDR	200001
IJPUMP	50040
ILSTX	611601

4. Input Specifications

Table 4.3 (Cont'd.)

IMAX	200000
IMOV	760000
IMSIV	880000
INITYP	710000
INLOOP	460000
IOPAFWR	560000
IOPT	110000
IOPTB	462000
IOPTDY	740000
IOUT	120000
IPB	140000
IPDIST	500060
IPERT	750000
IPLOC	600061
IPLOTL	140000
IPMAX	710000
IPR	150001
IPRD	710000
IPRES	500081
IPRINT	870000
IPRNT	462000
IPROF	663400
IPRTDY	740000
IPSIT	560000
IPSP	625000

IPUMP	500040
IPUMPD	500083
IQTOT	500083
IRCX	617000
IRWCU	623000
ISCRMX	612000
ISPAC	200020
ISPAM	200020
ISPAR	200020
ISRX	618000
ISTAGE	624000
ISTLOA	500083
ISTLPR	880003
ISYM	20000
ITAB	600080
ITAB2	470000
ITABD	600090
ITBX	613000
ITBYX	615000
ITERMAX	661900
ITEST	140000
ITIP	140000
ITITLE	10000
ITQX	614000
ITYP	140000

IX	210000
JMAX	200000
JY	210000
KAN	200000
KANTOT	200000
KMAX	200000
KRR	470000
KSENON	150000
LCST	625900
LDRUM	661300
LFR	880003
LHS	631000
LIC	661010
LID	661010
LPOOL	625900
LRETURN	661500
LSC	466000
LSUMP	625500
LTUBE	661200
M0	880000
M1ST	880000
M2	880000
MATL	634000
MATL	633000
MEIT	800000

4. Input Specifications

Table 4.3 (Cont'd.)

MEND	150000
MJ2	330000
MJI	330000
MM	380000
MMC	380000
MSIVX	619000
N0	200010
N1RWCU	623000
N2RWCU	623000
NAXIAL	460000
NBE	200000
NBMAX	800000
NBMIX1	463000
NBMIX2	464000
NBMIX3	465000
NC	880000
NCC	200010
NCLR1	625800
NCMAX	800000
NCSP	625800
NEND	150000
NFWTI	611401
NG	710000
NGC	663500
NHTF	622500

NHTRBP	622500
NIC	661600
NKNR	330000
NLINE	880000
NLPCI	625800
NOP	120000
NOP	110000
NOR	620000
NP	200010
NPC	200010
NRHR	625800
NRODS	380000
NSEC	200010
NSEP	624000
NSLAB	632000
NSMAX	800000
NSR	618000
NSTMOP	880000
NTC	663600
NTRYBY	615300
NTRYCI	616400
NTRYCO	616600
NTRYFH	611503
NTRYFW	611300
NTRYLS	611603

NTRYMS	619500
NTRYPS	618501
NTRYRC	617400
NTRYRO	617600
NTRYRS	618501
NTRYSP	618501
NTRYSR	618501
NTRYTB	613500
NTUBE	661200
NV	618500
NWIND	160000
OMDMIC	500054
OMEGA0	622,100.00
OMEGAH	500084
OMEGAK	500087
OMEGAQ	500088
OMEGAT	500086
OMGCMX	500059
OMGGIC	500054
OMGREF	500054
OMEGAW	500085
P0	600061
PAFWRB	622800
PC0	622000
PCR0	622000

4. Input Specifications

Table 4.3 (Cont'd.)

PCSS	625400
PDOWN	618201
PDR0	500054
PERIM	639100
PGC1	625900
PGC2	625900
PH	200016
PH0	500051
PH1	500051
PH2	00051
PHCBP	622100
PHCBP	622100
PHFWP	622100
PHFWP	622100
PHIEHP	622600
PHIELP	622700
PHIHP	622600
PHILP	622700
PHIRHP	622600
PHIRLP	622700
PLM2	880001
PLMI	880001
PLPCI	625400
PLS	880001
PM	200017

PMAXIC	663300
PMAXRC	614300
PMAXSC	612600
PMINMS	619400
PMINTB	613400
POLYTR	880004
PPOOL	661100
PRPSP	625100
PRSXXI	618508
PS	390000
PSIHP	622600
PSILP	622700
PSRGBY	621300
PSRGCV	621100
PSRXXI	618506
PUMPIN	500055
PUMPINR	500055
PUP	618200
QCOOL	600000
QJ	600060
QMAX	500088
QMD	730000
QMF	350000
QMP	730000
QOLDIN	663100

GRAM	500088
QSIN	500088
QT	350000
QTH	600000
QUALIC	663100
QUD	730000
QUP	730000
R2R1HP	622600
R2R1HP	622700
RCA	390000
RCCA	720000
REKS	611403
REKT	611403
REKW	611403
RELCY	820000
RELF	820000
RFCTR	200015
RFCWC	611401
RH	624100
RHOCS1	625400
RHOCS2	625400
RIDMPC	500055
RIFWP	622200
RIGPC	500055
RJJP	500053

4. Input Specifications

Table 4.3 (Cont'd.)

RKDR	500053
RKP0	500081
RKPMAX	500087
RKPRAM	500087
RKPSIN	500087
RKSCT	500053
RLAD	500054
RLCA	391000
RLEFF0	500052
RMINOR	625200
RMLPSP	625100
RMAJOR	625200
RMOD	350000
RNAKC	639500
RNUFWT0	622400
RNUHPT0	622300
RNULPT0	622300
ROCF	720000
RODINS	620000
ROUGH	880004
RR1	624100
RRGBY	621200
RRGCV	621000
RRS(I); I=1,3	624400
RSTALRP	622500

RSTARHP	622500
RWS(I); I=1,3	624300
SA	622100
SA	622100
SAREA	637000
SAREA	638000
SAREAD1	639100
SAREAD2	639100
SB	622100
SB	622100
SC	622100
SC	622100
SCDIA	467000
SCHT	466000
SCL	467000
SCLEV	467000
SCLOW	468000
SCPHI	468000
SCPR	466000
SCTL	466000
SCVEL	468000
SCVIS	468000
SCVOL	467000
SCVOT	466000
SDTMAX	500082

SFTVF	611403
SFTVO	611402
SFWCF	611403
SFWCV	622800
SFWPT	622800
SHTRF	622800
SIGA2B	461000
SIGAIB	461000
SJ	401000
SLMN	611401
SLMX	611401
SLVMAX	623200
SLVMIN	623200
SP	622200
SPRC	621300
SPRO	621300
SQ	622200
SR	622200
SS	622200
SSPOWR	740000
STANT	500010
STEP2	600050
STEPI	600050
SUBLIQ	550000
SVRGBY	621300

4. Input Specifications

Table 4.3 (Cont'd.)

SVRGCV	621100
SW1	625300
SW2	625300
SWFTV0	622200
T0	625300
T1RC	500056
T2RC	500056
T3RC	500056
T4RC	500056
TAIRD	639200
TAIRS	639200
TAU0	625200
TAU11	611402
TAU12	611402
TAU21	611402
TAUCL	500058
TAUDS	611402
TAUFCP	500055
TAUDT	611402
TAUFW	611402
TAUFWF	623300
TAUHFV	622300
TAUHTF	622300
TAUIS	611402
TAUIT	611402

TAUL	611402
TAULV	623300
TAUPL3	622300
TAUPLN	880004
TAUS	611402
TAUSL	623300
TAUVLV	880004
TBEG	770000
TBPSYS	613405
TBYX	615300
TCDBY	621200
TCDCV	621000
TCDV	611401
TCI	616500
TCIO	616400
TCIR	622200
TCIX	621200
TCMBY	621200
TCMCV	621000
TCPOOL	625900
TCRBY	621200
TCRDHS	625700
TCRCV	621000
TCSPS	625800
TCVBY	621200

TCVVCV	621000
TDELAY	462000
TDELBY	615100
TDELCI	616300
TDELCI	616200
TDELCI	615200
TDELCI	616100
TDELFIH	611502
TDELFW	611200
TDELFW	611100
TDELLS	611602
TDELMS	619300
TDELMS	619400
TDELMS	619200
TDELMS	619100
TDELRC	614300
TDELRC	614400
TDELRC	614200
TDELRC	614100
TDELRS	618301
TDELSC	612300
TDELSC	612400
TDELSC	612500
TDELSC	612200
TDELSC	612100

4. Input Specifications

Table 4.3 (Cont'd.)

TDELSR	618300
TDELSR	612700
TDELTB	613200
TDELTB	613400
TDELTB	613405
TDELTB	613100
TDELTB	613300
TDLRC	617300
TDLRC	617100
TDLRC	617200
TDLY	880005
TDMF	500059
TEK	440000
TEND	770000
TERWCU	623100
TFHTP	611502
TFW	600061
TFWB	625800
TFWMAX	500086
TFWRAM	500086
TFWSIN	500086
TFWTP	611100
TGC1	625900
TGC2	625900
THETA	624100

THICB	639100
THICD	639100
THICK	636000
THICK	635000
THO	500084
TIMEBY	615100
TIMECI	6161000
TIMEMS	619100
TIMERC	617100
TIMESR	618100
TIMETB	613100
TIMETQ	614100
TLIQMN	560000
TLPCI	625800
TLSTP	611602
TMAX	870000
TMOD	600061
TMSIVT	619500
TOFF	462000
TORQP0	500054
TPOOL	661100
TPSP	625100
TQO	500088
TRC	617500
TRCCF	500057

TRCO	617600
TRCX	617400
TRHR	625100
TRHROF	625300
TRHRON	625300
TRLB	625800
TRMN	623200
TRWCU	623100
TSAT	390000
TSCRAM	612100
TSD1	639200
TSD2	639200
TSLB	625800
TSLCS	469000
TSO	639300
TSRW1	625500
TSRWCU	623100
TSRWI	625500
TSRXI	618502
TSTP	880005
TSTRT	462000
TSUPER	560000
TTBX	613500
TTO	500086
TWO	500085

4. Input Specifications

Table 4.3 (Cont'd.)

TWWSC	625700
TZERO	661020
UPTIME	740000
URPV	625400
VC	622000
VCMPR	625500
VCSTMX	625500
VEL1	730000
VEL2	730000
VELSCR	612000
VFUP	550000
VH	200013
VHSP	200022
VHSP	200026
VHSP	200024
VLC	622000
VM21HP	622600
VM21LP	622700
VOCON	550000
VOLC1	625600
VOLC2	625600
W12MAX	625600
W21MAX	625600
WBNP	460000
WBMIX1	463000

WBMIX2	464000
WBMIX3	465000
WCIO	616600
WCIX	616400
WCORIN	600070
WCLR1	625600
WCRDHS	625600
WCSP0	625600
WDR0	500054
WETFRC	461000
WFMAX	500085
WFQBY	621200
WFQCV	611401
WFWRAM	500085
WFWSIN	500085
WINBEG	161000
WINEND	162000
WLEV0	200015
WLKV0	625700
WMAX	880004
WMAXCI	616300
WMAXFW	611200
WMAXRC	617300
WMAXSC	612500
WMAXTB	613300

WMINCI	616200
WMINMS	619200
WMINRC	614400
WMINSC	612400
WMNRC	617200
WMSIVT	619500
WPRSXXI	618500
WPRSXXI	618507
WRCO	617600
WRCX	617400
WRHR	625100
WRHR0	625700
WRWCU	623100
WSLMS	619300
WSPR20	625700
WSRMAX	618400
WSRW	625100
WSRW1	625700
WSRW2	625700
WSRXI	618503
WTBX	613500
WTBYX	615300
WW	480000
WWMAX	560000
WWMIN	560000

4. Input Specifications

Table 4.3 (Cont'd.)

X0MAX	500058
XCMAX	500058
XK	880006
XKBY	621200
XKCV	621000
XKCV	621000
XTSRI	618504
XWSRI	618505
YIMMAX	560000
YIMMIN	560000
ZETA	611401
ZICEN	661600
ZMAX	661600
ZO	661600
ZSP	200023
ZSP	200021
ZSTEAM	663300

5. OUTPUT DESCRIPTIONS

5.1 Tabulated Output of Steady-State and Transient Calculations

This section provides a sample of the RAMONA-4B printed tabular output. It includes the printouts of the steady-state and transient calculations. It includes the major parts such as Transient Description "Long" Hydraulic Printed Output, Vertical and Radial Power Distributions and Control Rod Map, Neutronic Printed Output, "Short" Hydraulic Printed Output, Vessel Mass and Energy Balance, Run Time Statistics, Plot Variables with Maps and Names and Plot Summary Data. The reader is referred to the NOMENCLATURE section of the companion report on models and correlations for RAMONA-4B [Rohatgi et al. 1996] for the variables printed in the output listing. **All printed variables are in SI units unless otherwise indicated.**

5.1.1 Sample Output for the Steady-State Calculation

This section provides a sample of a printed steady-state output. It includes the major parts such as Steady-State Description "Long" Hydraulic Printed Output, Vertical and Horizontal Power Distributions, Control Map, Neutronic Printed Output, "Short" Hydraulic Printed Output, Vessel Mass and Energy Balance, Runtime Statistics, Plot Variables with Maps and Names and Plot Summary Data. The reader is referred to the NOMENCLATURE for the variables printed in the output listing. **All printed variables are in SI units unless otherwise indicated.**

5. Output Descriptions

```

RRRR AAA M M OOO NN N AAA 4 BBBB
R R A A MM MM O O N N N A A 44 B B
RRRR A A M M M O O N N N A A --- 4 4 BBBB
R R A A A A M M O O N N A A A 444444 B B
R R A A M M OOO N N A A 4 BBBB

```

EXPANDED VERSION GENERATED 06/26/94

SOME LIMITING PARAMETERS FOR THIS VERSION

```

MAX NUMBER OF HYDRAULIC CHANNELS 200
MAX NUMBER OF NEUTRONIC CHANNELS 804
MAX NUMBER OF AXIAL SECTIONS 24
MAX NUMBER OF BOUNDARY NODES 150
MAX NUMBER OF CROSS SECTION SETS 1000
MAX NODE NR. IN X OR Y DIRECTIONS 30

```

CALCULATIONS Aug 4 94 AT 16:58:46

```

NEUTRONIC STEADY STATE
HYDRAULIC STEADY STATE
NEUTRONIC DYNAMICS
HYDRAULIC DYNAMICS

```

PRINT OUT OF INPUT DATA

```

STEAMLINE OPTION USED
MSIV Closure ATWS Analysis: 1/8 core of a BWR4 (BF1) PAGE 1

IOPT(I) 1 0 1 0 0 0 0 0 1 2 1 0 0 0 0
IOUT(I) 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0

CRITK = 1.000E+00 BG21 = 0.000E+00 BG22 = 0.000E+00 AB1 = 3.000E-01 AB2 = 7.000E-01 DREF = 1.500E+00
CREF = -6.670E-02 DAVER = 1.652E+00 AVT = 3.500E-01 AVB = 7.000E-01 BET = 2.500E+01 BEB = 2.000E+01
NEUTRONICS INPUT
*****

IMAX = 11 NEND = 2424 ISYM = 2 IPR1 = 0 IPR4 = 0
JMAX = 15 MEND = 101 NSMAX = 20 IPR2 = 0 IPR5 = 2
KMAX = 24 NCMAX = 30 IPR3 = 2 IPR6 = 1

QT = 3.29300E+09 DX = 1.52400E+01
QMF = 4.00000E-02 DZ = 1.58750E+01
DLS = 1.00000E-05 DLK = 1.00000E-04
FUEL MODEL DATA. (RO*CP IS GIVEN IN DYNAMICS)

NUMBER OF FUEL RODS IN A NODE = 62
NUMBER OF REGIONS RADially IN FUEL = 4
NUMBER OF REGIONS RADially IN CLADDING = 2
MAXIMUM GAP HEAT TRANSFER COEFF. (W/M2*DEG.) = 5.67800E+03
GCA0 = 5.67800E+03
GCA1 = 0.00000E+00
GCA2 = 0.00000E+00
FUEL CONDUCTIVITY COEFFICIENTS.
E1 = 8.50000E+00
E2 = 2.00000E-03
CLADDING HEAT CONDUCTIVITY (W/M*DEG.) = 1.38500E+01
OUTER RADIUS OF CLADDING (M) = 6.13400E-03
CLADDING THICKNESS (M) = 8.12800E-04

```

5. Output Descriptions

```

71
72 SYSTEM PRESSURE (N/M2) = 6.91540E+06
73 SATURATION TEMPERATURE (DEG. CELCIUS) = 2.86000E+02
74
75 POLY COEFFICIENTS
76 Cross Section Set 1
77
78 1.4103E+00 4.7200E-01 3.0510E-01 5.4470E-04 3.4039E-01 1.6515E-01 1.9495E-01 3.0893E-04
79 2.1222E-02 -1.5749E-02 6.7231E-04 -2.1276E-05 -1.3087E-05 2.8180E-02 -1.6456E-02 -4.0189E-04
80 -2.2288E-05 6.6131E-06 3.6318E-02 -4.8307E-03 -6.5685E-04 -1.4800E-05 2.6763E-03 -3.2186E-04
81 -2.7841E-04 -5.0940E-07 -1.1995E-06 3.6525E-02 -6.5768E-04 -1.0212E-03 -1.7902E-06 5.4831E+02
82 1.2096E+03 2.7698E+00 2.7412E+00 1.4257E+00 4.8508E-01 2.5404E-01 3.5253E-01 1.7674E-01
83 2.6308E-01 1.9146E-02 -1.5552E-02 3.1775E-05 2.8683E-02 -1.6598E-02 -2.7469E-04 4.7582E-02
84 -6.4586E-03 6.2366E-03 2.6659E-03 -3.4527E-04 -4.1515E-04 4.0462E-02 -1.9705E-03 -7.0915E-04
85 Cross Section Set 2
86
87 1.4025E+00 4.8644E-01 3.3212E-01 5.6447E-04 3.4224E-01 1.6179E-01 1.6775E-01 3.1673E-04
88 1.9761E-02 -1.5159E-02 9.2778E-04 -1.9068E-05 -1.1774E-05 2.7875E-02 -1.6035E-02 -3.9741E-04
89 -2.0234E-05 7.3634E-06 5.0063E-02 -5.9436E-03 -1.6658E-03 -1.5347E-05 3.5385E-03 -3.6779E-04
90 -4.1142E-04 -5.7823E-07 -1.9556E-06 5.9520E-02 -2.9531E-03 -2.9696E-03 -4.7944E-06 5.4831E+02
91 1.2096E+03 2.7167E+00 2.6927E+00 1.4102E+00 5.0193E-01 2.8513E-01 3.6155E-01 1.1363E-01
92 3.1892E-01 1.7622E-02 -1.1791E-02 -4.2632E-03 2.8371E-02 -1.6868E-02 6.2855E-04 6.8626E-02
93 -3.9915E-02 5.0629E-02 3.5545E-03 -3.5929E-04 -6.2004E-04 7.1353E-02 -2.4409E-02 2.3089E-02
94 Cross Section Set 3
95
96 1.4049E+00 5.4235E-01 2.7062E-01 5.3504E-04 3.3760E-01 1.8732E-01 1.3524E-01 3.4377E-04
97 1.9672E-02 -1.4927E-02 7.2754E-04 -1.5172E-05 -1.0635E-05 2.8008E-02 -1.6017E-02 -3.9716E-04
98 -1.6216E-05 7.0562E-06 5.0310E-02 -6.6589E-03 -1.0806E-03 -1.2653E-05 3.4198E-03 -4.5835E-04
99 -3.2429E-04 -5.3864E-07 -1.9861E-06 5.7903E-02 -4.2806E-03 -1.8660E-03 -2.9168E-06 5.4831E+02
100 1.2096E+03 2.7484E+00 2.7402E+00 1.4104E+00 5.5261E-01 2.3220E-01 3.6421E-01 1.4550E-01
101 2.6976E-01 1.7413E-02 -1.2065E-02 -3.8307E-03 2.8505E-02 -1.6675E-02 3.9816E-04 7.1010E-02
102 -3.6012E-02 4.4487E-02 3.4273E-03 -4.5703E-04 -5.1178E-04 7.1121E-02 -2.3621E-02 2.1202E-02
103 .
104 .
105 .
106 Cross Section Set 77
107
108 1.4095E+00 4.7082E-01 3.0889E-01 4.0346E-04 3.4231E-01 1.6219E-01 1.8091E-01 4.0213E-04
109 2.0761E-02 -1.5498E-02 7.4472E-04 -8.3541E-06 -8.9224E-06 2.7928E-02 -1.6231E-02 -4.0670E-04
110 -8.9184E-06 6.1601E-06 4.1288E-02 -4.9461E-03 -8.9452E-04 -6.9154E-06 2.8589E-03 -3.2000E-04
111 -3.0230E-04 -3.7973E-07 -1.3074E-06 4.4954E-02 -8.8397E-04 -1.5195E-03 2.1799E-06 5.4831E+02
112 1.2096E+03 2.7836E+00 2.7795E+00 1.4233E+00 4.7823E-01 2.6589E-01 3.5403E-01 1.8721E-01
113 2.2302E-01 1.8674E-02 -1.5474E-02 6.4155E-04 2.8446E-02 -1.6389E-02 -3.6778E-04 5.4294E-02
114 -4.7614E-03 1.6429E-03 2.8496E-03 -3.6572E-04 -3.9695E-04 5.0737E-02 -1.6690E-03 -2.7842E-03
115
116 Perturbation Adders to Cross-Section Independent Variables
117
118 Level Void Fuel Temp Mod Temp
119
120 1 0.00000E+00 0.00000E+00 0.00000E+00
121 2 0.00000E+00 0.00000E+00 0.00000E+00
122 3 0.00000E+00 0.00000E+00 0.00000E+00
123 4 0.00000E+00 0.00000E+00 0.00000E+00
124 5 0.00000E+00 0.00000E+00 0.00000E+00
125 6 0.00000E+00 0.00000E+00 0.00000E+00
126 7 0.00000E+00 0.00000E+00 0.00000E+00
127 8 0.00000E+00 0.00000E+00 0.00000E+00
128 9 0.00000E+00 0.00000E+00 0.00000E+00
129 10 0.00000E+00 0.00000E+00 0.00000E+00
130 11 0.00000E+00 0.00000E+00 0.00000E+00
131 12 0.00000E+00 0.00000E+00 0.00000E+00
132 13 0.00000E+00 0.00000E+00 0.00000E+00
133 14 0.00000E+00 0.00000E+00 0.00000E+00
134 15 0.00000E+00 0.00000E+00 0.00000E+00
135 16 0.00000E+00 0.00000E+00 0.00000E+00
136 17 0.00000E+00 0.00000E+00 0.00000E+00
137 18 0.00000E+00 0.00000E+00 0.00000E+00
138 19 0.00000E+00 0.00000E+00 0.00000E+00
139 20 0.00000E+00 0.00000E+00 0.00000E+00
140 21 0.00000E+00 0.00000E+00 0.00000E+00

```

```

141      22  0.00000E+00  0.00000E+00  0.00000E+00
142      23  0.00000E+00  0.00000E+00  0.00000E+00
143      24  0.00000E+00  0.00000E+00  0.00000E+00

```

147																			
148																			
149	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
150																			
151		16	17	18	19	20	21	22	23	24	25	26	27	28	29				
152																			
153			30	31	32	33	34	35	36	37	38	39	40	41	42				
154																			
155				43	44	45	46	47	48	49	50	51	52	53	54				
156																			
157					55	56	57	58	59	60	61	62	63	64	65				
158																			
159						66	67	68	69	70	71	72	73	74	75				
160																			
161							76	77	78	79	80	81	82	83	84				
162																			
163								85	86	87	88	89	90	91					
164																			
165									92	93	94	95	96						
166																			
167										97	98	99	100						
168																			
169											101								

CROSS-SECTION TYPE AXIAL LAYOUT (LAXTYP(IFCH,K))

5-4

5. Output Descriptions

211	36	16	32	32	32	33	33	33	19	19	19	20	20	20	20	21	21	21	22	22	22	23	23	23	24
212	37	1	27	27	27	3	3	3	30	30	30	31	31	7	7	7	7	7	14	14	14	15	15	15	9
213	38	16	32	32	32	33	33	33	20	20	20	20	20	20	20	21	21	21	22	22	22	23	23	23	24
214	39	48	56	56	56	57	57	57	51	51	51	52	52	52	52	26	26	26	8	8	8	53	53	53	9
215	40	16	17	17	17	18	18	18	19	19	19	62	62	62	62	22	22	22	23	23	23	39	39	39	24
216	41	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
217	42	1	2	2	2	3	3	3	5	5	5	5	5	5	6	6	6	6	7	7	7	8	8	8	9
218	43	1	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8	8	8	9
219	44	1	27	27	27	28	28	28	25	25	25	25	25	25	25	63	63	63	6	6	6	26	26	26	9
220	45	16	54	54	54	55	55	55	44	44	44	45	45	45	45	45	45	45	46	46	46	47	47	47	24
221	46	48	56	56	56	57	57	57	51	51	51	14	14	14	14	26	26	26	8	8	8	53	53	53	9
222	47	1	2	2	2	3	3	3	4	4	4	5	5	5	6	31	31	31	13	13	13	8	8	8	9
223	48	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	6	6	6	26	26	26	9
224	49	16	54	54	54	55	55	55	44	44	44	45	45	45	45	45	45	45	46	46	46	47	47	47	24
225	50	48	56	56	56	57	57	57	51	51	51	52	52	52	52	26	26	26	8	8	8	53	53	53	9
226	51	1	2	2	2	3	3	3	30	30	30	31	31	7	7	7	7	7	14	14	14	15	15	15	9
227	52	1	10	10	10	34	34	34	12	12	12	13	13	13	13	13	13	13	14	14	14	15	15	15	9
228	53	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
229	54	1	2	2	2	3	3	3	5	5	5	6	6	6	31	31	7	7	7	7	41	41	8	8	9
230	55	1	2	2	2	28	28	28	4	4	4	25	25	25	25	6	6	6	7	7	7	26	26	26	9
231	56	48	56	56	56	57	57	57	51	51	51	14	14	14	14	26	26	26	8	8	8	53	53	53	9
232	57	16	32	32	32	33	33	33	20	20	20	20	20	20	20	21	21	21	22	22	22	23	23	23	24
233	58	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	6	6	6	26	26	26	9
234	59	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	6	6	6	26	26	26	9
235	60	48	56	56	56	57	57	57	51	51	51	52	52	52	52	26	26	26	8	8	8	53	53	53	9
236	61	16	32	32	32	33	33	33	19	19	19	20	20	21	21	21	21	21	22	22	22	23	23	23	24
237	62	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	7	7	7	26	26	26	9
238	63	1	10	10	10	34	34	34	12	12	12	13	13	13	13	13	13	13	14	14	14	15	15	15	9
239	64	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
240	65	1	2	2	2	3	3	3	5	5	5	6	6	6	31	31	7	7	7	7	41	41	8	8	9
241	66	16	54	54	54	55	55	55	44	44	44	45	45	45	45	61	61	61	46	46	46	47	47	47	24
242	67	1	2	2	2	3	3	3	30	30	30	6	6	7	7	7	7	7	14	14	14	15	15	15	9
243	68	16	54	54	54	55	55	55	44	44	44	45	45	45	45	45	45	45	46	46	46	47	47	47	24
244	69	48	56	56	56	57	57	57	51	51	51	52	52	52	52	26	26	26	8	8	8	53	53	53	9
245	70	16	54	54	54	55	55	55	44	44	44	45	45	45	45	45	45	45	46	46	46	47	47	47	24
246	71	1	2	2	2	29	29	29	12	12	12	13	13	13	13	13	13	13	14	14	14	15	15	15	9
247	72	16	54	54	54	43	43	43	44	44	44	65	65	65	65	46	46	46	66	66	66	47	47	47	24
248	73	48	49	49	49	50	50	50	58	58	58	58	58	58	58	59	59	59	15	15	15	60	60	60	24
249	74	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
250	75	1	2	2	2	29	29	29	30	30	30	31	31	31	31	7	7	7	14	14	14	15	15	15	9
251	76	16	54	54	54	55	55	55	44	44	44	45	45	45	45	45	45	45	46	46	46	47	47	47	24
252	77	1	10	10	10	34	34	34	12	12	12	13	13	13	13	14	14	14	52	52	52	15	15	15	9
253	78	16	32	32	32	33	33	33	19	19	19	20	20	20	20	21	21	21	22	22	22	23	23	23	24
254	79	1	56	56	56	57	57	57	51	51	51	52	52	52	52	26	26	26	8	8	8	53	53	53	9
255	80	16	54	54	54	55	55	55	44	44	44	45	45	45	45	46	46	46	66	66	66	47	47	47	24
256	81	48	49	49	49	50	50	50	51	51	51	58	58	8	8	8	8	8	15	15	15	60	60	60	24
257	82	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
258	83	1	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	26	26	26	15	15	15	9
259	84	1	10	10	10	34	34	34	12	12	12	13	13	13	13	13	13	13	14	14	14	15	15	15	9
260	85	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	7	7	7	26	26	26	9
261	86	1	27	27	27	28	28	28	25	25	25	25	25	25	25	6	6	6	7	7	7	8	8	8	9
262	87	16	54	54	54	55	55	55	44	44	44	45	45	45	45	46	46	46	66	66	66	47	47	47	24
263	88	1	56	56	56	11	11	11	67	67	67	51	51	51	51	52	52	52	8	8	8	53	53	53	68
264	89	16	17	17	17	18	18	18	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
265	90	1	2	2	2	3	3	3	4	4	4	30	30	31	31	7	7	7	41	41	41	15	15	15	9
266	91	1	2	2	2	3	3	3	30	30	30	31	31	31	31	7	7	7	41	41	41	8	8	8	9
267	92	1	27	27	27	28	28	28	25	25	25	25	25	25	5	5	6	6	6	7	7	26	26	26	9
268	93	48	49	49	49	50	50	50	58	58	58	58	58	58	58	8	8	8	15	15	15	60	60	60	24
269	94	16	17	17	17	18	18	18	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
270	95	16	35	35	35	17	17	17	36	36	36	37	37	37	37	38	38	38	38	38	38	39	39	39	40
271	96	1	2	2	2	29	29	29	30	30	30	31	31	7	7	7	7	7	41	41	41	15	15	15	9
272	97	48	69	69	69	70	70	70	71	71	71	72	72	72	72	73	73	73	74	74	74	60	60	60	24
273	98	1	10	10	10	34	34	34	12	12	12	13	13	13	13	13	13	13	14	14	14	15	15	15	9
274	99	1	2	2	2	3	3	3	5	5	5	31	31	31	31	7	7	7	14	14	14	15	15	15	9
275	100	75	56	56	56	76	76	76	67	67	67	13	13	13	13	14	14	14	14	14	14	15	15	15	77
276	101	1	2	2	2	3	3	3	5	5	5	5	5	5	6	6	6	6	7	7	7	8	8	8	9

Fuel Type

Xenon Correction Coefficients

5. Output Descriptions

281													
282	1	5.773000E-04	1.101980E-01	1.252000E-04	1.342920E-01								
283	2	1.012100E-03	1.327390E+00	6.343000E-04	1.655160E-02								
284	3	1.056500E-03	9.482780E-01	7.264000E-04	2.148060E-01								
285	4	1.038200E-03	1.507650E+00	6.525000E-04	1.370350E-02								
286	5	1.068900E-03	1.362900E+00	6.434000E-04	1.152430E-02								

MAP OF HYDRAULIC CHANNELS

291													
292	1	1	2	1	1	6	19	6	8	8	11	8	15
293													
294	20	1	3	4	14	14	7	6	11	11	11	8	12
295													
296		2	4	17	5	2	6	7	11	11	15	11	12
297													
298		1	2	5	14	8	21	7	15	9	15	12	13
299													
300			1	14	22	8	8	8	10	9	9	18	13
301													
302			2	6	11	8	23	15	15	9	18	13	
303													
304				14	8	7	11	11	10	12	18	13	
305													
306						8	8	7	10	10	18	16	
307													
308						8	10	10	12	16			
309													
310								12	12	24	16		
311													
312								16					

MAP OF NEUTRONIC CHANNELS

313													
314													
315													
316													
317													
318	1	2	3	4	5	6	7	8	9	10	11	12	13
319													
320	16	17	18	19	20	21	22	23	24	25	26	27	28
321													
322			30	31	32	33	34	35	36	37	38	39	40
323													
324			43	44	45	46	47	48	49	50	51	52	53
325													
326				55	56	57	58	59	60	61	62	63	64
327													
328				66	67	68	69	70	71	72	73	74	75
329													
330				76	77	78	79	80	81	82	83	84	
331													
332				85	86	87	88	89	90	91			
333													
334				92	93	94	95	96					
335													
336				97	98	99	100						
337													
338								101					

MAP OF CONTROL RODS

339													
340													
341													
342													
343													
344													
345													
346		1	1										
347													
348		1	1										
349													
350													

5. Output Descriptions

CONTROL ROD INSERTION POSITION

6 6

6 6

GEOMETRICAL DATA

HYDRAULIC INPUT.

CHAN.NR.	FLOW AREA (M**M)	LENGTHS (M)	D - HYD. (M)	PERIM HOT (M)	PERIM COLD (M)	DP INLET (N/M**M)	DP OUTLET (N/M**M)	NUMBER OF SUBSECTIONS
1	5.6590E-02	3.8100E+00	1.4630E-02	1.3145E+01	3.4680E+00	-3.0000E+01	-1.3400E+00	24
2	4.1150E-02		1.4630E-02	9.5600E+00	2.5222E+00	-3.0000E+01	-1.3400E+00	
3	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
4	2.0580E-02		1.4630E-02	4.7800E+00	1.2611E+00	-3.0000E+01	-1.3400E+00	
5	2.0580E-02		1.4630E-02	4.7800E+00	1.2611E+00	-3.0000E+01	-1.3400E+00	
6	5.1440E-02		1.4630E-02	1.1950E+01	3.1528E+00	-3.0000E+01	-1.3400E+00	
7	5.1140E-02		1.4630E-02	1.1950E+01	3.1528E+00	-3.0000E+01	-1.3400E+00	
8	1.2345E-01		1.4630E-02	2.8680E+01	7.5666E+00	-3.0000E+01	-1.3400E+00	
9	4.1150E-02		1.4630E-02	9.5600E+00	2.5222E+00	-3.0000E+01	-1.3400E+00	
10	6.1730E-02		1.4630E-02	1.4340E+01	3.7836E+00	-3.0000E+01	-1.3400E+00	
11	1.0289E-01		1.4630E-02	2.3900E+01	6.3056E+00	-3.0000E+01	-1.3400E+00	
12	7.7170E-02		1.4630E-02	1.7925E+01	5.0455E+00	-3.0000E+01	-1.3400E+00	
13	7.2020E-02		1.4630E-02	1.6730E+01	4.4139E+00	-2.3000E+02	-1.3400E+00	
14	4.6030E-02		1.4630E-02	1.0753E+01	2.8375E+00	-3.0000E+01	-1.3400E+00	
15	7.2020E-02		1.4630E-02	1.6730E+01	4.4139E+00	-3.0000E+01	-1.3400E+00	
16	3.6010E-02		1.4630E-02	8.3650E+00	2.2071E+00	-2.3000E+02	-1.3400E+00	
17	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
18	4.1150E-02		1.4630E-02	9.5600E+00	2.5222E+00	-3.0000E+01	-1.3400E+00	
19	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
20	5.1444E-03		1.4630E-02	1.1950E+00	3.1530E-01	-3.0000E+01	-1.3400E+00	
21	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
22	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
23	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-3.0000E+01	-1.3400E+00	
24	1.0289E-02		1.4630E-02	2.3900E+00	6.3060E-01	-2.3000E+02	-1.3400E+00	
25	3.1750E-01		1.5450E-02			-7.0000E+02	-8.0000E+00	
RISER	1.0570E+01	4.9640E+00	1.5400E-01				-1.9100E+01	5
UPPER PL.	2.6320E+01	7.8230E+00	4.9496E+00					
DOWN C 1	2.6130E+01	6.0180E+00	7.1100E-01			0.0000E+00		6
DOWN C 2	1.2502E+00	5.0620E+00	2.2500E-01			-5.0000E-01		6
LOW.PL 1	1.8154E+01	3.1880E+00	6.3790E-01			0.0000E+00		2
LOW.PL 2	1.6444E+01	2.3060E+00	5.8120E-01			0.0000E+00		3

NUMBER OF PARALLEL CHANNELS	=	25
NUMBER OF COOLANT CHANNELS	=	24
FEEDWATER INLET IN SECTION	=	4
PUMP IN SECTION	=	10
WATER LEVEL(M)	=	6.73000E-01
GRAVITY ACCELERATION (M/S2)	=	9.80670E+00
HEAT TRANSFER COEFFICIENT (W/M2,DEG C) COOLANT-MODERATOR	=	3.10000E+03
FRACTION OF HEAT DIRECTLY GENERATED IN COOLANT AND MODERATOR	=	4.00000E-02
MODERATOR	=	1.50000E-02
ROD BUNDLES PEAKING FACTOR	=	1.10000E+00

SPACER DATA

SPACER IN CORE

5. Output Descriptions

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421
422 POSITION SPACER NR. 1 = 4.80000E-01 VELOCITY HEADS SPACER NR. 1 = -1.30000E+00
423 POSITION SPACER NR. 2 = 9.90000E-01 VELOCITY HEADS SPACER NR. 2 = -1.30000E+00
424 POSITION SPACER NR. 3 = 1.50000E+00 VELOCITY HEADS SPACER NR. 3 = -1.30000E+00
425 POSITION SPACER NR. 4 = 2.01000E+00 VELOCITY HEADS SPACER NR. 4 = -1.30000E+00
426 POSITION SPACER NR. 5 = 2.52000E+00 VELOCITY HEADS SPACER NR. 5 = -1.30000E+00
427 POSITION SPACER NR. 6 = 3.04000E+00 VELOCITY HEADS SPACER NR. 6 = -1.30000E+00
428 POSITION SPACER NR. 7 = 3.55000E+00 VELOCITY HEADS SPACER NR. 7 = -1.30000E+00
429
430
431 TWO-PHASE FLOW DATA
432 *****
433
434
435 LIGHT WATER
436 CONSTANTS FOR THE BOILING FORMULA 5.00000E+06 4.00000E+07 3.00000E-01
437 CONSTANTS FOR BECKERS CORRELATION 2.40000E+03 1.54000E+00 1.50000E+00
438
439 BYPASS FLOW RATIO BPRF= 1.0600E-01
440
441 DOWNCOMER GAP (METERS) DCGAP= 5.0000E-01
442
443 FEEDWATER JET STANTON NUMBER STANT= 2.0000E-02
444
445 NUMBER OF FEEDWATER ENTRANCES ANFW= 9.6000E+01
446
447 DIAMETER OF FEEDWATER PIPE (METERS) DFWP= 4.4450E-02
448
449
450 PUMP DATA
451 LOCATION OF PUMP 10
452 MOMENT OF INERTIA 1.81500E+03
453 RATED PUMP PRESSURE HEAD (PA) 1.59400E+06
454 TOTAL MASS FLOW THROUGH RECIRC LOOPS IN STEADY STATE (KG/S) 6.45600E+03
455 RATED PUMP TORQUE (N*M) 2.90000E+04
456 PUMP SPEED (RADIAN/S) 1.69650E+02
457 RATED PUMP SPEED (RADIAN/S) 1.69650E+02
458
459
460 JET PUMP DATA
461 NUMBER OF JET PUMPS 1
462 NOZZLE FLOW AREA (M2) 9.9920E-02
463 SUCTION FLOW AREA (M2) 5.7818E-01
464 THROAT FLOW AREA (M2) 6.7810E-01
465 SUCTION LEG LOSS COEFFICIENT 6.3890E-04
466
467 NUMBER OF DRIVE LOOPS 1
468 TOTAL L/A RATIO FOR EACH RECIRCULATION LOOP (/M) 5.7400E+01
469
470
471
472 STEAM SEPARATOR DATA
473 NUMBER OF SEPARATORS 211
474 TOTAL SEPARATOR AREA (M2) 1.9040E+01
475 SEPARATOR HEIGHT (M) 3.6700E+00
476 L/A RATIO FOR SEPARATOR 1.2000E+02
477
478 CORE INLET SUBCOOLING (C) 1.1540E+01
479
480
481 ADDITIONAL CONSTANTS
482 *****
483
484
485 NO LOCAL PRESSURE DEPENDENCE
486 FEEDWATER TEMPERATURE (DEGR C) = 1.91000E+02
487 SYSTEM PRESSURE (N/M2) = 6.91540E+06
488 ESTIMATED MODERATOR TEMPERATURE = 2.86000E+02
489 Requested Core Inlet Mass Flow Rate (kg/s) = 1.30400E+04
490 INCREMENT TO OBTAIN SECOND FLOW VALUE = 1.30400E+02

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5. Output Descriptions

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491 RELATIVE ACCURACY = 2.00000E-03
492 OUTPUT OPTION = 113
493
494 END HYDRAULIC INPUT
495 *****
496
497
498
499 STEAMLINE INPUT
500 *****
501 GEOMETRY
502 NO. OF NODES IN MAIN STEAMLINE = 6
503 NO. OF NODES IN BYPASS LINE = 2
504 NO. OF STEAMLINES = 4
505 CARDINAL NO. OF BYPASS BRANCH NODE = 5
506 CARDINAL NO. OF SAFETY/RELIEF VALVES NODE = 2
507 CARDINAL NO. OF MAIN STEAM ISOLATION VALVE (MSIV) NODE = 3
508
509 CROSS-SECTIONAL AREAS (M**2) OF -
510 STEAMLINE
511 STEAM DOME AND BYPASS BRANCH POINT = 2.48500E-01
512 BYPASS BRANCH POINT AND TURBINE STOP VALVE = 2.35500E-01
513 BYPASS LINE = 7.01500E-02
514
515 LENGTH OF STEAMLINE SECTION (M) BETWEEN
516 STEAM DOME AND BYPASS BRANCH POINT = 7.92392E+01
517 BYPASS BRANCH POINT AND TURBINE STOP VALVE = 4.17900E+00
518 LENGTH OF BYPASS LINE = 2.11920E+01
519
520 ENTRANCE CONTRACTION LOSS COEFFICIENT = 5.00000E-01
521 ROUGHNESS = 2.80000E-04
522
523
524 SAFETY
525 PSETU (N/M**2) = 0.00000E+00
526 PSETL (N/M**2) = 0.00000E+00
527 WMAXSR (KG/SEC) = 0.00000E+00
528 CFF = 0.00000E+00
529 CFB = 0.00000E+00
530 SLP1 = 0.00000E+00
531 SLP2 = 0.00000E+00
532
533
534 FLOW PARAMETERS
535 REL. CHANGE OF PLENUM PRESSURE (1/SEC) = 0.00000E+00
536 TURBINE VALVE CLOSURE RATE (1/SEC) = 1.05000E+01
537 POLYTROPIC EXPANSION COEFFICIENT = 1.13000E+00
538 MAXIMUM BYPASS FLOW RATE (KG/SEC) = 1.10540E+02
539 BYPASS VALVE OPENING DELAY (SEC) = 0.00000E+00
540 BYPASS VALVE OPENING TIME (SEC) = 0.00000E+00
541 LFR = 0
542
543 BOP Input Data Summary:
544
545 Pressure Drop Across TSV in N/m^2 = 8.7730E+05
546 Pressure Drop Across HP Turbine in N/m^2 = 4.1830E+06
547 MSIV Cross-Over Pressure Setpoint in N/m^2 = 1.1210E+06
548 Initial Condenser Pressure in N/m^2 = 5.0000E+03
549 Total Liquid Volume of Condenser in m^3 = 4.0000E+02
550 Total Mixture Volume of Condenser in m^3 = 1.6000E+03
551 Feedwater Pump Head in meter = 7.0409E+02
552 Condensate Booster Pump Head in meter = 3.8405E+02
553 Initial Feedwater Pump Speed in rad/s = 5.6549E+02
554 Moment of Inertia for Feedwater Pump = 2.0000E+02
555 Initial Feedwater Turbine Valve Flow, kg/s = 9.5923E+00
556 Condenser Circulating Water Temperature, C = 2.7000E+01
557 Fraction of Flow at FW Heater Shell Side = 3.4772E-01
558 Fraction of Heat Transfer in Drain Cooler = 2.4100E-01
559 Total Number of Feedwater Preheaters = 15
560 Number of Failed Feedwater Preheaters = 4

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5. Output Descriptions

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561 Feedwater Turbine Valve Coefficients:
562 CFTV1 = 2.0000E+00 CFTV2 = 0.0000E+00
563 CFTV3 = 1.0000E+00 CFTV4 = 5.0000E-01
564 Feedwater Pump Head Coefficients:
565 SA = -5.0816E-01 SB = -1.9184E-01 SC = 1.7000E+00
566 Feedwater Pump Torque Coefficients:
567 SP = -2.8866E-01 SQ = 2.6598E-01
568 SR = 2.2268E-01 SS = 8.0000E-01
569 High-Pressure Turbine Stage Parameters:
570 RSTARHP = 4.0000E-01 ALFAHP = 1.3090E+00 R2R1HP = 1.0000E+00
571 PHIHP = 9.7000E-01 PHIRHP = 9.8000E-01 PSIHHP = 9.5000E-01
572 FRHHP = 8.9000E-02 PHIEHP = 1.0000E+00 VM21HP = 1.2000E+00
573 Low-Pressure Turbine Stage Parameters:
574 RSTARLP = 5.0000E-01 ALFALP = 1.3090E+00 R2R1LP = 1.0330E+00
575 PHILP = 9.6000E-01 PHIRLP = 9.5000E-01 PSILP = 9.4800E-01
576 FRHLP = 2.5000E-02 PHIELP = 9.5000E-01 VM21LP = 1.2000E+00
577
578 CHIMNEY DATA
579 CHIMNEY HEIGHT EXCLUDING RISER (M) = 0.00000E+00
580 CONSTANT PART IN RISER MODIFIER = 0.00000E+00
581 COEFFICIENT "A" IN RISER MODIFIER = 0.00000E+00
582 COEFFICIENT "B" IN RISER MODIFIER = 0.00000E+00
583 LOSS COEFFICIENT DATA
584 DOWNCOMER 1
585 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT INLET
586 A= -5.00000E-01 B= 0.00000E+00 C= 0.00000E+00 AT EXIT
587 DOWNCOMER 2
588 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT INLET
589 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT EXIT
590 LOWER PLENUM 1
591 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT INLET
592 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT EXIT
593 LOWER PLENUM 2
594 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT INLET
595 A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT EXIT
596 CORE INLET LOSS COEFFICIENTS
597 1 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
598 2 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
599 3 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
600 4 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
601 5 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
602 6 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
603 7 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
604 8 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
605 9 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
606 10 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
607 11 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
608 12 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
609 13 A= -2.30000E+02 B= 0.00000E+00 C= 0.00000E+00
610 14 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
611 15 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
612 16 A= -2.30000E+02 B= 0.00000E+00 C= 0.00000E+00
613 17 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
614 18 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
615 19 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
616 20 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
617 21 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
618 22 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
619 23 A= -3.00000E+01 B= 0.00000E+00 C= 0.00000E+00
620 24 A= -2.30000E+02 B= 0.00000E+00 C= 0.00000E+00
621 25 A= -7.00000E+02 B= 0.00000E+00 C= 0.00000E+00
622 CORE OUTLET LOSS COEFFICIENTS
623 1 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
624 2 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
625 3 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
626 4 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
627 5 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
628 6 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
629 7 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
630 8 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00

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5. Output Descriptions

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631      9 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
632     10 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
633     11 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
634     12 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
635     13 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
636     14 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
637     15 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
638     16 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
639     17 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
640     18 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
641     19 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
642     20 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
643     21 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
644     22 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
645     23 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
646     24 A= -1.34000E+00 B= 0.00000E+00 C= 0.00000E+00
647     25 A= -8.00000E+00 B= 0.00000E+00 C= 0.00000E+00
648  RISER
649  A= 0.00000E+00 B= 0.00000E+00 C= 0.00000E+00 AT INLET
650  A= -1.91000E+01 B= 0.00000E+00 C= 0.00000E+00 AT EXIT
651  ISOLATION CONDENSER INPUT DATA
652  LIC = 0
653  LIC = 0 : NO IC IN OPERATION
654  = 1 : NORMAL IC OPERATION
655  = 2 : FORCED TIME SET IC OPERATION
656  LID = 0
657  LID = 0 : STEAM LINE TO ISOLATION CONDENSER CLOSED ( BWR )
658  LID = 1 : STEAM LINE TO ISOLATION CONDENSER OPEN ( SBWR )
659  VALVE DELAY MODEL INPUT
660  VALVE EQUIVALENT DIAMETER (M) = 1.52400E-01
661  TIME DELAY IN IC ACTIVATION (SEC) = 2.00000E+00
662  TIME DELAY IN VALVE FULL OPEN (SEC) = 5.00000E-01
663  0* IC POOL DATA
664  POOL VOLUME (M**3) = 3.27000E+02
665  POOL PRESSURE (PA) = 1.01300E+05
666  POOL TEMPERATURE (K) = 3.05000E+02
667  * IC TUBE DATA
668  TUBE INNER DIAMETER (M) = 4.83500E-02
669  TUBE OUTER DIAMETER (M) = 5.00000E-02
670  TUBE CONDUCTIVITY (W/M-K) = 4.50000E+01
671  NUMBER OF TUBES IN IC = 2.48000E+02
672  LENGTH OF TUBES IN IC (M) = 2.00000E+00
673  * CONDENSER DRUM DATA
674  UPPER DRUM DIAMETER (M) = 6.50000E-01
675  LOWER DRUM DIAMETER (M) = 6.50000E-01
676  DRUM LENGTH (M) = 2.10000E+00
677  * FLOW LOSS COEFFICIENT AND TIME LAG
678  STEAM LINE LOSS COEFFICIENT = 4.00000E+00
679  LIQUID LINE LOSS COEFFICIENT = 1.00000E+00
680  STEAM LINE TIME LAG = 0.00000E+00
681  LIQUID LINE TIME LAG = 0.00000E+00
682  FOULING FACTOR FOR TUBES = 0.00000E+00
683  * GEOMETRIC DIMENSIONS
684  RETURN LINE DIAMETER (M) = 1.52400E-01
685  RETURN LINE ELEVATION (M) = 6.70000E+00
686  MAXIMUM HEIGHT (M) = 1.01000E+01
687  ELEVATION OF DOWNCOMER ENTRANCE (M) = 1.35500E+01
688  LOCATION OF IC LIQUID RETURN (M) = 1.15000E+01
689  NUMBER OF ICS IN ACTION = 1.00000E+00
690  STEAM INLET PIPE AREA (M**2) = 5.06700E-02
691  LIQUID OUTLET PIPE AREA (M**2) = 1.82400E-02
692  TUBE SURFACE AREA (M**2) = 1.07200E+00
693  INITIAL STEAM LINE PRESSURE DROP (PA) = 4.00000E+04
694  INITIAL LIQUID LINE PRESSURE DROP (PA) = 4.00000E+04
695  MAXIMUM NUMBER OF ITERATIONS = 0
696  INITIAL QUALITY INSIDE IC = 0.00000E+00
697  INITIAL HEAT TRANSFER (W/M**2) = 1.00000E+05
698  GAS VENT INDICATOR-IGAS = 0
699  MAXIMUM PRESSURE AT WHICH IC IS ACTIVATED (PA) = 7.58000E+06
700  STEAM LINE LENGTH (M) = 1.01000E+01

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5. Output Descriptions

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701 INDICATOR FOR HPOOL PROFILE = 0
702 ONUMBER OF GROUPS OF TUBES = 3
703 GROUP NUMBER OF TUBES HEAT TRANSFER COEFFICIENT MODIFIER
704 1 4.00000E+01 0.00000E+00
705
706
707 2 4.00000E+01 0.00000E+00
708
709
710 3 4.00000E+01 0.00000E+00
711
712
713 SLCS INPUT DATA
714 LSC = 0
715 LSC = 0 : NO SLCS IN OPERATION
716 = 1 : NORMAL ATWS INITIATED SLCS OPERATION
717 = 2 : MANUALLY INITIATED SLCS OPERATION
718 Tank data
719 Tank volume (m^3) = 2.05000E+01
720 Tank Liquid Temperature (C) = 3.01000E+01
721 Tank Gas Pressure (Pa) = 1.48200E+07
722 Tank Bottom Elevation (m) = 8.00000E+00
723 Liquid Line Data
724 Pipe Diameter (m) = 7.62000E-02
725 Pipe Length (m) = 1.00000E+01
726 Liquid Volume in Tank (m^3) = 7.80000E+00
727 Liquid Level in Tank (m) = 2.00000E+00
728 Return Line Pressure (Pa) = 0.00000E+00
729 Variables for automatic SLCS initiation
730 High Pressure Setpoint (Pa) = 7.76000E+06
731 Low Level in Vessel (m) = 5.00000E+00
732 Boron Properties
733 Boron Concentration (PPM) = 1.17500E+05
734 Boron Density (kg/m3) = 1.20000E+03
735 Liquid Properties
736 Liquid Density (kg/m3) = 0.00000E+00
737 Liquid Viscosity (Ns/m2) = 8.00000E-04
738 Assumed Initial Liquid Velocity (m/sec) = 2.00000E+01
739 Sudden Contraction Loss Coefficient = 1.20000E+02
740 Isentropic expansion coefficient = 1.40000E+00
741 Read valve input data
742 Signal transmission delay time (sec) = 1.00000E+00
743 Valve Diameter (m) = 5.60000E-02
744 Valve Opening time (sec) = 5.00000E-01
745 -----
746
747
748 Heat Structure Input Data
749 lhs = 0
750 lhs = 0 : NO Heat Structure Calculation
751 = 1 : NORMAL Heat Structure Calculation
752
753 MSIV Closure ATWS Analysis: 1/8 core of a BWR4 (BF1)
754 ERROR MESSAGES FROM ROUTINE TESTINP
755 *****
756
757
758 NO ERRORS WAS DETECTED IN TSTINP
759
760 PROGRAM CONTINUES
761
762
763 Iteration Number = 12
764 Convergence in Flux = T
765 Convergence in Normalized Power = T
766 Convergence in Eigenvalue = T
767 Eigenvalue After Current Iteration = 1.01315
768
769
770

```

PAGE 3

5. Output Descriptions

771	Time (s)	T.Power (W)	CW Level (m)	Steam Flow	FW Flow	FW Temp	Core Inlet Subc	
772	0.0000E+00	3.2930E+09	0.0000E+00	1.6374E+03	1.6374E+03	1.9100E+02	1.1530E+01	
774								
775	Pressure	JP Head	Tot Vap Gener	Core Flow	Riser Vap Gen	WLC Vap Upflow	Rel.C.Undr	Vap CU F
776	6.9154E+06	2.2138E+05	1.6374E+03	1.3040E+04	0.0000E+00	0.0000E+00	1.0347E-03	1.1786E
777								
778	RP Head	Rec Flow	RP Spd (rpm)	RP Torque	JP diff loss			
779	0.0000E+00	6.4560E+03	1.6200E+03	0.0000E+00	2.2144E-03			
780								
781	ITERS							
782	0							
783								
784	Power, W	Flow In	Flow Out	Liq Vel In	Press Drop	Exit Qual	Exit Void	
785	2.3831E+07	9.2243E+01	9.2243E+01	2.1425E+00	-1.4780E+05	1.2642E-01	6.3366E-01	
786	2.0329E+07	6.1934E+01	6.1934E+01	1.9782E+00	-1.4780E+05	1.7230E-01	6.8832E-01	
787	5.0678E+06	1.5704E+01	1.5704E+01	2.0061E+00	-1.4780E+05	1.6871E-01	6.8493E-01	
788	9.1724E+06	3.2887E+01	3.2887E+01	2.1004E+00	-1.4780E+05	1.3995E-01	6.5253E-01	
789	1.0381E+07	3.0594E+01	3.0594E+01	1.9540E+00	-1.4780E+05	1.7956E-01	6.9501E-01	
790	2.3237E+07	8.0367E+01	8.0367E+01	2.0535E+00	-1.4780E+05	1.4666E-01	6.6081E-01	
791	2.5981E+07	7.4519E+01	7.4519E+01	1.9153E+00	-1.4780E+05	1.8587E-01	7.0040E-01	
792	5.2515E+07	1.9653E+02	1.9653E+02	2.0924E+00	-1.4780E+05	1.3243E-01	6.4224E-01	
793	1.6073E+07	6.7210E+01	6.7210E+01	2.1468E+00	-1.4780E+05	1.1432E-01	6.1404E-01	
794	2.6748E+07	9.6162E+01	9.6162E+01	2.0475E+00	-1.4780E+05	1.3989E-01	6.5218E-01	
795	5.0529E+07	1.5159E+02	1.5159E+02	1.9366E+00	-1.4780E+05	1.7593E-01	6.9158E-01	
796	2.9013E+07	1.2648E+02	1.2648E+02	2.1543E+00	-1.4780E+05	1.0814E-01	6.0297E-01	
797	1.2554E+07	6.1193E+01	6.1193E+01	1.1168E+00	-1.4780E+05	9.2273E-02	5.5681E-01	
798	2.2589E+07	6.9224E+01	6.9224E+01	1.9767E+00	-1.4780E+05	1.7103E-01	6.8707E-01	
799	2.7801E+07	1.1785E+02	1.1785E+02	2.1508E+00	-1.4780E+05	1.1225E-01	6.1043E-01	
800	6.1273E+06	3.0644E+01	3.0644E+01	1.1185E+00	-1.4780E+05	8.8830E-02	5.4859E-01	
801	5.1940E+06	1.5485E+01	1.5485E+01	1.9782E+00	-1.4780E+05	1.7707E-01	6.9285E-01	
802	1.3373E+07	7.1333E+01	7.1333E+01	2.2785E+00	-1.4780E+05	8.0820E-02	5.4215E-01	
803	5.3979E+06	1.4906E+01	1.4906E+01	1.9043E+00	-1.4780E+05	1.9459E-01	7.0759E-01	
804	2.6403E+06	7.6304E+00	7.6304E+00	1.9496E+00	-1.4780E+05	1.8397E-01	6.9892E-01	
805	4.2942E+06	1.6571E+01	1.6571E+01	2.1169E+00	-1.4780E+05	1.2706E-01	6.3450E-01	
806	5.4212E+06	1.4808E+01	1.4808E+01	1.8918E+00	-1.4780E+05	1.9724E-01	7.0964E-01	
807	5.2634E+06	1.4857E+01	1.4857E+01	1.8980E+00	-1.4780E+05	1.8964E-01	7.0352E-01	
808	1.9172E+06	8.7208E+00	8.7208E+00	1.1141E+00	-1.4781E+05	1.0177E-01	5.7761E-01	
					-1.4780E+05	0.0000E+00	0.0000E+00	

STEADY STATE RESULTS

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816
817
818 Mixture Level is in Steam Dome, .673 Meters Above Downcomer Entrance
819
820 Conditions in Steam Dome
821
822
823 Void * Water Subcool * Water Temp * Evap Rate *
824 Fraction* Deg C * Deg C * Kg/S *
825 * * * *
826 .0407 .000 284.947 .000
827
828
829 Position* Flow * Void * Liq Vel * Vap Vel * Subcool * Liq Temp*Evap Rate*Heat Flux* CPR * CHFR *Wall Tmp*WT Reg
830 (m) * Quality * Fraction* m/s * m/s * Deg C * Deg C * kg/s * MW/m2 * * * Deg C *
831 * * * * * * * * * *
832 Downcomer 1
833
834 Component 1 - Entrance Cell 2, Exit Cell 8
835 .00000* .0010* .0528* .6205* .2369* .0000* 284.947* .000*
836 1.00300* .0010* .0528* .6205* .2369* .0000* 284.947* .000*
837 2.00600* .0000* .0000* .6559* -.1875* 11.5400* 273.407* -11.786*
838 3.00900* .0000* .0000* .6559* -.1875* 11.5303* 273.417* .000*
839 4.01200* .0000* .0000* .6559* -.1875* 11.5303* 273.417* .000*
840 5.01500* .0000* .0000* .6559* -.1875* 11.5303* 273.417* .000*
841 6.01800* .0000* .0000* .6559* -.1875* 11.5303* 273.417* .000*

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5. Output Descriptions

841	Downcomer 2							
842			Component	2 - Entrance Cell	9, Exit Cell	15		
843	6.01800*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
844	6.86167*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
845	7.70533*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
846	8.54900*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
847	9.39267*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
848	10.23633*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
849	11.08000*	.0000*	.0000*	13.7095*	-.1875*	11.5303*	273.417*	.000*
850	Lower Plenum 1							
851			Component	3 - Entrance Cell	16, Exit Cell	18		
852	.00000*	.0000*	.0000*	.9441*	.9441*	11.5303*	273.417*	.000*
853	1.59400*	.0000*	.0000*	.9441*	.9441*	11.5303*	273.417*	.000*
854	3.18800*	.0000*	.0000*	.9441*	.9441*	11.5303*	273.417*	.000*
855	Lower Plenum 2							
856			Component	4 - Entrance Cell	19, Exit Cell	22		
857	-2.30600*	.0000*	.0000*	1.0423*	.1875*	11.5303*	273.417*	.000*
858	-1.53733*	.0000*	.0000*	1.0423*	.1875*	11.5303*	273.417*	.000*
859	-.76867*	.0000*	.0000*	1.0423*	.1875*	11.5303*	273.417*	.000*
860	.00000*	.0000*	.0000*	1.0423*	.1875*	11.5303*	273.417*	.000*
861	Channel 1, Entrance Cell 23, Exit Cell 623							
862	.00000*	.0000*	.0000*	2.1425*	.1875*	11.5303*	273.417*	.000*
863	.15875*	.0000*	.0000*	2.1442*	.1875*	11.1587*	273.788*	.000*
864	.31750*	.0000*	.0000*	2.1478*	.1876*	10.3966*	274.550*	.000*
865	.47625*	.0000*	.0000*	2.1528*	.1877*	9.3361*	275.611*	.000*
866	.63500*	.0003*	.0169*	2.1949*	.8477*	8.1684*	276.778*	.029*
867	.79375*	.0010*	.0327*	2.2348*	1.3229*	7.0408*	277.906*	.059*
868	.95250*	.0022*	.0546*	2.2893*	1.8252*	5.9095*	279.037*	.115*
869	1.11125*	.0043*	.0843*	2.3647*	2.3188*	4.7640*	280.183*	.196*
870	1.27000*	.0075*	.1223*	2.4655*	2.7606*	3.6398*	281.307*	.290*
871	1.42875*	.0115*	.1657*	2.5892*	3.1281*	2.6160*	282.331*	.369*
872	1.58750*	.0163*	.2127*	2.7360*	3.4556*	1.7260*	283.221*	.442*
873	1.74625*	.0219*	.2622*	2.9074*	3.7823*	.9677*	283.979*	.524*
874	1.90500*	.0282*	.3100*	3.0934*	4.1159*	.3569*	284.590*	.581*
875	2.06375*	.0351*	.3550*	3.2890*	4.4662*	-.1094*	285.056*	.631*
876	2.22250*	.0425*	.3968*	3.4927*	4.8402*	-.4320*	285.379*	.684*
877	2.38125*	.0507*	.4364*	3.7077*	5.2506*	-.6719*	285.619*	.756*
878	2.54000*	.0593*	.4717*	3.9216*	5.6782*	-.8374*	285.784*	.790*
879	2.69875*	.0681*	.5032*	4.1315*	6.1198*	-.9540*	285.901*	.818*
880	2.85750*	.0775*	.5319*	4.3422*	6.5881*	-1.0540*	286.001*	.868*
881	3.01625*	.0870*	.5571*	4.5428*	7.0601*	-1.1212*	286.068*	.875*
882	3.17500*	.0964*	.5789*	4.7296*	7.5269*	-1.1604*	286.107*	.866*
883	3.33375*	.1061*	.5989*	4.9119*	8.0115*	-1.2061*	286.153*	.899*
884	3.49250*	.1149*	.6148*	5.0652*	8.4454*	-1.1874*	286.134*	.805*
885	3.65125*	.1219*	.6266*	5.1824*	8.7953*	-1.0964*	286.043*	.650*
886	3.81000*	.1264*	.6337*	5.2531*	9.0178*	-.9189*	285.866*	.414*
887	Channel 2, Entrance Cell 24, Exit Cell 624							
888	.00000*	.0000*	.0000*	1.9782*	.1875*	11.5303*	-273.417*	.000*
889	.15875*	.0000*	.0000*	1.9807*	.1876*	10.9640*	273.983*	.000*
890	.31750*	.0000*	.0019*	1.9901*	.2632*	9.6323*	275.315*	.001*
891	.47625*	.0009*	.0321*	2.0574*	1.2180*	8.1101*	276.837*	.057*
892	.63500*	.0027*	.0622*	2.1268*	1.8302*	6.5741*	278.373*	.111*
893	.79375*	.0051*	.0938*	2.2027*	2.2703*	5.1668*	279.780*	.147*
894	.95250*	.0084*	.1327*	2.3003*	2.6526*	3.8660*	281.081*	.206*
895	1.11125*	.0131*	.1812*	2.4317*	3.0078*	2.6727*	282.274*	.287*
896	1.27000*	.0191*	.2374*	2.6010*	3.3582*	1.6215*	283.325*	.374*
897	1.42875*	.0262*	.2945*	2.7963*	3.7165*	.7637*	284.183*	.441*
898	1.58750*	.0342*	.3485*	3.0077*	4.0964*	.0939*	284.853*	.494*
899	1.74625*	.0431*	.3988*	3.2326*	4.5113*	-.3712*	285.318*	.551*
900	1.90500*	.0526*	.4433*	3.4596*	4.9493*	-.6750*	285.622*	.587*
901	2.06375*	.0624*	.4822*	3.6820*	5.4027*	-.8718*	285.819*	.610*
902	2.22250*	.0726*	.5159*	3.8974*	5.8685*	-1.0025*	285.949*	.627*
903	2.38125*	.0831*	.5459*	4.1080*	6.3533*	-1.1020*	286.049*	.653*
904	2.54000*	.0939*	.5721*	4.3091*	6.8480*	-1.1747*	286.122*	.667*
905	2.69875*	.1048*	.5951*	4.5005*	7.3518*	-1.2313*	286.178*	.679*
906	2.85750*	.1162*	.6159*	4.6842*	7.8724*	-1.2876*	286.234*	.702*
907	3.01625*	.1275*	.6341*	4.8546*	8.3935*	-1.3267*	286.274*	.703*
908	3.17500*	.1387*	.6499*	5.0094*	8.9058*	-1.3461*	286.293*	.691*
909	3.33375*	.1497*	.6639*	5.1509*	9.4126*	-1.3576*	286.305*	.684*
910	3.49250*	.1596*	.6751*	5.2676*	9.8640*	-1.3109*	286.258*	.609*

5. Output Descriptions

911	3.65125*	.1675*	.6835*	5.3541*	10.2274*	-1.1941*	286.141*	.491*	.455*	1.73*****	291.685	NCB
912	3.81000*	.1723*	.6883*	5.4036*	10.4468*	-.9763*	285.923*	.297*	.250*	1.71*****	290.750	NCB
913	Channel 3, Entrance Cell			25, Exit Cell	625							
914	.00000*	.0000*	.0000*	2.0061*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
915	.15875*	.0000*	.0000*	2.0072*	.1875*	11.2922*	273.655*	.000*	.051*9999.00*****	276.701	SPH	
916	.31750*	.0000*	.0000*	2.0101*	.1876*	10.6267*	274.320*	.000*	.144*9999.00*****	282.841	SPH	
917	.47625*	.0000*	.0000*	2.0142*	.1877*	9.6828*	275.264*	.000*	.204*9999.00*****	287.367	SPH	
918	.63500*	.0001*	.0058*	2.0309*	.4179*	8.5307*	276.416*	.001*	.253*9999.00*****	290.765	NCB	
919	.79375*	.0007*	.0271*	2.0797*	1.1040*	7.3126*	277.634*	.010*	.305*	8.43*****	291.043	NCB
920	.95250*	.0022*	.0543*	2.1425*	1.7171*	6.0382*	278.909*	.024*	.370*	7.11*****	291.345	NCB
921	1.11125*	.0059*	.1038*	2.2598*	2.4128*	4.5416*	280.405*	.058*	.555*	5.73*****	292.027	NCB
922	1.27000*	.0112*	.1623*	2.4125*	2.9166*	3.1190*	281.828*	.083*	.633*	4.80*****	292.264	NCB
923	1.42875*	.0177*	.2256*	2.5995*	3.3286*	1.8962*	283.051*	.103*	.667*	4.17*****	292.362	NCB
924	1.58750*	.0254*	.2886*	2.8137*	3.7254*	.9109*	284.036*	.120*	.681*	3.72*****	292.401	NCB
925	1.74625*	.0341*	.3481*	3.0484*	4.1467*	.1395*	284.807*	.137*	.697*	3.37*****	292.444	NCB
926	1.90500*	.0437*	.4018*	3.2931*	4.5978*	-.3852*	285.332*	.150*	.695*	3.09*****	292.438	NCB
927	2.06375*	.0538*	.4487*	3.5384*	5.0729*	-.7237*	285.671*	.159*	.691*	2.87*****	292.426	NCB
928	2.22250*	.0644*	.4893*	3.7786*	5.5666*	-.9435*	285.890*	.166*	.691*	2.68*****	292.428	NCB
929	2.38125*	.0753*	.5245*	4.0122*	6.0782*	-1.0932*	286.040*	.172*	.700*	2.51*****	292.452	NCB
930	2.54000*	.0866*	.5549*	4.2357*	6.6022*	-1.1969*	286.144*	.177*	.707*	2.37*****	292.470	NCB
931	2.69875*	.0981*	.5815*	4.4482*	7.1371*	-1.2732*	286.220*	.180*	.715*	2.24*****	292.492	NCB
932	2.85750*	.1100*	.6051*	4.6537*	7.6939*	-1.3457*	286.293*	.188*	.743*	2.12*****	292.563	NCB
933	3.01625*	.1220*	.6257*	4.8437*	8.2519*	-1.3951*	286.342*	.188*	.739*	2.01*****	292.554	NCB
934	3.17500*	.1338*	.6434*	5.0158*	8.8006*	-1.4206*	286.368*	.185*	.722*	1.91*****	292.510	NCB
935	3.33375*	.1453*	.6586*	5.1706*	9.3364*	-1.4285*	286.375*	.181*	.702*	1.83*****	292.456	NCB
936	3.49250*	.1555*	.6708*	5.2980*	9.8133*	-1.3775*	286.324*	.161*	.614*	1.76*****	292.210	NCB
937	3.65125*	.1638*	.6799*	5.3923*	10.1971*	-1.2551*	286.202*	.130*	.480*	1.71*****	291.777	NCB
938	3.81000*	.1687*	.6849*	5.4450*	10.4244*	-1.0236*	285.970*	.077*	.257*	1.69*****	290.790	NCB
939	Channel 4, Entrance Cell			26, Exit Cell	626							
940	.00000*	.0000*	.0000*	2.1004*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
941	.15875*	.0000*	.0000*	2.1015*	.1875*	11.3002*	273.647*	.000*	.052*9999.00*****	276.618	SPH	
942	.31750*	.0000*	.0000*	2.1040*	.1876*	10.7492*	274.198*	.000*	.124*9999.00*****	281.316	SPH	
943	.47625*	.0000*	.0000*	2.1076*	.1877*	9.9756*	274.971*	.000*	.175*9999.00*****	284.977	SPH	
944	.63500*	.0000*	.0000*	2.1119*	.1877*	9.0284*	275.918*	.000*	.214*9999.00*****	288.184	SPH	
945	.79375*	.0002*	.0113*	2.1407*	.6383*	7.9603*	276.987*	.005*	.253*	8.02*****	290.765	NCB
946	.95250*	.0009*	.0323*	2.1912*	1.2914*	6.8271*	278.120*	.026*	.309*	7.09*****	291.061	NCB
947	1.11125*	.0034*	.0718*	2.2856*	2.0931*	5.4636*	279.483*	.080*	.469*	5.90*****	291.735	NCB
948	1.27000*	.0070*	.1173*	2.4019*	2.6597*	4.1081*	280.839*	.120*	.544*	5.04*****	291.993	NCB
949	1.42875*	.0117*	.1681*	2.5434*	3.0863*	2.8806*	282.066*	.153*	.579*	4.44*****	292.104	NCB
950	1.58750*	.0173*	.2220*	2.7107*	3.4509*	1.8327*	283.114*	.184*	.596*	4.01*****	292.156	NCB
951	1.74625*	.0239*	.2779*	2.9065*	3.8160*	.9558*	283.991*	.218*	.624*	3.65*****	292.239	NCB
952	1.90500*	.0313*	.3306*	3.1163*	4.1910*	.2685*	284.678*	.241*	.624*	3.37*****	292.238	NCB
953	2.06375*	.0393*	.3796*	3.3382*	4.5930*	-.2345*	285.181*	.266*	.629*	3.14*****	292.254	NCB
954	2.22250*	.0480*	.4238*	3.5651*	5.0197*	-.5718*	285.519*	.285*	.630*	2.94*****	292.255	NCB
955	2.38125*	.0573*	.4637*	3.7947*	5.4731*	-.8053*	285.752*	.304*	.643*	2.76*****	292.294	NCB
956	2.54000*	.0669*	.4986*	4.0195*	5.9420*	-.9631*	285.910*	.316*	.648*	2.61*****	292.307	NCB
957	2.69875*	.0767*	.5293*	4.2372*	6.4234*	-1.0725*	286.019*	.324*	.653*	2.47*****	292.323	NCB
958	2.85750*	.0871*	.5570*	4.4526*	6.9301*	-1.1671*	286.114*	.342*	.683*	2.34*****	292.405	NCB
959	3.01625*	.0975*	.5810*	4.6554*	7.4387*	-1.2294*	286.176*	.343*	.678*	2.22*****	292.392	NCB
960	3.17500*	.1078*	.6017*	4.8420*	7.9397*	-1.2636*	286.211*	.338*	.662*	2.12*****	292.349	NCB
961	3.33375*	.1184*	.6204*	5.0206*	8.4531*	-1.3017*	286.249*	.346*	.679*	2.02*****	292.394	NCB
962	3.49250*	.1278*	.6353*	5.1691*	8.9113*	-1.2'37*	286.221*	.309*	.594*	1.94*****	292.149	NCB
963	3.65125*	.1353*	.6462*	5.2816*	9.2795*	-1.1'04*	286.117*	.249*	.462*	1.89*****	291.711	NCB
964	3.81000*	.1399*	.6525*	5.3461*	9.5039*	-.9683*	285.915*	.152*	.256*	1.87*****	290.782	NCB
965	Channel 5, Entrance Cell			27, Exit Cell	627							
966	.00000*	.0000*	.0000*	1.9540*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
967	.15875*	.0000*	.0000*	1.9567*	.1876*	10.8835*	274.063*	.000*	.136*9999.00*****	282.303	SPH	
968	.31750*	.0002*	.0106*	1.9836*	.5828*	9.4427*	275.504*	.005*	.313*	14.72*****	291.081	NCB
969	.47625*	.0014*	.0408*	2.0509*	1.4062*	7.8271*	277.120*	.038*	.417*	9.32*****	291.539	NCB
970	.63500*	.0036*	.0741*	2.1276*	1.9909*	6.2234*	278.724*	.067*	.472*	7.08*****	291.746	NCB
971	.79375*	.0064*	.1093*	2.2125*	2.4097*	4.7813*	280.166*	.086*	.475*	5.96*****	291.758	NCB
972	.95250*	.0102*	.1516*	2.3205*	2.7691*	3.4795*	281.467*	.116*	.504*	5.20*****	291.858	NCB
973	1.11125*	.0153*	.2029*	2.4637*	3.1104*	2.3121*	282.635*	.157*	.554*	4.60*****	292.026	NCB
974	1.27000*	.0219*	.2609*	2.6450*	3.4624*	1.3026*	283.644*	.202*	.608*	4.10*****	292.190	NCB
975	1.42875*	.0296*	.3181*	2.8494*	3.8315*	.4960*	284.451*	.234*	.626*	3.72*****	292.244	NCB
976	1.58750*	.0380*	.3711*	3.0670*	4.2259*	-.1073*	285.054*	.259*	.632*	3.41*****	292.261	NCB
977	1.74625*	.0474*	.4198*	3.2951*	4.6549*	-.5107*	285.458*	.286*	.642*	3.15*****	292.290	NCB
978	1.90500*	.0572*	.4623*	3.5213*	5.1028*	-.7700*	285.717*	.301*	.639*	2.94*****	292.282	NCB
979	2.06375*	.0674*	.4991*	3.7406*	5.5630*	-.9363*	285.883*	.310*	.637*	2.76*****	292.276	NCB
980	2.22250*	.0777*	.5310*	3.9516*	6.0339*	-1.0471*	285.994*	.317*	.640*	2.60*****	292.284	NCB

5. Output Descriptions

981	2.38125*	.0885*	.5594*	4.1574*	6.5237*	-1.1354*	286.082*	.330*	.660*	2.45*****	292.340	NCB
982	2.54000*	.0995*	.5841*	4.3534*	7.0225*	-1.2008*	286.148*	.336*	.667*	2.32*****	292.360	NCB
983	2.69875*	.1107*	.6060*	4.5384*	7.5292*	-1.2522*	286.199*	.342*	.674*	2.20*****	292.379	NCB
984	2.85750*	.1223*	.6258*	4.7163*	8.0541*	-1.3072*	286.254*	.354*	.698*	2.09*****	292.445	NCB
985	3.01625*	.1338*	.6431*	4.8806*	8.5788*	-1.3448*	286.292*	.354*	.694*	1.99*****	292.434	NCB
986	3.17500*	.1452*	.6582*	5.0294*	9.0944*	-1.3631*	286.310*	.348*	.678*	1.90*****	292.391	NCB
987	3.33375*	.1565*	.6716*	5.1657*	9.6076*	-1.3773*	286.324*	.346*	.674*	1.81*****	292.379	NCB
988	3.49250*	.1666*	.6824*	5.2778*	10.0647*	-1.3308*	286.278*	.309*	.590*	1.74*****	292.136	NCB
989	3.65125*	.1747*	.6905*	5.3603*	10.4317*	-1.2112*	286.158*	.248*	.460*	1.69*****	291.703	NCB
990	3.81000*	.1796*	.6950*	5.4064*	10.6502*	-.9855*	285.932*	.148*	.249*	1.67*****	290.740	NCB
991	Channel 6, Entrance Cell 28, Exit Cell 628											
992	.00000*	.0000*	.0000*	2.0535*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
993	.15875*	.0000*	.0000*	2.0566*	.1876*	10.8461*	274.101*	.000*	.151*	9999.00*****	282.900	SPH
994	.31750*	.0001*	.0094*	2.0820*	.5584*	9.4849*	275.462*	.010*	.309*	13.78*****	291.063	NCB
995	.47625*	.0012*	.0375*	2.1478*	1.3914*	7.9629*	276.984*	.087*	.407*	9.03*****	291.500	NCB
996	.63500*	.0031*	.0673*	2.2196*	1.9768*	6.4554*	278.492*	.150*	.454*	7.02*****	291.681	NCB
997	.79375*	.0053*	.0962*	2.2924*	2.3771*	5.1199*	279.827*	.177*	.437*	6.04*****	291.618	NCB
998	.95250*	.0081*	.1296*	2.3796*	2.7179*	3.9195*	281.027*	.229*	.447*	5.39*****	291.656	NCB
999	1.11125*	.0118*	.1686*	2.4882*	3.0265*	2.8498*	282.097*	.294*	.469*	4.89*****	291.735	NCB
1000	1.27000*	.0165*	.2145*	2.6267*	3.3324*	1.8982*	283.049*	.380*	.509*	4.46*****	291.876	NCB
1001	1.42875*	.0220*	.2625*	2.7869*	3.6373*	1.1038*	283.843*	.445*	.524*	4.10*****	291.928	NCB
1002	1.58750*	.0283*	.3098*	2.9633*	3.9547*	.4628*	284.484*	.502*	.533*	3.81*****	291.958	NCB
1003	1.74625*	.0354*	.3562*	3.1571*	4.3030*	-.0522*	284.999*	.570*	.558*	3.54*****	292.038	NCB
1004	1.90500*	.0431*	.3993*	3.3592*	4.6759*	-.4019*	285.349*	.620*	.560*	3.32*****	292.044	NCB
1005	2.06375*	.0514*	.4388*	3.5662*	5.0734*	-.6434*	285.590*	.666*	.571*	3.12*****	292.080	NCB
1006	2.22250*	.0600*	.4738*	3.7707*	5.4850*	-.8052*	285.752*	.692*	.574*	2.94*****	292.087	NCB
1007	2.38125*	.0689*	.5051*	3.9718*	5.9112*	-.9194*	285.866*	.717*	.583*	2.78*****	292.115	NCB
1008	2.54000*	.0780*	.5327*	4.1662*	6.3463*	-.9995*	285.946*	.733*	.587*	2.63*****	292.129	NCB
1009	2.69875*	.0873*	.5572*	4.3535*	6.7892*	-1.0586*	286.006*	.747*	.593*	2.50*****	292.146	NCB
1010	2.85750*	.0971*	.5798*	4.5390*	7.2552*	-1.1216*	286.069*	.785*	.623*	2.37*****	292.236	NCB
1011	3.01625*	.1069*	.5997*	4.7132*	7.7215*	-1.1638*	286.111*	.786*	.619*	2.25*****	292.224	NCB
1012	3.17500*	.1165*	.6170*	4.8738*	8.1799*	-1.1855*	286.132*	.773*	.604*	2.15*****	292.180	NCB
1013	3.33375*	.1264*	.6329*	5.0282*	8.6499*	-1.2153*	286.162*	.793*	.621*	2.05*****	292.229	NCB
1014	3.49250*	.1352*	.6457*	5.1574*	9.0692*	-1.1850*	286.132*	.707*	.543*	1.97*****	291.989	NCB
1015	3.65125*	.1422*	.6552*	5.2544*	9.4060*	-1.0854*	286.032*	.569*	.422*	1.91*****	291.561	NCB
1016	3.81000*	.1467*	.6608*	5.3115*	9.6151*	-.8980*	285.845*	.354*	.240*	1.88*****	290.688	NCB
1017	Channel 7, Entrance Cell 29, Exit Cell 629											
1018	.00000*	.0000*	.0000*	1.9153*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
1019	.15875*	.0000*	.0000*	1.9190*	.1876*	10.6455*	274.301*	.000*	.181*	9999.00*****	285.462	SPH
1020	.31750*	.0010*	.0335*	1.9913*	1.2168*	8.8536*	276.093*	.075*	.428*	11.15*****	291.582	NCB
1021	.47625*	.0036*	.0747*	2.0836*	1.9614*	6.9092*	278.038*	.195*	.555*	7.12*****	292.028	NCB
1022	.63500*	.0075*	.1224*	2.1970*	2.4836*	5.0828*	279.864*	.290*	.605*	5.48*****	292.182	NCB
1023	.79375*	.0121*	.1709*	2.3227*	2.8486*	3.5685*	281.378*	.337*	.577*	4.69*****	292.097	NCB
1024	.95250*	.0174*	.2223*	2.4696*	3.1671*	2.3282*	282.619*	.401*	.569*	4.19*****	292.074	NCB
1025	1.11125*	.0238*	.2755*	2.6396*	3.4861*	1.3296*	283.617*	.473*	.575*	3.81*****	292.091	NCB
1026	1.27000*	.0313*	.3292*	2.8342*	3.8364*	.5278*	284.419*	.558*	.600*	3.50*****	292.167	NCB
1027	1.42875*	.0396*	.3795*	3.0415*	4.2145*	-.0749*	285.022*	.620*	.607*	3.24*****	292.187	NCB
1028	1.58750*	.0487*	.4254*	3.2567*	4.6225*	-.4698*	285.417*	.677*	.608*	3.03*****	292.193	NCB
1029	1.74625*	.0584*	.4665*	3.4740*	5.0563*	-.7314*	285.678*	.724*	.617*	2.84*****	292.218	NCB
1030	1.90500*	.0684*	.5023*	3.6852*	5.5030*	-.8993*	285.846*	.747*	.616*	2.68*****	292.214	NCB
1031	2.06375*	.0786*	.5333*	3.8879*	5.9586*	-1.0088*	285.956*	.763*	.616*	2.54*****	292.215	NCB
1032	2.22250*	.0890*	.5603*	4.0810*	6.4209*	-1.0831*	286.030*	.775*	.618*	2.41*****	292.220	NCB
1033	2.38125*	.0997*	.5842*	4.2662*	6.8940*	-1.1423*	286.089*	.793*	.628*	2.30*****	292.251	NCB
1034	2.54000*	.1104*	.6053*	4.4408*	7.3727*	-1.1875*	286.134*	.802*	.632*	2.19*****	292.263	NCB
1035	2.69875*	.1213*	.6240*	4.6050*	7.8559*	-1.2241*	286.171*	.810*	.636*	2.09*****	292.274	NCB
1036	2.85750*	.1325*	.6409*	4.7611*	8.3510*	-1.2639*	286.211*	.830*	.652*	2.00*****	292.319	NCB
1037	3.01625*	.1435*	.6558*	4.9046*	8.8433*	-1.2896*	286.237*	.825*	.645*	1.91*****	292.300	NCB
1038	3.17500*	.1544*	.6689*	5.0341*	9.3244*	-1.2983*	286.245*	.807*	.628*	1.84*****	292.249	NCB
1039	3.33375*	.1648*	.6803*	5.1499*	9.7889*	-1.2907*	286.238*	.779*	.603*	1.77*****	292.176	NCB
1040	3.49250*	.1741*	.6896*	5.2438*	10.2002*	-1.2328*	286.180*	.690*	.525*	1.71*****	291.932	NCB
1041	3.65125*	.1815*	.6965*	5.3142*	10.5294*	-1.1124*	286.059*	.553*	.409*	1.67*****	291.507	NCB
1042	3.81000*	.1859*	.7004*	5.3519*	10.7230*	-.8966*	285.844*	.326*	.217*	1.65*****	290.549	NCB
1043	Channel 8, Entrance Cell 30, Exit Cell 630											
1044	.00000*	.0000*	.0000*	2.0924*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
1045	.15875*	.0000*	.0000*	2.0957*	.1876*	10.8133*	274.134*	.000*	.161*	9999.00*****	283.389	SPH
1046	.31750*	.0002*	.0118*	2.1268*	.6540*	9.4459*	275.501*	.034*	.320*	12.98*****	291.116	NCB
1047	.47625*	.0013*	.0398*	2.1936*	1.4684*	7.9237*	277.023*	.226*	.419*	8.62*****	291.547	NCB
1048	.63500*	.0032*	.0697*	2.2673*	2.0489*	6.4227*	278.524*	.376*	.464*	6.76*****	291.717	NCB
1049	.79375*	.0054*	.0980*	2.3401*	2.4389*	5.1070*	279.840*	.428*	.439*	5.87*****	291.625	NCB
1050	.95250*	.0081*	.1297*	2.4253*	2.7671*	3.9357*	281.011*	.535*	.441*	5.29*****	291.634	NCB

5. Output Descriptions

1051	1.11125*	.0115*	.1663*	2.5287*	3.0628*	2.9005*	282.046*	.669*	.454*	4.84*****	291.680	NCB
1052	1.27000*	.0160*	.2098*	2.6615*	3.3602*	1.9724*	282.975*	.871*	.494*	4.44*****	291.827	NCB
1053	1.42875*	.0211*	.2552*	2.8137*	3.6533*	1.1964*	283.750*	1.012*	.505*	4.11*****	291.864	NCB
1054	1.58750*	.0269*	.3000*	2.9805*	3.9545*	.5685*	284.378*	1.131*	.510*	3.84*****	291.879	NCB
1055	1.74625*	.0333*	.3434*	3.1602*	4.2758*	.0632*	284.884*	1.255*	.522*	3.60*****	291.919	NCB
1056	1.90500*	.0402*	.3841*	3.3475*	4.6173*	-.2903*	285.237*	1.358*	.520*	3.39*****	291.915	NCB
1057	2.06375*	.0475*	.4214*	3.5383*	4.9767*	-.5310*	285.478*	1.442*	.522*	3.21*****	291.921	NCB
1058	2.22250*	.0551*	.4551*	3.7280*	5.3490*	-.6935*	285.640*	1.500*	.523*	3.04*****	291.924	NCB
1059	2.38125*	.0633*	.4862*	3.9212*	5.7454*	-.8192*	285.766*	1.600*	.547*	2.88*****	292.002	NCB
1060	2.54000*	.0716*	.5139*	4.1087*	6.1497*	-.9055*	285.852*	1.634*	.549*	2.74*****	292.008	NCB
1061	2.69875*	.0800*	.5385*	4.2896*	6.5594*	-.9658*	285.913*	1.657*	.550*	2.61*****	292.012	NCB
1062	2.85750*	.0887*	.5609*	4.4664*	6.9820*	-1.0186*	285.966*	1.709*	.565*	2.49*****	292.059	NCB
1063	3.01625*	.0974*	.5807*	4.6327*	7.4020*	-1.0514*	285.998*	1.700*	.557*	2.37*****	292.035	NCB
1064	3.17500*	.1058*	.5980*	4.7867*	7.8130*	-1.0657*	286.013*	1.663*	.541*	2.27*****	291.984	NCB
1065	3.33375*	.1146*	.6140*	4.9369*	8.2369*	-1.0917*	286.039*	1.716*	.560*	2.17*****	292.044	NCB
1066	3.49250*	.1223*	.6269*	5.0633*	8.6137*	-1.0629*	286.010*	1.526*	.488*	2.09*****	291.803	NCB
1067	3.65125*	.1286*	.6365*	5.1589*	8.9153*	-.9718*	285.919*	1.223*	.378*	2.03*****	291.378	NCB
1068	3.81000*	.1324*	.6422*	5.2157*	9.1028*	-.8045*	285.751*	.762*	.214*	2.00*****	290.529	NCB
1069	Channel 9, Entrance Cell			31, Exit Cell	631							
1070	.00000*	.0000*	.0000*	2.1468*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
1071	.15875*	.0000*	.0000*	2.1497*	.1876*	10.9114*	274.036*	.000*	.143*9999.00*****	282.065	SPH	
1072	.31750*	.0000*	.0046*	2.1655*	.3847*	9.6466*	275.300*	.003*	.295*9999.00*****	290.993	NCB	
1073	.47625*	.0009*	.0322*	2.2325*	1.3083*	8.2102*	276.737*	.060*	.393*	9.12*****	291.441	NCB
1074	.63500*	.0026*	.0599*	2.3019*	1.9273*	6.7651*	278.182*	.109*	.443*	7.10*****	291.641	NCB
1075	.79375*	.0045*	.0863*	2.3705*	2.3474*	5.4681*	279.479*	.129*	.429*	6.13*****	291.587	NCB
1076	.95250*	.0069*	.1161*	2.4510*	2.7010*	4.2935*	280.653*	.165*	.436*	5.49*****	291.613	NCB
1077	1.11125*	.0100*	.1504*	2.5476*	3.0123*	3.2440*	281.703*	.206*	.447*	5.01*****	291.655	NCB
1078	1.27000*	.0140*	.1913*	2.6714*	3.3158*	2.2943*	282.653*	.269*	.484*	4.60*****	291.791	NCB
1079	1.42875*	.0186*	.2343*	2.8133*	3.6035*	1.4921*	283.455*	.312*	.491*	4.26*****	291.815	NCB
1080	1.58750*	.0238*	.2774*	2.9695*	3.8914*	.8349*	284.112*	.349*	.493*	3.98*****	291.821	NCB
1081	1.74625*	.0296*	.3198*	3.1397*	4.1953*	.2990*	284.648*	.389*	.503*	3.74*****	291.857	NCB
1082	1.90500*	.0358*	.3595*	3.3161*	4.5119*	-.1059*	285.053*	.416*	.499*	3.53*****	291.842	NCB
1083	2.06375*	.0424*	.3964*	3.4973*	4.8450*	-.3830*	285.330*	.443*	.496*	3.34*****	291.831	NCB
1084	2.22250*	.0492*	.4298*	3.6774*	5.1873*	-.5677*	285.515*	.458*	.489*	3.18*****	291.808	NCB
1085	2.38125*	.0563*	.4604*	3.8575*	5.5430*	-.6977*	285.645*	.478*	.495*	3.03*****	291.829	NCB
1086	2.54000*	.0635*	.4876*	4.0319*	5.9021*	-.7828*	285.730*	.483*	.490*	2.89*****	291.810	NCB
1087	2.69875*	.0708*	.5118*	4.2001*	6.2632*	-.8392*	285.786*	.487*	.486*	2.77*****	291.797	NCB
1088	2.85750*	.0783*	.5341*	4.3664*	6.6368*	-.8888*	285.836*	.504*	.501*	2.65*****	291.848	NCB
1089	3.01625*	.0857*	.5538*	4.5228*	7.0050*	-.9164*	285.863*	.497*	.489*	2.54*****	291.806	NCB
1090	3.17500*	.0928*	.5710*	4.6672*	7.3607*	-.9237*	285.871*	.480*	.468*	2.44*****	291.732	NCB
1091	3.33375*	.1000*	.5867*	4.8062*	7.7191*	-.9338*	285.881*	.484*	.472*	2.35*****	291.746	NCB
1092	3.49250*	.1063*	.5993*	4.9230*	8.0334*	-.8984*	285.845*	.424*	.405*	2.27*****	291.490	NCB
1093	3.65125*	.1113*	.6087*	5.0111*	8.2816*	-.8132*	285.760*	.336*	.308*	2.22*****	291.061	NCB
1094	3.81000*	.1143*	.6140*	5.0629*	8.4316*	-.6669*	285.614*	.203*	.168*	2.19*****	290.199	NCB
1095	Channel 10, Entrance Cell			32, Exit Cell	632							
1096	.00000*	.0000*	.0000*	2.0475*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
1097	.15875*	.0000*	.0000*	2.0507*	.1876*	10.8195*	274.127*	.000*	.157*9999.00*****	283.264	SPH	
1098	.31750*	.0005*	.0215*	2.1019*	.9587*	9.2797*	275.667*	.046*	.370*	12.16*****	291.347	NCB
1099	.47625*	.0022*	.0546*	2.1799*	1.7480*	7.5705*	277.376*	.167*	.488*	7.82*****	291.805	NCB
1100	.63500*	.0049*	.0918*	2.2715*	2.3149*	5.9098*	279.037*	.261*	.540*	6.05*****	291.978	NCB
1101	.79375*	.0081*	.1292*	2.3688*	2.7044*	4.4748*	280.472*	.304*	.518*	5.20*****	291.906	NCB
1102	.95250*	.0119*	.1699*	2.4823*	3.0249*	3.2436*	281.703*	.366*	.513*	4.66*****	291.889	NCB
1103	1.11125*	.0164*	.2140*	2.6156*	3.3178*	2.2064*	282.740*	.436*	.515*	4.26*****	291.896	NCB
1104	1.27000*	.0219*	.2615*	2.7738*	3.6192*	1.3335*	283.613*	.526*	.536*	3.93*****	291.967	NCB
1105	1.42875*	.0281*	.3082*	2.9470*	3.9311*	.6366*	284.310*	.590*	.538*	3.67*****	291.973	NCB
1106	1.58750*	.0347*	.3522*	3.1294*	4.2583*	.0943*	284.853*	.642*	.536*	3.44*****	291.968	NCB
1107	1.74625*	.0421*	.3940*	3.3227*	4.6135*	-.2916*	285.239*	.708*	.545*	3.24*****	291.995	NCB
1108	1.90500*	.0498*	.4319*	3.5174*	4.9850*	-.5471*	285.494*	.746*	.540*	3.07*****	291.981	NCB
1109	2.06375*	.0579*	.4657*	3.7101*	5.3687*	-.7165*	285.663*	.773*	.539*	2.92*****	291.977	NCB
1110	2.22250*	.0661*	.4956*	3.8967*	5.7586*	-.8268*	285.774*	.787*	.535*	2.78*****	291.964	NCB
1111	2.38125*	.0744*	.5222*	4.0773*	6.1552*	-.9023*	285.849*	.802*	.537*	2.66*****	291.968	NCB
1112	2.54000*	.0828*	.5457*	4.2503*	6.5542*	-.9531*	285.900*	.807*	.534*	2.54*****	291.961	NCB
1113	2.69875*	.0912*	.5666*	4.4149*	6.9550*	-.9886*	285.936*	.811*	.533*	2.44*****	291.957	NCB
1114	2.85750*	.0998*	.5856*	4.5738*	7.3629*	-1.0210*	285.968*	.825*	.542*	2.34*****	291.985	NCB
1115	3.01625*	.1083*	.6023*	4.7219*	7.7651*	-1.0385*	285.985*	.814*	.531*	2.24*****	291.949	NCB
1116	3.17500*	.1165*	.6170*	4.8573*	8.1537*	-1.0386*	285.986*	.786*	.509*	2.16*****	291.877	NCB
1117	3.33375*	.1243*	.6298*	4.9811*	8.5274*	-1.0270*	285.974*	.757*	.487*	2.08*****	291.802	NCB
1118	3.49250*	.1312*	.6401*	5.0833*	8.8544*	-.9746*	285.922*	.662*	.419*	2.02*****	291.546	NCB
1119	3.65125*	.1367*	.6478*	5.1604*	9.1135*	-.8748*	285.822*	.525*	.321*	1.98*****	291.123	NCB
1120	3.81000*	.1399*	.6522*	5.2040*	9.2654*	-.7072*	285.654*	.309*	.169*	1.96*****	290.204	NCB

5. Output Descriptions

1121	Channel 11, Entrance Cell	33, Exit Cell	633						
1122	.00000*	.0000*	.0000*	1.9366*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.
1123	.15875*	.0000*	.0000*	1.9403*	.1876*	10.6456*	274.301*	.000*	.184*9999.00***** 285.551 SPH
1124	.31750*	.0010*	.0326*	2.0116*	1.2068*	8.8830*	276.064*	.146*	.426* 11.09***** 291.576 NCB
1125	.47625*	.0035*	.0733*	2.1036*	1.9615*	6.9593*	277.988*	.388*	.556* 7.10***** 292.033 NCB
1126	.63500*	.0074*	.1206*	2.2169*	2.4928*	5.1411*	279.806*	.581*	.610* 5.47***** 292.198 NCB
1127	.79375*	.0119*	.1691*	2.3437*	2.8660*	3.6208*	281.326*	.683*	.587* 4.67***** 292.128 NCB
1128	.95250*	.0172*	.2205*	2.4916*	3.1887*	2.3730*	282.574*	.810*	.579* 4.17***** 292.103 NCB
1129	1.11125*	.0235*	.2732*	2.6613*	3.5078*	1.3713*	283.576*	.947*	.580* 3.80***** 292.106 NCB
1130	1.27000*	.0308*	.3263*	2.8543*	3.8551*	.5683*	284.379*	1.111*	.601* 3.49***** 292.170 NCB
1131	1.42875*	.0389*	.3755*	3.0584*	4.2260*	-.0379*	284.985*	1.222*	.603* 3.25***** 292.175 NCB
1132	1.58750*	.0476*	.4207*	3.2695*	4.6243*	-.4345*	285.381*	1.329*	.600* 3.04***** 292.168 NCB
1133	1.74625*	.0570*	.4613*	3.4834*	5.0483*	-.6987*	285.646*	1.423*	.609* 2.86***** 292.194 NCB
1134	1.90500*	.0666*	.4966*	3.6910*	5.4829*	-.8665*	285.813*	1.462*	.604* 2.70***** 292.180 NCB
1135	2.06375*	.0764*	.5272*	3.8897*	5.9239*	-.9736*	285.921*	1.485*	.600* 2.57***** 292.168 NCB
1136	2.22250*	.0863*	.5538*	4.0782*	6.3681*	-1.0430*	285.990*	1.497*	.597* 2.44***** 292.158 NCB
1137	2.38125*	.0964*	.5773*	4.2584*	6.8195*	-1.0952*	286.042*	1.522*	.603* 2.33***** 292.176 NCB
1138	2.54000*	.1065*	.5980*	4.4278*	7.2730*	-1.1324*	286.079*	1.529*	.602* 2.23***** 292.174 NCB
1139	2.69875*	.1166*	.6163*	4.5870*	7.7281*	-1.1610*	286.108*	1.535*	.602* 2.14***** 292.174 NCB
1140	2.85750*	.1269*	.6329*	4.7390*	8.1934*	-1.1938*	286.141*	1.569*	.616* 2.05***** 292.214 NCB
1141	3.01625*	.1372*	.6476*	4.8789*	8.6534*	-1.2127*	286.160*	1.552*	.606* 1.97***** 292.185 NCB
1142	3.17500*	.1471*	.6604*	5.0058*	9.0998*	-1.2142*	286.161*	1.506*	.585* 1.89***** 292.121 NCB
1143	3.33375*	.1567*	.6717*	5.1194*	9.5320*	-1.2046*	286.151*	1.458*	.564* 1.82***** 292.056 NCB
1144	3.49250*	.1652*	.6809*	5.2123*	9.9122*	-1.1466*	286.093*	1.284*	.488* 1.77***** 291.803 NCB
1145	3.65125*	.1719*	.6877*	5.2820*	10.2147*	-1.0307*	285.978*	1.022*	.377* 1.73***** 291.374 NCB
1146	3.81000*	.1759*	.6916*	5.3199*	10.3933*	-.8306*	285.778*	.605*	.201* 1.71***** 290.440 NCB
1147	Channel 12, Entrance Cell	34, Exit Cell	634						
1148	.00000*	.0000*	.0000*	2.1543*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.
1149	.15875*	.0000*	.0000*	2.1567*	.1876*	11.0184*	273.929*	.000*	.119*9999.00***** 280.576 SPH
1150	.31750*	.0000*	.0028*	2.1688*	.3124*	9.7590*	275.188*	.003*	.293*9999.00***** 290.985 NCB
1151	.47625*	.0009*	.0314*	2.2381*	1.2914*	8.3137*	276.633*	.111*	.395* 9.34***** 291.452 NCB
1152	.63500*	.0026*	.0600*	2.3097*	1.9341*	6.8434*	278.104*	.210*	.454* 7.16***** 291.680 NCB
1153	.79375*	.0049*	.0915*	2.3917*	2.4234*	5.4518*	279.495*	.294*	.480* 6.00***** 291.775 NCB
1154	.95250*	.0078*	.1265*	2.4870*	2.8110*	4.1940*	280.753*	.372*	.489* 5.28***** 291.808 NCB
1155	1.11125*	.0114*	.1652*	2.5992*	3.1370*	3.0894*	281.858*	.453*	.495* 4.77***** 291.828 NCB
1156	1.27000*	.0157*	.2073*	2.7314*	3.4349*	2.1395*	282.807*	.540*	.504* 4.38***** 291.858 NCB
1157	1.42875*	.0205*	.2506*	2.8798*	3.7221*	1.3523*	283.595*	.613*	.503* 4.07***** 291.858 NCB
1158	1.58750*	.0259*	.2929*	3.0401*	4.0121*	.7178*	284.229*	.675*	.499* 3.82***** 291.844 NCB
1159	1.74625*	.0317*	.3335*	3.2095*	4.3141*	.2130*	284.734*	.733*	.499* 3.61***** 291.841 NCB
1160	1.90500*	.0378*	.3713*	3.3838*	4.6287*	-.1576*	285.105*	.779*	.491* 3.42***** 291.815 NCB
1161	2.06375*	.0443*	.4061*	3.5598*	4.9552*	-.4071*	285.354*	.817*	.483* 3.26***** 291.785 NCB
1162	2.22250*	.0509*	.4374*	3.7334*	5.2881*	-.5717*	285.519*	.837*	.473* 3.11***** 291.752 NCB
1163	2.38125*	.0576*	.4654*	3.9018*	5.6236*	-.6782*	285.625*	.846*	.464* 2.98***** 291.719 NCB
1164	2.54000*	.0643*	.4903*	4.0646*	5.9604*	-.7472*	285.694*	.850*	.458* 2.87***** 291.695 NCB
1165	2.69875*	.0710*	.5127*	4.2211*	6.2978*	-.7925*	285.739*	.853*	.453* 2.76***** 291.678 NCB
1166	2.85750*	.0778*	.5329*	4.3720*	6.6365*	-.8241*	285.771*	.857*	.452* 2.65***** 291.673 NCB
1167	3.01625*	.0845*	.5508*	4.5138*	6.9688*	-.8396*	285.786*	.840*	.440* 2.56***** 291.627 NCB
1168	3.17500*	.0908*	.5665*	4.6441*	7.2868*	-.8374*	285.784*	.805*	.417* 2.47***** 291.540 NCB
1169	3.33375*	.0967*	.5797*	4.7598*	7.5796*	-.8133*	285.760*	.741*	.379* 2.40***** 291.386 NCB
1170	3.49250*	.1018*	.5904*	4.8561*	7.8334*	-.7616*	285.708*	.643*	.323* 2.34***** 291.129 NCB
1171	3.65125*	.1058*	.5984*	4.9295*	8.0336*	-.6781*	285.625*	.508*	.246* 2.29***** 290.725 NCB
1172	3.81000*	.1081*	.6030*	4.9717*	8.1511*	-.5486*	285.496*	.299*	.129* 2.27***** 289.861 NCB
1173	Channel 13, Entrance Cell	35, Exit Cell	635						
1174	.00000*	.0000*	.0000*	1.1168*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.
1175	.15875*	.0000*	.0000*	1.1178*	.1875*	11.0993*	273.848*	.000*	.052*9999.00***** 278.766 SPH
1176	.31750*	.0000*	.0000*	1.1200*	.1876*	10.2153*	274.732*	.000*	.107*9999.00***** 284.842 SPH
1177	.47625*	.0000*	.0000*	1.1230*	.1878*	8.9852*	275.962*	.000*	.149*9999.00***** 290.042 NCB
1178	.63500*	.0000*	.0000*	1.1266*	.1879*	7.5283*	277.419*	.000*	.177*9999.00***** 290.267 NCB
1179	.79375*	.0003*	.0131*	1.1449*	.4646*	6.1169*	278.830*	.016*	.181* 12.51***** 290.299 NCB
1180	.95250*	.0012*	.0341*	1.1721*	.8035*	4.8218*	280.125*	.055*	.190* 10.76***** 290.364 NCB
1181	1.11125*	.0028*	.0596*	1.2050*	1.0999*	3.6625*	281.284*	.099*	.198* 9.53***** 290.423 NCB
1182	1.27000*	.0053*	.0919*	1.2476*	1.3650*	2.6354*	282.312*	.156*	.214* 8.54***** 290.530 NCB
1183	1.42875*	.0086*	.1288*	1.2986*	1.5796*	1.7794*	283.167*	.203*	.220* 7.78***** 290.564 NCB
1184	1.58750*	.0127*	.1694*	1.3586*	1.7595*	1.0961*	283.851*	.246*	.223* 7.17***** 290.584 NCB
1185	1.74625*	.0175*	.2137*	1.4299*	1.9261*	.5610*	284.386*	.295*	.232* 6.64***** 290.640 NCB
1186	1.90500*	.0228*	.2576*	1.5076*	2.0845*	.1686*	284.778*	.326*	.232* 6.21***** 290.638 NCB
1187	2.06375*	.0286*	.3000*	1.5903*	2.2443*	-.0921*	285.039*	.354*	.231* 5.84***** 290.635 NCB
1188	2.22250*	.0347*	.3395*	1.6753*	2.4075*	-.2395*	285.186*	.374*	.228* 5.52***** 290.619 NCB
1189	2.38125*	.0411*	.3758*	1.7614*	2.5755*	-.3240*	285.271*	.391*	.230* 5.25***** 290.629 NCB
1190	2.54000*	.0476*	.4083*	1.8457*	2.7446*	-.3689*	285.316*	.396*	.228* 5.00***** 290.616 NCB

5. Output Descriptions

1191	2.69875*	.0541*	.4372*	1.9275*	2.9144*	-.3928*	285.340*	.399*	.227*	4.78*****	290.609	NCB
1192	2.85750*	.0608*	.4638*	2.0087*	3.0889*	-.4123*	285.359*	.411*	.232*	4.58*****	290.644	NCB
1193	3.01625*	.0674*	.4871*	2.0855*	3.2602*	-.4188*	285.366*	.404*	.227*	4.39*****	290.608	NCB
1194	3.17500*	.0737*	.5073*	2.1564*	3.4245*	-.4138*	285.361*	.388*	.216*	4.24*****	290.540	NCB
1195	3.33375*	.0801*	.5257*	2.2246*	3.5887*	-.4129*	285.360*	.387*	.216*	4.09*****	290.539	NCB
1196	3.49250*	.0856*	.5404*	2.2814*	3.7308*	-.3833*	285.330*	.336*	.184*	3.98*****	290.319	NCB
1197	3.65125*	.0898*	.5509*	2.3240*	3.8403*	-.3253*	285.272*	.259*	.138*	3.91*****	289.947	NCB
1198	3.81000*	.0923*	.5568*	2.3482*	3.9043*	-.2375*	285.184*	.152*	.075*	3.90*****	289.244	NCB
1199	Channel 14, Entrance Cell 36, Exit Cell 636											
1200	.00000*	.0000*	.0000*	1.9767*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
1201	.15875*	.0000*	.0000*	1.9797*	.1876*	10.8257*	274.121*	.000*	.149*	9999.00*****	283.066	SPH
1202	.31750*	.0002*	.0143*	2.0144*	.7116*	9.3558*	275.591*	.017*	.326*	13.73*****	291.148	NCB
1203	.47625*	.0016*	.0449*	2.0836*	1.5065*	7.7195*	277.227*	.095*	.432*	8.81*****	291.597	NCB
1204	.63500*	.0039*	.0789*	2.1634*	2.0794*	6.1095*	278.837*	.160*	.483*	6.77*****	291.788	NCB
1205	.79375*	.0068*	.1140*	2.2497*	2.4817*	4.6853*	280.262*	.197*	.476*	5.75*****	291.762	NCB
1206	.95250*	.0105*	.1549*	2.3562*	2.8229*	3.4207*	281.526*	.256*	.493*	5.07*****	291.821	NCB
1207	1.11125*	.0153*	.2026*	2.4916*	3.1420*	2.3097*	282.637*	.331*	.525*	4.55*****	291.931	NCB
1208	1.27000*	.0214*	.2568*	2.6619*	3.4740*	1.3477*	283.599*	.423*	.572*	4.11*****	292.083	NCB
1209	1.42875*	.0285*	.3106*	2.8540*	3.8213*	.5737*	284.373*	.490*	.589*	3.75*****	292.133	NCB
1210	1.58750*	.0363*	.3611*	3.0589*	4.1909*	-.0232*	284.970*	.542*	.595*	3.46*****	292.154	NCB
1211	1.74625*	.0450*	.4084*	3.2770*	4.5966*	-.4298*	285.377*	.604*	.609*	3.21*****	292.194	NCB
1212	1.90500*	.0543*	.4504*	3.4953*	5.0224*	-.6953*	285.642*	.639*	.608*	3.01*****	292.192	NCB
1213	2.06375*	.0638*	.4872*	3.7093*	5.4625*	-.8688*	285.816*	.662*	.609*	2.83*****	292.194	NCB
1214	2.22250*	.0736*	.5193*	3.9165*	5.9140*	-.9850*	285.932*	.680*	.612*	2.67*****	292.204	NCB
1215	2.38125*	.0839*	.5480*	4.1199*	6.3852*	-1.0772*	286.024*	.710*	.633*	2.52*****	292.264	NCB
1216	2.54000*	.0944*	.5732*	4.3146*	6.8653*	-1.1446*	286.091*	.724*	.639*	2.39*****	292.282	NCB
1217	2.69875*	.1050*	.5954*	4.4992*	7.3531*	-1.1967*	286.144*	.736*	.646*	2.27*****	292.301	NCB
1218	2.85750*	.1160*	.6156*	4.6778*	7.8593*	-1.2519*	286.199*	.764*	.670*	2.15*****	292.368	NCB
1219	3.01625*	.1271*	.6334*	4.8435*	8.3651*	-1.2893*	286.236*	.763*	.665*	2.05*****	292.356	NCB
1220	3.17500*	.1379*	.6489*	4.9943*	8.8620*	-1.3074*	286.254*	.750*	.650*	1.95*****	292.313	NCB
1221	3.33375*	.1488*	.6628*	5.1348*	9.3621*	-1.3273*	286.274*	.755*	.654*	1.87*****	292.324	NCB
1222	3.49250*	.1585*	.6740*	5.2509*	9.8076*	-1.2859*	286.233*	.673*	.572*	1.80*****	292.082	NCB
1223	3.65125*	.1663*	.6823*	5.3368*	10.1652*	-1.1723*	286.119*	.541*	.446*	1.75*****	291.650	NCB
1224	3.81000*	.1710*	.6871*	5.3857*	10.3802*	-.9576*	285.905*	.326*	.244*	1.72*****	290.711	NCB
1225	Channel 15, Entrance Cell 37, Exit Cell 637											
1226	.00000*	.0000*	.0000*	2.1508*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
1227	.15875*	.0000*	.0000*	2.1537*	.1876*	10.9233*	274.024*	.000*	.140*	9999.00*****	281.902	SPH
1228	.31750*	.0001*	.0067*	2.1742*	.7115*	9.6335*	275.313*	.008*	.303*	9999.00*****	291.036	NCB
1229	.47625*	.0010*	.0341*	2.2411*	1.3609*	8.1764*	276.771*	.113*	.402*	8.95*****	291.481	NCB
1230	.63500*	.0027*	.0622*	2.3117*	1.9723*	6.7184*	278.228*	.198*	.451*	6.98*****	291.671	NCB
1231	.79375*	.0048*	.0898*	2.3839*	2.3985*	5.4024*	279.545*	.241*	.442*	6.00*****	291.638	NCB
1232	.95250*	.0073*	.1206*	2.4676*	2.7507*	4.2185*	280.728*	.302*	.446*	5.38*****	291.651	NCB
1233	1.11125*	.0105*	.1555*	2.5673*	3.0588*	3.1682*	281.779*	.374*	.455*	4.92*****	291.683	NCB
1234	1.27000*	.0145*	.1958*	2.6907*	3.3529*	2.2356*	282.711*	.470*	.480*	4.53*****	291.777	NCB
1235	1.42875*	.0191*	.2381*	2.8315*	3.6345*	1.4509*	283.496*	.542*	.485*	4.21*****	291.794	NCB
1236	1.58750*	.0242*	.2801*	2.9858*	3.9174*	.8099*	284.137*	.603*	.486*	3.95*****	291.795	NCB
1237	1.74625*	.0299*	.3217*	3.1539*	4.2174*	.2860*	284.661*	.674*	.497*	3.71*****	291.834	NCB
1238	1.90500*	.0360*	.3607*	3.3280*	4.5300*	-.1091*	285.056*	.719*	.492*	3.51*****	291.818	NCB
1239	2.06375*	.0425*	.3971*	3.5071*	4.8595*	-.3810*	285.328*	.768*	.490*	3.33*****	291.812	NCB
1240	2.22250*	.0493*	.4300*	3.6853*	5.1983*	-.5625*	285.509*	.794*	.484*	3.17*****	291.789	NCB
1241	2.38125*	.0562*	.4598*	3.8613*	5.5458*	-.6858*	285.633*	.817*	.483*	3.03*****	291.787	NCB
1242	2.54000*	.0632*	.4864*	4.0319*	5.8965*	-.7669*	285.714*	.826*	.478*	2.90*****	291.769	NCB
1243	2.69875*	.0703*	.5102*	4.1966*	6.2492*	-.8207*	285.768*	.832*	.475*	2.78*****	291.757	NCB
1244	2.85750*	.0775*	.5321*	4.3589*	6.6125*	-.8668*	285.814*	.857*	.486*	2.66*****	291.799	NCB
1245	3.01625*	.0847*	.5514*	4.5119*	6.9706*	-.8925*	285.839*	.845*	.475*	2.55*****	291.758	NCB
1246	3.17500*	.0916*	.5684*	4.6533*	7.3168*	-.8991*	285.846*	.817*	.455*	2.46*****	291.686	NCB
1247	3.33375*	.0985*	.5837*	4.7879*	7.6609*	-.9038*	285.851*	.813*	.452*	2.37*****	291.674	NCB
1248	3.49250*	.1046*	.5960*	4.9012*	7.9628*	-.8670*	285.814*	.713*	.388*	2.29*****	291.423	NCB
1249	3.65125*	.1094*	.6052*	4.9871*	8.2017*	-.7838*	285.731*	.565*	.297*	2.24*****	291.001	NCB
1250	3.81000*	.1122*	.6104*	5.0368*	8.3437*	-.6405*	285.587*	.337*	.158*	2.21*****	290.119	NCB
1251	Channel 16, Entrance Cell 38, Exit Cell 638											
1252	.00000*	.0000*	.0000*	1.1185*	.1875*	11.5303*	273.417*	.000*	.000*	*****	n.a.	
1253	.15875*	.0000*	.0000*	1.1195*	.1875*	11.1306*	273.816*	.000*	.048*	9999.00*****	278.379	SPH
1254	.31750*	.0000*	.0000*	1.1215*	.1876*	10.2991*	274.648*	.000*	.100*	9999.00*****	284.158	SPH
1255	.47625*	.0000*	.0000*	1.1243*	.1877*	9.1602*	275.787*	.000*	.138*	9999.00*****	288.847	SPH
1256	.63500*	.0000*	.0000*	1.1276*	.1879*	7.8495*	277.097*	.000*	.159*	9999.00*****	290.130	NCB
1257	.79375*	.0000*	.0000*	1.1308*	.1880*	6.5616*	278.385*	.000*	.157*	9999.00*****	290.113	NCB
1258	.95250*	.0004*	.0159*	1.1518*	.5173*	5.3427*	279.604*	.011*	.162*	11.02*****	290.149	NCB
1259	1.11125*	.0013*	.0357*	1.1773*	.8272*	4.2306*	280.716*	.028*	.168*	9.96*****	290.202	NCB
1260	1.27000*	.0029*	.0613*	1.2100*	1.1184*	3.2174*	281.730*	.051*	.182*	9.06*****	290.307	NCB

5. Output Descriptions

1261	1.42875*	.0052*	.0908*	1.2490*	1.3602*	2.3360*	282.611*	.072*	.190*	8.34*****	290.362	NCB
1262	1.58750*	.0083*	.1250*	1.2958*	1.5630*	1.5937*	283.353*	.093*	.197*	7.73*****	290.412	NCB
1263	1.74625*	.0122*	.1646*	1.3539*	1.7428*	.9795*	283.967*	.119*	.210*	7.18*****	290.500	NCB
1264	1.90500*	.0167*	.2067*	1.4208*	1.9038*	.5006*	284.446*	.139*	.215*	6.71*****	290.534	NCB
1265	2.06375*	.0218*	.2498*	1.4959*	2.0594*	.1378*	284.809*	.157*	.221*	6.29*****	290.574	NCB
1266	2.22250*	.0275*	.2921*	1.5770*	2.2170*	-.1048*	285.052*	.173*	.224*	5.92*****	290.592	NCB
1267	2.38125*	.0336*	.3330*	1.6636*	2.3830*	-.2516*	285.198*	.190*	.231*	5.59*****	290.633	NCB
1268	2.54000*	.0401*	.3706*	1.7515*	2.5540*	-.3362*	285.283*	.199*	.233*	5.30*****	290.648	NCB
1269	2.69875*	.0468*	.4048*	1.8392*	2.7293*	-.3856*	285.333*	.205*	.236*	5.03*****	290.665	NCB
1270	2.85750*	.0538*	.4362*	1.9277*	2.9122*	-.4215*	285.368*	.215*	.245*	4.79*****	290.718	NCB
1271	3.01625*	.0609*	.4641*	2.0128*	3.0951*	-.4400*	285.387*	.216*	.243*	4.57*****	290.707	NCB
1272	3.17500*	.0678*	.4883*	2.0930*	3.2743*	-.4450*	285.392*	.211*	.236*	4.37*****	290.667	NCB
1273	3.33375*	.0749*	.5107*	2.1723*	3.4586*	-.4565*	285.403*	.218*	.244*	4.19*****	290.711	NCB
1274	3.49250*	.0811*	.5286*	2.2392*	3.6210*	-.4328*	285.380*	.192*	.211*	4.05*****	290.506	NCB
1275	3.65125*	.0860*	.5415*	2.2896*	3.7473*	-.3727*	285.320*	.149*	.160*	3.97*****	290.133	NCB
1276	3.81000*	.0888*	.5486*	2.3181*	3.8208*	-.2736*	285.221*	.087*	.086*	3.94*****	289.394	NCB
1277	Channel 17, Entrance Cell 39, Exit Cell 639											
1278	.00000*	.0000*	.0000*	1.9782*	.1875*	11.5303*	273.417*	.000*	.000*	*****n.a.		
1279	.15875*	.0000*	.0000*	1.9795*	.1875*	11.2416*	273.705*	.000*	.061*	9999.00*****	277.389	SPH
1280	.31750*	.0000*	.0000*	1.9829*	.1876*	10.4544*	274.493*	.000*	.168*	9999.00*****	284.547	SPH
1281	.47625*	.0000*	.0000*	1.9876*	.1877*	9.3639*	275.583*	.000*	.232*	9999.00*****	289.533	SPH
1282	.63500*	.0003*	.0150*	2.0228*	.7351*	8.1415*	276.805*	.004*	.277*	9.24*****	290.901	NCB
1283	.79375*	.0010*	.0332*	2.0649*	1.2476*	6.9335*	278.013*	.011*	.303*	7.87*****	291.036	NCB
1284	.95250*	.0026*	.0609*	2.1283*	1.8116*	5.6743*	279.273*	.026*	.371*	6.75*****	291.350	NCB
1285	1.11125*	.0070*	.1166*	2.2603*	2.5109*	4.1392*	280.808*	.068*	.595*	5.43*****	292.153	NCB
1286	1.27000*	.0131*	.1814*	2.4321*	3.0090*	2.7089*	282.238*	.094*	.674*	4.54*****	292.379	NCB
1287	1.42875*	.0205*	.2491*	2.6385*	3.4292*	1.5137*	283.433*	.114*	.702*	3.94*****	292.455	NCB
1288	1.58750*	.0289*	.3138*	2.8683*	3.8458*	.5775*	284.369*	.131*	.708*	3.52*****	292.474	NCB
1289	1.74625*	.0383*	.3728*	3.1127*	4.2882*	-.1166*	285.064*	.145*	.712*	3.20*****	292.484	NCB
1290	1.90500*	.0485*	.4250*	3.3628*	4.7598*	-.5645*	285.511*	.157*	.706*	2.95*****	292.468	NCB
1291	2.06375*	.0591*	.4699*	3.6092*	5.2512*	-.8490*	285.796*	.165*	.701*	2.74*****	292.453	NCB
1292	2.22250*	.0701*	.5084*	3.8477*	5.7579*	-1.0325*	285.979*	.171*	.701*	2.57*****	292.453	NCB
1293	2.38125*	.0816*	.5419*	4.0798*	6.2858*	-1.1642*	286.111*	.178*	.718*	2.41*****	292.498	NCB
1294	2.54000*	.0933*	.5709*	4.3002*	6.8245*	-1.2560*	286.203*	.182*	.724*	2.27*****	292.513	NCB
1295	2.69875*	.1053*	.5959*	4.5085*	7.3723*	-1.3239*	286.271*	.185*	.730*	2.15*****	292.531	NCB
1296	2.85750*	.1176*	.6182*	4.7063*	7.9360*	-1.3857*	286.333*	.190*	.749*	2.04*****	292.580	NCB
1297	3.01625*	.1298*	.6375*	4.8882*	8.4995*	-1.4277*	286.375*	.190*	.745*	1.94*****	292.568	NCB
1298	3.17500*	.1419*	.6541*	5.0523*	9.0529*	-1.4481*	286.395*	.187*	.727*	1.85*****	292.523	NCB
1299	3.33375*	.1535*	.6683*	5.1971*	9.5857*	-1.4448*	286.392*	.180*	.696*	1.77*****	292.440	NCB
1300	3.49250*	.1638*	.6797*	5.3159*	10.0594*	-1.3866*	286.334*	.160*	.609*	1.71*****	292.195	NCB
1301	3.65125*	.1721*	.6881*	5.4035*	10.4406*	-1.2594*	286.206*	.129*	.477*	1.67*****	291.764	NCB
1302	3.81000*	.1771*	.6928*	5.4521*	10.6659*	-1.0237*	285.971*	.076*	.255*	1.65*****	290.778	NCB
1303	Channel 18, Entrance Cell 40, Exit Cell 640											
1304	.00000*	.0000*	.0000*	2.2785*	.1875*	11.5303*	273.417*	.000*	.000*	*****n.a.		
1305	.15875*	.0000*	.0000*	2.2804*	.1875*	11.1438*	273.803*	.000*	.095*	9999.00*****	278.875	SPH
1306	.31750*	.0000*	.0000*	2.2849*	.1876*	10.2397*	274.707*	.000*	.222*	9999.00*****	286.583	SPH
1307	.47625*	.0002*	.0118*	2.3179*	.6969*	9.0530*	275.894*	.012*	.304*	9.40*****	291.037	NCB
1308	.63500*	.0009*	.0312*	2.3691*	1.3495*	7.8214*	277.125*	.050*	.353*	7.57*****	291.271	NCB
1309	.79375*	.0020*	.0516*	2.4237*	1.8624*	6.6261*	278.321*	.080*	.374*	6.56*****	291.363	NCB
1310	.95250*	.0035*	.0743*	2.4854*	2.2947*	5.4966*	279.450*	.110*	.388*	5.91*****	291.420	NCB
1311	1.11125*	.0055*	.0999*	2.5571*	2.6656*	4.4495*	280.497*	.142*	.399*	5.43*****	291.467	NCB
1312	1.27000*	.0080*	.1292*	2.6422*	2.9917*	3.4926*	281.454*	.179*	.412*	5.04*****	291.519	NCB
1313	1.42875*	.0110*	.1616*	2.7411*	3.2796*	2.6417*	282.305*	.213*	.419*	4.72*****	291.546	NCB
1314	1.58750*	.0145*	.1963*	2.8541*	3.5432*	1.9026*	283.044*	.245*	.423*	4.45*****	291.561	NCB
1315	1.74625*	.0184*	.2330*	2.9829*	3.8019*	1.2661*	283.681*	.283*	.433*	4.21*****	291.602	NCB
1316	1.90500*	.0228*	.2696*	3.1222*	4.0591*	.7385*	284.208*	.309*	.432*	4.00*****	291.596	NCB
1317	2.06375*	.0274*	.3051*	3.2691*	4.3213*	.3087*	284.638*	.332*	.430*	3.81*****	291.589	NCB
1318	2.22250*	.0323*	.3386*	3.4201*	4.5899*	-.0304*	284.977*	.350*	.424*	3.65*****	291.568	NCB
1319	2.38125*	.0376*	.3707*	3.5770*	4.8724*	-.2718*	285.219*	.374*	.423*	3.49*****	291.564	NCB
1320	2.54000*	.0430*	.4004*	3.7347*	5.1630*	-.4390*	285.386*	.388*	.418*	3.35*****	291.545	NCB
1321	2.69875*	.0486*	.4278*	3.8912*	5.4595*	-.5541*	285.501*	.398*	.415*	3.22*****	291.532	NCB
1322	2.85750*	.0543*	.4529*	4.0470*	5.7637*	-.6365*	285.583*	.409*	.418*	3.09*****	291.542	NCB
1323	3.01625*	.0600*	.4755*	4.1961*	6.0648*	-.6874*	285.634*	.405*	.406*	2.97*****	291.498	NCB
1324	3.17500*	.0655*	.4953*	4.3351*	6.3549*	-.7104*	285.657*	.391*	.386*	2.87*****	291.412	NCB
1325	3.33375*	.0707*	.5124*	4.4624*	6.6294*	-.7116*	285.659*	.370*	.360*	2.78*****	291.303	NCB
1326	3.49250*	.0752*	.5261*	4.5698*	6.8679*	-.6797*	285.627*	.322*	.306*	2.71*****	291.048	NCB
1327	3.65125*	.0787*	.5364*	4.6518*	7.0553*	-.6126*	285.560*	.253*	.231*	2.65*****	290.635	NCB
1328	3.81000*	.0808*	.5422*	4.6990*	7.1652*	-.5015*	285.448*	.149*	.120*	2.63*****	289.779	NCB
1329	Channel 19, Entrance Cell 41, Exit Cell 641											
1330	.00000*	.0000*	.0000*	1.9043*	.1875*	11.5303*	273.417*	.000*	.000*	*****n.a.		

5. Output Descriptions

1331	.15875*	.0000*	.0000*	1.9074*	.1876*	10.7806*	274.166*	.000*	.154*9999.00*****	283.667	SPH	
1332	.31750*	.0006*	.0246*	1.9616*	.9899*	9.1097*	275.837*	.009*	.379*	12.76*****	291.385	NC
1333	.47625*	.0027*	.0611*	2.0418*	1.7483*	7.2702*	277.677*	.031*	.500*	8.01*****	291.846	NCB
1334	.63500*	.0059*	.1037*	2.1402*	2.2955*	5.4958*	279.451*	.049*	.558*	6.09*****	292.037	NCB
1335	.79375*	.0100*	.1492*	2.2533*	2.6851*	3.9624*	280.985*	.060*	.553*	5.13*****	292.023	NCB
1336	.95250*	.0151*	.2002*	2.3917*	3.0194*	2.6588*	282.288*	.076*	.565*	4.51*****	292.061	NCB
1337	1.11125*	.0213*	.2556*	2.5595*	3.3483*	1.5765*	283.370*	.093*	.587*	4.04*****	292.129	NCB
1338	1.27000*	.0287*	.3120*	2.7534*	3.6998*	.7050*	284.242*	.111*	.611*	3.67*****	292.200	NCB
1339	1.42875*	.0371*	.3653*	2.9637*	4.0806*	.0302*	284.917*	.125*	.625*	3.37*****	292.241	NCB
1340	1.58750*	.0464*	.4147*	3.1858*	4.4972*	-.4206*	285.367*	.139*	.633*	3.12*****	292.264	NCB
1341	1.74625*	.0565*	.4588*	3.4119*	4.9433*	-.7185*	285.665*	.150*	.643*	2.91*****	292.294	NCB
1342	1.90500*	.0669*	.4973*	3.6335*	5.4075*	-.9122*	285.859*	.156*	.647*	2.73*****	292.304	NCB
1343	2.06375*	.0777*	.5305*	3.8472*	5.8844*	-1.0403*	285.987*	.161*	.651*	2.57*****	292.315	NCB
1344	2.22250*	.0887*	.5594*	4.0513*	6.3713*	-1.1284*	286.075*	.164*	.656*	2.43*****	292.330	NCB
1345	2.38125*	.1001*	.5850*	4.2478*	6.8743*	-1.2011*	286.148*	.170*	.673*	2.30*****	292.378	NCB
1346	2.54000*	.1117*	.6074*	4.4337*	7.3858*	-1.2574*	286.204*	.173*	.681*	2.18*****	292.399	NCB
1347	2.69875*	.1234*	.6272*	4.6085*	7.9061*	-1.3052*	286.252*	.175*	.690*	2.07*****	292.425	NCB
1348	2.85750*	.1356*	.6452*	4.7747*	8.4426*	-1.3565*	286.303*	.181*	.711*	1.97*****	292.482	NCB
1349	3.01625*	.1477*	.6610*	4.9273*	8.9800*	-1.3934*	286.340*	.181*	.710*	1.88*****	292.477	NCB
1350	3.17500*	.1597*	.6748*	5.0645*	9.5084*	-1.4112*	286.358*	.178*	.694*	1.80*****	292.435	NCB
1351	3.33375*	.1712*	.6866*	5.1857*	10.0165*	-1.4055*	286.352*	.171*	.663*	1.72*****	292.351	NCB
1352	3.49250*	.1814*	.6963*	5.2832*	10.4683*	-1.3462*	286.293*	.153*	.581*	1.66*****	292.109	NCB
1353	3.65125*	.1897*	.7035*	5.3561*	10.8321*	-1.2193*	286.166*	.123*	.455*	1.62*****	291.686	NCB
1354	3.81000*	.1946*	.7076*	5.3950*	11.0479*	-.9863*	285.933*	.073*	.246*	1.60*****	290.722	NCB
1355	Channel 20, Entrance Cell 42, Exit Cell 642											
1356	.00000*	.0000*	.0000*	1.9496*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
1357	.15875*	.0000*	.0000*	1.9515*	.1876*	11.0647*	273.882*	.000*	.098*9999.00*****	279.809	SPH	
1358	.31750*	.0000*	.0000*	1.9566*	.1877*	9.8746*	275.072*	.000*	.250*9999.00*****	290.239	SPH	
1359	.47625*	.0006*	.0248*	2.0118*	1.0164*	8.4037*	276.543*	.005*	.347*	9.85*****	291.244	NCB
1360	.63500*	.0021*	.0534*	2.0762*	1.6539*	6.8798*	278.067*	.012*	.414*	7.46*****	291.528	NCB
1361	.79375*	.0045*	.0864*	2.1532*	2.1516*	5.4155*	279.531*	.018*	.452*	6.18*****	291.675	NCB
1362	.95250*	.0080*	.1281*	2.2551*	2.5786*	4.0296*	280.917*	.027*	.504*	5.30*****	291.858	NCB
1363	1.11125*	.0130*	.1801*	2.3930*	2.9600*	2.7539*	282.193*	.038*	.564*	4.63*****	292.058	NCB
1364	1.27000*	.0193*	.2390*	2.5680*	3.3224*	1.6471*	283.300*	.048*	.612*	4.11*****	292.202	NCB
1365	1.42875*	.0269*	.2990*	2.7717*	3.6956*	.7450*	284.202*	.058*	.639*	3.71*****	292.283	NCB
1366	1.58750*	.0354*	.3557*	2.9941*	4.0962*	.0407*	284.906*	.065*	.656*	3.38*****	292.331	NCB
1367	1.74625*	.0451*	.4084*	3.2316*	4.5379*	-.4392*	285.386*	.073*	.672*	3.11*****	292.375	NCB
1368	1.90500*	.0553*	.4546*	3.4706*	5.0055*	-.7509*	285.698*	.078*	.674*	2.89*****	292.382	NCB
1369	2.06375*	.0660*	.4944*	3.7031*	5.4887*	-.9504*	285.897*	.081*	.673*	2.70*****	292.378	NCB
1370	2.22250*	.0769*	.5287*	3.9267*	5.9843*	-1.0815*	286.028*	.083*	.676*	2.54*****	292.385	NCB
1371	2.38125*	.0883*	.5587*	4.1437*	6.4991*	-1.1815*	286.128*	.087*	.694*	2.39*****	292.435	NCB
1372	2.54000*	.0999*	.5849*	4.3498*	7.0247*	-1.2555*	286.202*	.089*	.703*	2.26*****	292.459	NCB
1373	2.69875*	.1118*	.6079*	4.5453*	7.5616*	-1.3156*	286.262*	.091*	.714*	2.14*****	292.489	NCB
1374	2.85750*	.1240*	.6285*	4.7317*	8.1170*	-1.3760*	286.323*	.094*	.738*	2.03*****	292.551	NCB
1375	3.01625*	.1364*	.6466*	4.9038*	8.6747*	-1.4198*	286.367*	.094*	.737*	1.93*****	292.550	NCB
1376	3.17500*	.1485*	.6622*	5.0590*	9.2238*	-1.4424*	286.389*	.093*	.722*	1.84*****	292.509	NCB
1377	3.33375*	.1602*	.6756*	5.1957*	9.7526*	-1.4405*	286.387*	.089*	.691*	1.76*****	292.427	NCB
1378	3.49250*	.1706*	.6864*	5.3076*	10.2231*	-1.3830*	286.330*	.079*	.605*	1.70*****	292.183	NCB
1379	3.65125*	.1790*	.6944*	5.3899*	10.6022*	-1.2560*	286.203*	.064*	.474*	1.65*****	291.756	NCB
1380	3.81000*	.1840*	.6989*	5.4355*	10.8262*	-1.0193*	285.966*	.038*	.254*	1.63*****	290.772	NCB
1381	Channel 21, Entrance Cell 43, Exit Cell 643											
1382	.00000*	.0000*	.0000*	2.1169*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
1383	.15875*	.0000*	.0000*	2.1202*	.1876*	10.8294*	274.118*	.000*	.160*9999.00*****	283.188	SPH	
1384	.31750*	.0001*	.0072*	2.1415*	.4863*	9.5320*	275.415*	.001*	.301*9999.00*****	291.024	NCB	
1385	.47625*	.0010*	.0339*	2.2058*	1.3376*	8.0832*	276.864*	.016*	.393*	8.98*****	291.444	NCB
1386	.63500*	.0026*	.0611*	2.2732*	1.9256*	6.6468*	278.300*	.027*	.435*	7.08*****	291.611	NCB
1387	.79375*	.0044*	.0858*	2.3367*	2.3109*	5.3860*	279.561*	.030*	.407*	6.19*****	291.500	NCB
1388	.95250*	.0067*	.1138*	2.4114*	2.6435*	4.2480*	280.699*	.038*	.412*	5.59*****	291.518	NCB
1389	1.11125*	.0097*	.1469*	2.5029*	2.9462*	3.2230*	281.724*	.049*	.428*	5.12*****	291.581	NCB
1390	1.27000*	.0137*	.1882*	2.6253*	3.2527*	2.2755*	282.671*	.067*	.478*	4.68*****	291.770	NCB
1391	1.42875*	.0185*	.2325*	2.7683*	3.5455*	1.4669*	283.480*	.079*	.493*	4.33*****	291.821	NCB
1392	1.58750*	.0238*	.2772*	2.9278*	3.8401*	.8004*	284.147*	.089*	.500*	4.03*****	291.847	NCB
1393	1.74625*	.0298*	.3206*	3.0996*	4.1473*	.2636*	284.683*	.098*	.506*	3.77*****	291.867	NCB
1394	1.90500*	.0362*	.3616*	3.2799*	4.4715*	-.1407*	285.088*	.107*	.508*	3.55*****	291.872	NCB
1395	2.06375*	.0431*	.3998*	3.4658*	4.8145*	-.4181*	285.365*	.114*	.508*	3.35*****	291.873	NCB
1396	2.22250*	.0504*	.4347*	3.6533*	5.1730*	-.6084*	285.555*	.120*	.511*	3.18*****	291.883	NCB
1397	2.38125*	.0583*	.4679*	3.8504*	5.5660*	-.7627*	285.710*	.132*	.548*	3.00*****	292.007	NCB
1398	2.54000*	.0665*	.4976*	4.0433*	5.9691*	-.8688*	285.816*	.136*	.551*	2.84*****	292.017	NCB
1399	2.69875*	.0748*	.5240*	4.2299*	6.3789*	-.9422*	285.889*	.138*	.553*	2.70*****	292.021	NCB
1400	2.85750*	.0833*	.5474*	4.4095*	6.7935*	-.9945*	285.941*	.140*	.555*	2.57*****	292.027	NCB

5. Output Descriptions

1401	3.01625*	.0917*	.5681*	4.5789*	7.2065*	-1.0278*	285.975*	.139*	.548*	2.45*****	292.006	NCB
1402	3.17500*	.0999*	.5863*	4.7370*	7.6128*	-1.0448*	285.992*	.137*	.536*	2.34*****	291.966	NCB
1403	3.33375*	.1087*	.6037*	4.8964*	8.0451*	-1.0854*	286.032*	.146*	.574*	2.23*****	292.088	NCB
1404	3.49250*	.1166*	.6177*	5.0310*	8.4319*	-1.0675*	286.014*	.131*	.503*	2.15*****	291.855	NCB
1405	3.65125*	.1230*	.6281*	5.1342*	8.7432*	-.9835*	285.930*	.105*	.391*	2.08*****	291.436	NCB
1406	3.81000*	.1271*	.6345*	5.1974*	8.9433*	-.8242*	285.771*	.068*	.232*	2.05*****	290.639	NCB
1407	Channel 22, Entrance Cell 44, Exit Cell 644											
1408	.00000*	.0000*	.0000*	1.8918*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.			
1409	.15875*	.0000*	.0000*	1.8953*	.1876*	10.6781*	274.269*	.000*	.173*9999.00*****285.056 SPH			
1410	.31750*	.0009*	.0312*	1.9624*	1.1514*	8.9041*	276.043*	.013*	.415*	11.67*****	291.533	NCB
1411	.47625*	.0034*	.0713*	2.0508*	1.8932*	6.9755*	277.971*	.037*	.540*	7.40*****	291.980	NCB
1412	.63500*	.0071*	.1179*	2.1595*	2.4167*	5.1552*	279.792*	.056*	.592*	5.68*****	292.142	NCB
1413	.79375*	.0116*	.1658*	2.2811*	2.7835*	3.6339*	281.313*	.066*	.569*	4.83*****	292.072	NCB
1414	.95250*	.0169*	.2178*	2.4262*	3.1049*	2.3739*	282.573*	.080*	.570*	4.29*****	292.075	NCB
1415	1.11125*	.0234*	.2727*	2.5981*	3.4300*	1.3471*	283.600*	.096*	.586*	3.88*****	292.124	NCB
1416	1.27000*	.0313*	.3293*	2.7997*	3.7935*	.5109*	284.436*	.116*	.624*	3.53*****	292.240	NCB
1417	1.42875*	.0401*	.3823*	3.0165*	4.1897*	-.1133*	285.060*	.131*	.636*	3.25*****	292.274	NCB
1418	1.58750*	.0498*	.4303*	3.2413*	4.6182*	-.5202*	285.467*	.143*	.640*	3.02*****	292.285	NCB
1419	1.74625*	.0600*	.4725*	3.4648*	5.0684*	-.7818*	285.729*	.151*	.641*	2.82*****	292.289	NCB
1420	1.90500*	.0706*	.5090*	3.6816*	5.5323*	-.9493*	285.896*	.156*	.641*	2.65*****	292.289	NCB
1421	2.06375*	.0813*	.5404*	3.8891*	6.0059*	-1.0592*	286.006*	.160*	.643*	2.51*****	292.293	NCB
1422	2.22250*	.0923*	.5678*	4.0869*	6.4889*	-1.1365*	286.083*	.163*	.649*	2.38*****	292.309	NCB
1423	2.38125*	.1037*	.5922*	4.2783*	6.9895*	-1.2048*	286.152*	.169*	.669*	2.25*****	292.367	NCB
1424	2.54000*	.1153*	.6137*	4.4587*	7.4987*	-1.2588*	286.206*	.172*	.677*	2.14*****	292.390	NCB
1425	2.69875*	.1271*	.6328*	4.6278*	8.0148*	-1.3034*	286.250*	.174*	.684*	2.04*****	292.408	NCB
1426	2.85750*	.1391*	.6499*	4.7875*	8.5440*	-1.3494*	286.296*	.178*	.701*	1.94*****	292.453	NCB
1427	3.01625*	.1511*	.6650*	4.9336*	9.0716*	-1.3806*	286.328*	.178*	.696*	1.86*****	292.440	NCB
1428	3.17500*	.1629*	.6782*	5.0646*	9.5890*	-1.3936*	286.341*	.175*	.679*	1.78*****	292.394	NCB
1429	3.33375*	.1743*	.6895*	5.1801*	10.0863*	-1.3851*	286.332*	.168*	.649*	1.71*****	292.310	NCB
1430	3.49250*	.1843*	.6988*	5.2731*	10.5278*	-1.3242*	286.271*	.149*	.568*	1.65*****	292.068	NCB
1431	3.65125*	.1924*	.7057*	5.3424*	10.8829*	-1.1972*	286.144*	.120*	.444*	1.61*****	291.645	NCB
1432	3.81000*	.1972*	.7096*	5.3793*	11.0929*	-.9660*	285.913*	.071*	.239*	1.59*****	290.680	NCB
1433	Channel 23, Entrance Cell 45, Exit Cell 645											
1434	.00000*	.0000*	.0000*	1.8980*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.			
1435	.15875*	.0000*	.0000*	1.9019*	.1876*	10.5754*	274.372*	.000*	.195*9999.00*****286.467 SPH			
1436	.31750*	.0013*	.0383*	1.9834*	1.1511*	8.6991*	276.248*	.019*	.459*	10.56*****	291.699	NCB
1437	.47625*	.0043*	.0833*	2.0838*	2.0577*	6.6729*	278.274*	.045*	.594*	6.75*****	292.148	NCB
1438	.63500*	.0087*	.1355*	2.2090*	2.5708*	4.7934*	280.154*	.066*	.644*	5.20*****	292.297	NCB
1439	.79375*	.0136*	.1882*	2.3484*	2.9349*	3.2613*	281.686*	.076*	.612*	4.45*****	292.203	NCB
1440	.95250*	.0198*	.2427*	2.5090*	3.2603*	2.0333*	282.914*	.089*	.599*	3.98*****	292.164	NCB
1441	1.11125*	.0267*	.2972*	2.6902*	3.5919*	1.0677*	283.879*	.102*	.598*	3.63*****	292.162	NCB
1442	1.27000*	.0346*	.3506*	2.8925*	3.9564*	.3083*	284.639*	.119*	.618*	3.34*****	292.220	NCB
1443	1.42875*	.0435*	.3999*	3.1055*	4.3509*	-.2303*	285.177*	.131*	.620*	3.11*****	292.227	NCB
1444	1.58750*	.0529*	.4441*	3.3222*	4.7709*	-.5775*	285.524*	.141*	.619*	2.91*****	292.222	NCB
1445	1.74625*	.0630*	.4834*	3.5386*	5.2143*	-.8067*	285.754*	.149*	.627*	2.74*****	292.246	NCB
1446	1.90500*	.0732*	.5173*	3.7469*	5.6675*	-.9520*	285.899*	.153*	.623*	2.59*****	292.237	NCB
1447	2.06375*	.0836*	.5466*	3.9449*	6.1264*	-1.0451*	285.992*	.155*	.621*	2.46*****	292.229	NCB
1448	2.22250*	.0941*	.5720*	4.1325*	6.5896*	-1.1076*	286.055*	.156*	.620*	2.34*****	292.227	NCB
1449	2.38125*	.1048*	.5944*	4.3096*	7.0581*	-1.1542*	286.101*	.158*	.624*	2.23*****	292.237	NCB
1450	2.54000*	.1155*	.6141*	4.4759*	7.5296*	-1.1897*	286.137*	.159*	.625*	2.14*****	292.242	NCB
1451	2.69875*	.1262*	.6316*	4.6315*	8.0036*	-1.2183*	286.165*	.160*	.627*	2.05*****	292.246	NCB
1452	2.85750*	.1373*	.6475*	4.7795*	8.4895*	-1.2537*	286.201*	.164*	.643*	1.96*****	292.293	NCB
1453	3.01625*	.1482*	.6615*	4.9149*	8.9704*	-1.2745*	286.221*	.162*	.633*	1.88*****	292.266	NCB
1454	3.17500*	.1588*	.6738*	5.0372*	9.4384*	-1.2780*	286.225*	.158*	.613*	1.81*****	292.207	NCB
1455	3.33375*	.1691*	.6846*	5.1457*	9.8911*	-1.2686*	286.216*	.153*	.591*	1.75*****	292.140	NCB
1456	3.49250*	.1782*	.6933*	5.2337*	10.2904*	-1.2085*	286.155*	.135*	.513*	1.69*****	291.889	NCB
1457	3.65125*	.1854*	.6998*	5.2993*	10.6083*	-1.0865*	286.033*	.107*	.396*	1.65*****	291.457	NCB
1458	3.81000*	.1896*	.7035*	5.3341*	10.7938*	-.8717*	285.819*	.063*	.209*	1.64*****	290.493	NCB
1459	Channel 24, Entrance Cell 46, Exit Cell 646											
1460	.00000*	.0000*	.0000*	1.1141*	.1875*	11.5303*	273.417*	.000*	.000*****n.a.			
1461	.15875*	.0000*	.0000*	1.1153*	.1876*	11.0463*	273.901*	.000*	.058*9999.00*****279.422 SPH			
1462	.31750*	.0000*	.0000*	1.1177*	.1877*	10.0475*	274.899*	.000*	.120*9999.00*****286.320 SPH			
1463	.47625*	.0000*	.0000*	1.1210*	.1878*	8.6831*	276.264*	.000*	.165*9999.00*****290.173 NCB			
1464	.63500*	.0000*	.0021*	1.1272*	.2371*	7.1321*	277.815*	.000*	.189*9999.00*****290.353 NCB			
1465	.79375*	.0004*	.0180*	1.1486*	.5528*	5.7553*	279.192*	.004*	.182*	12.71*****	290.305	NCB
1466	.95250*	.0014*	.0383*	1.1749*	.8584*	4.5188*	280.428*	.009*	.185*	11.04*****	290.329	NCB
1467	1.11125*	.0030*	.0632*	1.2070*	1.1323*	3.4241*	281.523*	.014*	.191*	9.84*****	290.372	NCB
1468	1.27000*	.0056*	.0950*	1.2491*	1.3835*	2.4568*	282.490*	.022*	.207*	8.85*****	290.482	NCB
1469	1.42875*	.0089*	.1317*	1.2997*	1.5908*	1.6502*	283.297*	.029*	.214*	8.07*****	290.525	NCB
1470	1.58750*	.0130*	.1724*	1.3600*	1.7676*	1.0038*	283.943*	.035*	.219*	7.42*****	290.559	NCB

5. Output Descriptions

1471	1.74625*	.0179*	.2176*	1.4331*	1.9361*	.4899*	284.457*	.043*	.234*	6.85*****	290.651	NCB
1472	1.90500*	.0235*	.2626*	1.5134*	2.0985*	.1109*	284.836*	.048*	.236*	6.37*****	290.667	NCB
1473	2.06375*	.0295*	.3061*	1.5992*	2.2639*	-.1320*	285.079*	.053*	.237*	5.96*****	290.672	NCB
1474	2.22250*	.0359*	.3468*	1.6879*	2.4346*	-.2713*	285.218*	.056*	.238*	5.61*****	290.676	NCB
1475	2.38125*	.0428*	.3845*	1.7789*	2.6133*	-.3552*	285.302*	.060*	.244*	5.29*****	290.715	NCB
1476	2.54000*	.0498*	.4183*	1.8689*	2.7956*	-.4029*	285.350*	.061*	.246*	5.01*****	290.723	NCB
1477	2.69875*	.0569*	.4487*	1.9572*	2.9812*	-.4317*	285.379*	.062*	.248*	4.76*****	290.737	NCB
1478	2.85750*	.0645*	.4771*	2.0471*	3.1781*	-.4630*	285.410*	.066*	.263*	4.52*****	290.822	NCB
1479	3.01625*	.0721*	.5022*	2.1330*	3.3744*	-.4791*	285.426*	.066*	.260*	4.30*****	290.808	NCB
1480	3.17500*	.0795*	.5240*	2.2131*	3.5658*	-.4820*	285.429*	.065*	.252*	4.11*****	290.761	NCB
1481	3.33375*	.0870*	.5439*	2.2908*	3.7603*	-.4900*	285.437*	.066*	.257*	3.93*****	290.786	NCB
1482	3.49250*	.0936*	.5598*	2.3561*	3.9310*	-.4623*	285.409*	.058*	.221*	3.80*****	290.575	NCB
1483	3.65125*	.0988*	.5713*	2.4050*	4.0637*	-.3972*	285.344*	.045*	.168*	3.71*****	290.196	NCB
1484	3.81000*	.1018*	.5776*	2.4326*	4.1409*	-.2912*	285.238*	.026*	.091*	3.68*****	289.449	NCB

Channel 25, Entrance Cell 47, Exit Cell 647

1486	.00000*	.0000*	.0000*	.6646*	.1875*	11.5303*	273.417*	.000*	.000*****	n.a.		
1487	.15875*	.0000*	.0000*	.6648*	.1875*	11.4267*	273.522*	.000*	.075*****	n.a.		
1488	.31750*	.0000*	.0000*	.6652*	.1875*	11.1749*	273.772*	.000*	.166*****	n.a.		
1489	.47625*	.0000*	.0000*	.6657*	.1876*	10.8204*	274.127*	.000*	.221*****	n.a.		
1490	.63500*	.0000*	.0000*	.6663*	.1876*	10.3958*	274.551*	.000*	.248*****	n.a.		
1491	.79375*	.0000*	.0000*	.6669*	.1877*	9.9429*	275.004*	.000*	.245*****	n.a.		
1492	.95250*	.0000*	.0000*	.6677*	.1877*	9.4576*	275.489*	.000*	.250*****	n.a.		
1493	1.11125*	.0000*	.0000*	.6684*	.1878*	8.9374*	276.010*	.000*	.263*****	n.a.		
1494	1.27000*	.0000*	.0000*	.6692*	.1878*	8.3815*	276.565*	.000*	.282*****	n.a.		
1495	1.42875*	.0000*	.0000*	.6701*	.1879*	7.8112*	277.136*	.000*	.288*****	n.a.		
1496	1.58750*	.0000*	.0000*	.6709*	.1879*	7.2364*	277.711*	.000*	.290*****	n.a.		
1497	1.74625*	.0000*	.0000*	.6718*	.1880*	6.6575*	278.289*	.000*	.297*****	n.a.		
1498	1.90500*	.0000*	.0000*	.6726*	.1880*	6.0876*	278.859*	.000*	.296*****	n.a.		
1499	2.06375*	.0000*	.0000*	.6734*	.1881*	5.5291*	279.418*	.000*	.295*****	n.a.		
1500	2.22250*	.0000*	.0000*	.6742*	.1881*	4.9851*	279.962*	.000*	.295*****	n.a.		
1501	2.38125*	.0000*	.0000*	.6750*	.1882*	4.4494*	280.498*	.000*	.300*****	n.a.		
1502	2.54000*	.0000*	.0000*	.6758*	.1883*	3.9287*	281.018*	.000*	.301*****	n.a.		
1503	2.69875*	.0000*	.0000*	.6766*	.1883*	3.4230*	281.524*	.000*	.302*****	n.a.		
1504	2.85750*	.0000*	.0000*	.6773*	.1884*	2.9235*	282.023*	.000*	.310*****	n.a.		
1505	3.01625*	.0000*	.0000*	.6781*	.1884*	2.4447*	282.502*	.000*	.306*****	n.a.		
1506	3.17500*	.0000*	.0000*	.6787*	.1884*	1.9928*	282.954*	.000*	.296*****	n.a.		
1507	3.33375*	.0000*	.0000*	.6794*	.1885*	1.5594*	283.388*	.000*	.293*****	n.a.		
1508	3.49250*	.0000*	.0000*	.6800*	.1885*	1.1859*	283.761*	.000*	.254*****	n.a.		
1509	3.65125*	.0000*	.0000*	.6804*	.1886*	.8935*	284.053*	.000*	.196*****	n.a.		
1510	3.81000*	.0000*	.0000*	.6807*	.1886*	.7173*	284.230*	.000*	.107*****	n.a.		

*** Peak Clad Temperature = 2.92580E+02 at Channel = 17 and Node = 18

Riser

Component 30 - Entrance Cell 648, Exit Cell 653

1514	3.81000*	.1247*	.6269*	3.9073*	6.8037*	-.5850*	285.532*	.000*				
1515	4.80280*	.1260*	.6292*	3.9212*	6.8539*	-.1383*	285.085*	17.937*				
1516	5.79560*	.1264*	.6297*	3.9245*	6.8659*	-.0332*	284.980*	4.296*				
1517	6.78840*	.1265*	.6298*	3.9253*	6.8688*	-.0079*	284.955*	1.029*				
1518	7.78120*	.1265*	.6299*	3.9255*	6.8695*	-.0019*	284.949*	.246*				
1519	8.77400*	.1265*	.6299*	3.9256*	6.8696*	-.0005*	284.947*	.059*				

Minimum CPR = 1.587 in Channel 22 at Axial Position 3.810 m

Minimum CHF Ratio =***** in Channel 1 at Axial Position .000 m

CORE AVERAGE BORON CONCENTRATION = 0.0000E+00 PPM

CORE INLET MIXING ZONE BORON CONC.= 0.0000E+00 M^3

Core Average In-Bundle Void Fraction: .36135

Bypass Inlet Pressure Loss Coefficient = -586.21

Node	Void
1	.00000
2	.01130
3	.03547
4	.06323

5. Output Descriptions

	Subroutine	Time(s)
1611		
1612		
1613		
1614	STATIC	3.910
1615	SAHRA	123.040
1616	POLKA	14.310
1617	TELPO	2.230
1618	XEDOP	4.000
1619	MATRICA	.960
1620	FLUPO	7.120
1621		

5.1.2 Sample Output for the Transient Calculation

This section provides a sample of a printed steady-state output. It includes the major parts such as Transient Description "Long" Hydraulic Printed Output, Vertical and Horizontal Power Distributions, Control Map, Neutronic Printed Output, "Short" Hydraulic Printed Output, Vessel Mass and Energy Balance, Runtime Statistics, Plot Variables with Maps and Names and Plot Summary Data. The reader is referred to the NOMENCLATURE for the variables printed in the output listing. All printed variables are in SI units unless otherwise indicated.

INPUT-PARAMETERS FOR DYNAMIC HYDRAULICS

```

19  PRESSURE DATA
20  *****
21  MAIN STEAM VALVE COEFFICIENT (M4) = 0.00000E+00
22  VARIABLE SYSTEM PRESSURE
23
24
25
26
27  INTEGRATION SPECIFICATION
28  *****
29
30
31  STABILITY LIMIT CONSTANT           = 3.00000E-02
32  MINIMUM TIME STEP LENGTH (S)      = 1.00000E-02
33  MAXIMUM RELATIVE TRUNCATION ERROR = 2.00000E-02
34
35
36
37  DISTURBANCES/ *****
38
39
40
41
42  FEEDWATER FLOW DISTURBANCE
43
44  START TIME FOR THE DISTURBANCE (S) = 0.00000E+00
45  RAMP COEFFICIENT (RELATIVE)        = -2.00000E-01
46  RAMP MAXIMUM (RELATIVE)            = -1.00000E+00
47  INTERVAL BETWEEN RAMPS (S)        = 1.00000E+04
48  RELATIVE AMPLITUDE OF SINUSOIDAL DISTURBANCE = 0.00000E+00
49  ANGULAR FREQUENCY OF OSCILLATIONS (1/S) = 0.00000E+00
50
51
52  FEEDWATER TEMPERATURE DISTURBANCE
53
54  START TIME FOR THE DISTURBANCE (S) = 0.00000E+00
55  RAMP COEFFICIENT (RELATIVE)        = -2.78000E-02
56  RAMP MAXIMUM (RELATIVE)            = -8.32000E-01
57  INTERVAL BETWEEN RAMPS (S)        = 1.00000E+04
58  RELATIVE AMPLITUDE OF SINUSOIDAL DISTURBANCE = 0.00000E+00
59  ANGULAR FREQUENCY OF OSCILLATIONS (1/S) = 0.00000E+00
60
61
62
63  PLANT PROTECTION TRIPS
64  *****
65
66
67
68  MSIV TRP ON TIME = 0.00000E+00    DELAY 5.00000E-01
69
70  MSIV FLOW RATE AFTER TRIP

```

5. Output Descriptions

TIME	FRACTIONAL FLOWRATE
0.00000E+00	1.00000E+00
4.00000E-01	9.00000E-01
1.85000E+00	4.00000E-01
2.40000E+00	5.00000E-02
3.40000E+00	2.00000E-02
3.70000E+00	5.00000E-04
4.00000E+00	0.00000E+00

S/R VALVE NO. 1

S/R OPENING ON HIGH PRESSURE SETPOINT 7.7221E+06 WITH DELAY TIME = 0.0000E+00 S
 S/R CLOSING ON LOW PRESSURE SETPOINT 7.3774E+06 WITH DELAY TIME = 0.0000E+00 S

FOR THIS VALVE, OPENING S/R FLOWRATE AFTER TRIP

TIME	FRACTIONAL FLOWRATE
0.00000E+00	0.00000E+00
4.00000E-01	4.00000E-01
6.50000E-01	6.50000E-01
1.00000E+00	1.00000E+00

FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURE

PRESSURE	PERCENT OPENING
7.72213E+06	0.00000E+00
7.72410E+06	1.00000E+00

FOR THIS VALVE, CLOSING S/R FLOWRATE AFTER TRIP

TIME	PERCENT FLOWRATE
0.00000E+00	1.00000E+00
4.00000E-01	6.00000E-01
6.50000E-01	3.50000E-01
1.00000E+00	0.00000E+00

FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURES

PRESSURE	PERCENT CLOSING
7.37740E+06	1.00000E+00
7.37700E+06	0.00000E+00

S/R VALVE NO. 2

S/R OPENING ON HIGH PRESSURE SETPOINT 7.7911E+06 WITH DELAY TIME = 0.0000E+00 S
 S/R CLOSING ON LOW PRESSURE SETPOINT 7.4463E+06 WITH DELAY TIME = 0.0000E+00 S

FOR THIS VALVE, OPENING S/R FLOWRATE AFTER TRIP

TIME	FRACTIONAL FLOWRATE
0.00000E+00	0.00000E+00
4.00000E-01	4.00000E-01
6.50000E-01	6.50000E-01
1.00000E+00	1.00000E+00

FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURE

PRESSURE	PERCENT OPENING
7.79108E+06	0.00000E+00
7.79300E+06	1.00000E+00

FOR THIS VALVE, CLOSING S/R FLOWRATE AFTER TRIP

TIME	PERCENT FLOWRATE
0.00000E+00	1.00000E+00

5. Output Descriptions

141 4.00000E-01 6.00000E-01
 142 6.50000E-01 3.50000E-01
 143 1.00000E+00 0.00000E+00
 144
 145 FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURES
 146 PRESSURE PERCENT CLOSING
 147
 148 7.44630E+06 1.00000E+00
 149 7.44590E+06 0.00000E+00
 150
 151
 152 S/R VALVE NO. 3
 153
 154
 155 S/R OPENING ON HIGH PRESSURE SETPOINT 7.8600E+06 WITH DELAY TIME = 0.0000E+00 S
 156 S/R CLOSING ON LOW PRESSURE SETPOINT 7.5153E+06 WITH DELAY TIME = 0.0000E+00 S
 157
 158 FOR THIS VALVE, OPENING S/R FLOWRATE AFTER TRIP
 159 TIME FRACTIONAL FLOWRATE
 160
 161 0.00000E+00 0.00000E+00
 162 4.00000E-01 4.00000E-01
 163 6.50000E-01 6.50000E-01
 164 1.00000E+00 1.00000E+00
 165
 166 FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURE
 167 PRESSURE PERCENT OPENING
 168
 169 7.86000E+06 0.00000E+00
 170 7.86200E+06 1.00000E+00
 171
 172 FOR THIS VALVE, CLOSING S/R FLOWRATE AFTER TRIP
 173 TIME PERCENT FLOWRATE
 174
 175 0.00000E+00 1.00000E+00
 176 4.00000E-01 6.00000E-01
 177 6.50000E-01 3.50000E-01
 178 1.00000E+00 0.00000E+00
 179
 180 FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURES
 181 PRESSURE PERCENT CLOSING
 182
 183 7.51530E+06 1.00000E+00
 184 7.51490E+06 0.00000E+00
 185
 186
 187 S/R VALVE NO. 4
 188
 189
 190 S/R OPENING ON HIGH PRESSURE SETPOINT 8.7219E+06 WITH DELAY TIME = 0.0000E+00 S
 191 S/R CLOSING ON LOW PRESSURE SETPOINT 8.3772E+06 WITH DELAY TIME = 0.0000E+00 S
 192
 193 FOR THIS VALVE, OPENING S/R FLOWRATE AFTER TRIP
 194 TIME FRACTIONAL FLOWRATE
 195
 196 0.00000E+00 0.00000E+00
 197 4.00000E-01 4.00000E-01
 198 6.50000E-01 6.50000E-01
 199 1.00000E+00 1.00000E+00
 200
 201 FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURE
 202 PRESSURE PERCENT OPENING
 203
 204 8.72190E+06 0.00000E+00
 205 8.72390E+06 1.00000E+00
 206
 207 FOR THIS VALVE, CLOSING S/R FLOWRATE AFTER TRIP
 208 TIME PERCENT FLOWRATE
 209
 210 0.00000E+00 1.00000E+00

5. Output Descriptions

211		4.00000E-01	6.00000E-01	
212		6.50000E-01	3.50000E-01	
213		1.00000E+00	0.00000E+00	
214				
215	FOR THIS S/R VALVE, LIFT CHARACTERISTICS AS FUNCTION OF SETPOINT PRESSURES			
216		PRESSURE	PERCENT CLOSING	
217				
218		8.37720E+06	1.00000E+00	
219		8.37680E+06	0.00000E+00	
220				
221				
222	PRESSURE REGULATOR MODEL			
223	GAIN FACTOR FOR PRESSURE SETPOINT ADJUSTMENT	(N/m ²) =	2.00000E+04	
224	GAIN FACTOR FOR PRESSURE ERROR SIGNAL	(m ² /N) =	4.83500E-06	
225	TIME CONSTANT FOR TURBINE CONTROL VALVE PRESSURE SENSOR	(S) =	1.00000E-01	
226	LEAD TIME OF LEAD/LAG COMPENSATOR FOR PRESSURE SIGNAL	(S) =	2.00000E+00	
227	LAG TIME OF LEAD/LAG COMPENSATOR FOR PRESSURE SIGNAL	(S) =	5.00000E+00	
228	TURBINE CONTROL VALVE DAMPING COEFFICIENT		9.19000E-01	
229	TURBINE CONTROL VALVE NATURAL FREQUENCY	(1/S) =	1.41400E+00	
230	TURBINE CONTROL VALVE PRESSURE SETPOINT	(N/M ²) =	6.42060E+06	
231	TURBINE CONTROL VALVE POSITION	(FRACTION OF FULLY OPEN) =	6.57500E-01	
232				
233				
234	GENERATOR LOAD REJECTION SIGNAL (0=TRIPPED, 1=NO TRIP)	=	1.00000E+00	
235	LOAD SETPOINT FOR PRESSURE REGULATOR (0.0 TO 1.0)	=	9.00000E-01	
236	LOAD BIAS FOR PRESSURE REGULATOR (0.0 TO 1.0)	=	9.00000E-02	
237	BIAS FOR BYPASS VALVE (0.0 TO 1.0)	=	1.80000E-02	
238	MANUAL BYPASS OVERRIDE FOR BYPASS VALVE (0.0 TO 1.0)	=	0.00000E+00	
239	BYPASS VALVE DAMPING COEFFICIENT	=	1.00000E+00	
240	BYPASS VALVE NATURAL FREQUENCY	(1/S) =	2.75000E+00	
241	TURBINE CONTROL VALVE STUCK CLOSED SIGNAL (0=NO, 1=YES)	=	0.00000E+00	
242	TURBINE CONTROL VALVE STUCK OPEN SIGNAL (0=NO, 1=YES)	=	0.00000E+00	
243	RC PUMP TRP ON HIGH SYSTEM PRESSURE	7.92470E+06	DELAY	5.30000E-01
244				
245	HPCI TRP ON LOW VESSEL WATER LEVEL	-1.14850E+01	DELAY	0.00000E+00
246				
247	HPCI FLOW RATE			
248	TIME	FLOW RATE		
249				
250		0.00000E+00	0.00000E+00	
251		2.50000E+01	3.59720E+02	
252	HPCI OFF TRP ON HIGH VESSEL WATER LEVEL	1.20700E+00	DELAY	0.00000E+00
253				
254	HPCI OFF FRACTIONAL FLOW RATE			
255	TIME	FRACTIONAL FLOW RATE		
256				
257		0.00000E+00	1.00000E+00	
258		1.80000E+01	0.00000E+00	
259	OHPCI FLOW TEMPERATURE (DEGREES C) =	2.111000E+01		
260	ORCIC FLOW TEMPERATURE (DEGREES C) =	0.000000E+00		
261				
262				
263				
264				
265	NO FEEDWATER CONTROL			
266	*****			
267				
268				
269				
270				
271	BORON TRANSPORT AND REACTIVITY DATA			
272	-----			
273				
274	CORE REPRESENTED BY 25 RADIAL CHANNELS AND BY 24 AXIAL SECTIONS			
275	INJECTION AT CELL 2 OF LOOP PART 2			
276	WITH MASS FLOW	5.56 KG/S	WITH CONCENTRATION OF	.238E+05 PPM
277	RATED CORE FLOW RATE IS	1.3667E+04 KG/S		
278	FAST MICROSCOPIC CROSS SECTION IS	4.9000E+01 BARNS		
279	THERMAL MICROSCOPIC CROSS SECTION IS	1.5000E+03 BARNS		
280	WET FRACTION	1.0000E+00	ADJUSTMENT FACTOR =	0.00E+00

5. Output Descriptions

281 INJECTION STARTS AT 0.0000E+00 S, STOPS AT 1.00E+04 S
 282 WITH DELAY OF 6.0000E+01 S
 283
 284

BORON MIXING EFFICIENCY TABULAR INPUT FOR DOWNCOMER:

FRACTIONAL FLOW	MIXING EFFICIENCY
-1.000	1.000
-.950	1.000
-.750	.870
-.250	.750
-.050	.000
-.020	.000
.000	.000
.040	.950
.250	1.000
.950	1.000
1.000	1.000
2.000	1.000

BORON MIXING EFFICIENCY TABULAR INPUT FOR LOWER PLENUM 1:

FRACTIONAL FLOW	MIXING EFFICIENCY
-1.000	1.000
-.950	1.000
-.750	1.000
-.250	.750
-.050	.000
-.020	.000
.000	.000
.040	.000
.250	.750
.950	1.000
1.000	1.000
2.000	1.000

BORON MIXING EFFICIENCY TABULAR INPUT FOR LOWER PLENUM 2, CORE, AND RISER:

FRACTIONAL FLOW	MIXING EFFICIENCY
-1.000	1.000
-.950	1.000
-.750	1.000
-.250	1.000
-.050	.950
-.020	.910
.000	.000
.040	.000
.250	.750
.950	1.000
1.000	1.000
2.000	1.000

OUTPUT INFORMATION

ITAB	STEP1	HALT1	STEP2
1	5.000E-01	2.000E+00	5.000E+00

INPUT-PARAMETERS FOR NEUTRON KINETICS

5. Output Descriptions

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351  NUMBER OF DELAYED NEUTRON GROUPS (NG)          = 6
352  MAX. NUMBER OF ITERATIONS IN SOLVING PSI EQ.    = 20
353
354  OPTIONS SPECIFIED ON CARD 710000 ,IPR(1) I=1,2...
355  -3  1  1  0  1  -1  0  1  0  0  0
356
357
358  DECAY HEAT MODEL BEING USED
359
360  EXPOSURE/S.S. POWER RATIO                      1.00000
361  EXPOSURE UPTIME(S)                             .400E+08
362  FRCT DECAY FROM U-235                          .50000
363  FRCT DECAY FROM PU-239                         .40000
364  FRCT DECAY FROM U-238                         .10000
365  FRACTION PROMPT HEAT TO MODERATOR + COOLANT      .04000
366  FRACTION DELAY HEAT TO MODERATOR + COOLANT      .04000
367  VOLUMETRIC HEAT CAPACITY OF FUEL (J/M3*DEG)     = 3.157000E+06
368  VOLUMETRIC HEAT CAP. OF CLADDING (J/M3*DEG)     = 2.127000E+06
369  INITIAL STEP LENGTH, NEUTRONICS (S)             = 1.000000E-02
370  MAXIMUM STEP LENGTH, NEUTRONICS (S)             = 3.000000E-01
371  ACCURACY IN PREDICTED-CORRECTED FLUX TEST       = 5.000000E-02
372  LOCAL ACCURACY IN FLUX ITERATION                = 1.000000E-03
373  FAST NEUTRON VELOCITY (CM/S)                   = 0.000000E+00
374  THERMAL NEUTRON VELOCITY (CM/S)                 = 3.670000E+05
375  QUP - PROMPT HEAT TO URANIUM PER FISSION (J)     = 2.880906E-11
376  QUD - DELAYED HEAT TO URANIUM PER FISSION. (J)  = 1.952991E-12
377  QMP - PROMPT HEAT TO COOLANT PER FISSION. (J)   = 1.200377E-12
378  QMD - DELAYED HEAT TO COOLANT PER FISSION. (J)  = 8.137465E-14
379  SJ - THE AMOUNT OF MEV/FISSION (MEV/FISS)       = 2.000000E+02
380
381  DELAYED NEUTRON FRACTIONS,B( ), AND DECAY CONSTANTS, AL( ).
382  B(NG) = 2.075000E-04 AL(NG) = 1.270000E-02
383  1.163000E-03 3.170000E-02
384  1.027000E-03 1.150000E-01
385  2.222000E-03 3.110000E-01
386  6.989000E-04 1.400000E+00
387  1.420000E-04 3.870000E+00

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5. Output Descriptions

1	Time (s)	T.Power (W)	CW Level (m)	Steam Flow	FW Flow	FW Temp	Core Inlet Subc	
2	2.5275E+00	3.8200E+09	-6.7831E-02	6.3150E+02	8.0972E+02	1.7758E+02	1.5954E+01	
3								
4	Pressure	JP Head	Tot Vap Gener	Core Flow	Riser Vap Gen	WLC Vap Upflow	Rel.C.Undr	Vap CU F
5	7.3973E+06	1.9499E+05	1.4089E+03	1.3313E+04	0.0000E+00	0.0000E+00	1.0347E-03	0.0000E
6								
7	RP Head	Rec Flow	RP Spd (rpm)	RP Torque	JP diff loss			
8	1.5932E+06	6.4688E+03	1.6200E+03	3.0019E+04	2.2144E-03			
9								
10	DT (S)	DT1 (S)	DT2 (S)	TRUNC		F(LKRIT)	Y(LKRIT)	
11	3.0000E-02	3.0000E-02	9.3468E-02	1.3187E-03				
12								
13	KKRIT	LKRIT	INDLAM	COUNT				
14	1	0	5896	135				
15								
16	Power, W	Flow In	Flow Out	Liq Vel In	Press Drop	Exit Qual	Exit Void	
17	2.7601E+07	9.4364E+01	9.1223E+01	2.1934E+00	-1.4501E+05	1.2692E-01	6.2080E-01	
18	2.3552E+07	6.3204E+01	6.1395E+01	2.0203E+00	-1.4503E+05	1.7835E-01	6.8329E-01	
19	5.8715E+06	1.5906E+01	1.5589E+01	2.0336E+00	-1.4511E+05	1.7534E-01	6.8052E-01	
20	1.0630E+07	3.3436E+01	3.2618E+01	2.1371E+00	-1.4507E+05	1.4259E-01	6.4330E-01	
21	1.2030E+07	3.1189E+01	3.0333E+01	1.9934E+00	-1.4503E+05	1.8655E-01	6.9084E-01	
22	2.6944E+07	8.2498E+01	7.9589E+01	2.1096E+00	-1.4499E+05	1.4872E-01	6.5099E-01	
23	3.0163E+07	7.5944E+01	7.4044E+01	1.9533E+00	-1.4504E+05	1.9281E-01	6.9619E-01	
24	6.0988E+07	2.0214E+02	1.9471E+02	2.1538E+00	-1.4498E+05	1.3220E-01	6.2863E-01	
25	1.8716E+07	6.9173E+01	6.6638E+01	2.2111E+00	-1.4497E+05	1.1153E-01	5.9460E-01	
26	3.1126E+07	9.8672E+01	9.5565E+01	2.1026E+00	-1.4501E+05	1.4009E-01	6.3969E-01	
27	5.8742E+07	1.5459E+02	1.5082E+02	1.9764E+00	-1.4504E+05	1.8118E-01	6.8583E-01	
28	3.3779E+07	1.3026E+02	1.2556E+02	2.2203E+00	-1.4497E+05	1.0387E-01	5.7976E-01	
29	1.4252E+07	6.2044E+01	5.3964E+01	1.1332E+00	-1.4748E+05	8.6413E-02	5.2301E-01	
30	2.6182E+07	7.0743E+01	6.8632E+01	2.0216E+00	-1.4502E+05	1.7655E-01	6.8153E-01	
31	3.2400E+07	1.2133E+02	1.1677E+02	2.2159E+00	-1.4496E+05	1.0932E-01	5.9046E-01	
32	6.9226E+06	3.0964E+01	2.6911E+01	1.1310E+00	-1.4692E+05	8.3271E-02	5.1459E-01	
33	6.0132E+06	1.5670E+01	1.5383E+01	2.0034E+00	-1.4512E+05	1.8461E-01	6.8923E-01	
34	1.5544E+07	7.3528E+01	7.0353E+01	2.3503E+00	-1.4492E+05	7.4091E-02	5.0617E-01	
35	6.2544E+06	1.5178E+01	1.4784E+01	1.9405E+00	-1.4505E+05	2.0342E-01	7.0486E-01	
36	3.0578E+06	7.7623E+00	7.5557E+00	1.9848E+00	-1.4505E+05	1.9246E-01	6.9602E-01	
37	4.9831E+06	1.7058E+01	1.6399E+01	2.1808E+00	-1.4497E+05	1.2628E-01	6.1967E-01	
38	6.2846E+06	1.5073E+01	1.4692E+01	1.9270E+00	-1.4503E+05	2.0628E-01	7.0704E-01	
39	6.1174E+06	1.5109E+01	1.4775E+01	1.9317E+00	-1.4507E+05	1.9708E-01	6.9971E-01	
40	2.1759E+06	8.8542E+00	7.7030E+00	1.1320E+00	-1.4766E+05	9.8200E-02	5.5128E-01	
41	7.1624E+06	1.5950E+02	1.5753E+02	6.6079E-01	-1.4623E+05	0.0000E+00	0.0000E+00	

"LONG" HYDRAULIC PRINTED OUTPUT

Mixture Level in Downcomer 1, .067 Meters Below Entrance

50	Position*	Flow	• Void	* Liq Vel	• Vap Vel	• Subcool	• Liq Temp	*Evap Rate	*Heat Flux	CPR	* CHFR	*Wall Tmp	*HT Reg
51	(m)	• Quality	* Fraction	m/s	m/s	Deg C	Deg C	kg/s	MW/m2			Deg C	
52													
53													
54	Downcomer 1												
55				Component	1 - Entrance Cell	3, Exit Cell	8						
56	.06664*	.0000*	.0013*	.6450*	.0000*	2.3968*	287.130*	-9.120*					
57	1.00300*	.0000*	.0000*	.6779*	.0000*	12.9457*	276.582*	.000*					
58	2.00600*	.0000*	.0000*	.6769*	.0000*	14.8338*	274.693*	.000*					
59	3.00900*	.0000*	.0000*	.6760*	.0000*	15.5978*	273.929*	.000*					
60	4.01200*	.0000*	.0000*	.6750*	.0000*	15.8570*	273.670*	.000*					
61	5.01500*	.0000*	.0000*	.6740*	.0000*	15.9314*	273.596*	.000*					
62	Downcomer 2												
63				Component	2 - Entrance Cell	9, Exit Cell	15						
64	6.01800*	.0000*	.0000*	14.0871*	-.1845*	15.9314*	273.596*	.000*					
65	6.86167*	.0000*	.0000*	14.0863*	.0000*	15.9341*	273.593*	.000*					
66	7.70533*	.0000*	.0000*	14.0855*	.0000*	15.9366*	273.591*	.000*					
67	8.54900*	.0000*	.0000*	14.0846*	.0000*	15.9388*	273.588*	.000*					
68	9.39267*	.0000*	.0000*	14.0838*	.0000*	15.9408*	273.586*	.000*					
69	10.23633*	.0000*	.0000*	14.0830*	.0000*	15.9426*	273.585*	.000*					
70	11.08000*	.0000*	.0000*	14.0822*	.0000*	15.9442*	273.583*	.000*					

5. Output Descriptions

71	Lower Plenum 1						
72			Component	3 - Entrance Cell	16, Exit Cell	18	
73	.00000*	.0000*	.0000*	.9698*	15.9442*	273.583*	.000*
74	1.59400*	.0000*	.0000*	.9682*	.0000*	15.9527*	273.574*
75	3.18800*	.0000*	.0000*	.9667*	.0000*	15.9541*	273.573*
76	Lower Plenum 2						
77			Component	4 - Entrance Cell	19, Exit Cell	22	
78	-2.30600*	.0000*	.0000*	1.0672*	.1845*	15.9541*	273.573*
79	-1.53733*	.0000*	.0000*	1.0665*	.0000*	15.9543*	273.573*
80	-.76867*	.0000*	.0000*	1.0657*	.0000*	15.9544*	273.573*
81	.00000*	.0000*	.0000*	1.0650*	.0000*	15.9544*	273.573*
82	Channel 1, Entrance Cell 23, Exit Cell 623						
83	.00000*	.0000*	.0000*	2.1934*	.0000*	15.9544*	273.573*
84	.15875*	.0000*	.0000*	2.1952*	.0000*	15.5490*	273.978*
85	.31750*	.0000*	.0000*	2.1992*	.0000*	14.7220*	274.805*
86	.47625*	.0000*	.0000*	2.2047*	.0000*	13.5809*	275.946*
87	.63500*	.0000*	.0004*	2.2121*	.2045*	12.2368*	277.290*
88	.79375*	.0001*	.0069*	2.2298*	.4830*	10.8608*	278.666*
89	.95250*	.0007*	.0256*	2.2752*	1.1437*	9.4568*	280.070*
90	1.11125*	.0021*	.0509*	2.3363*	1.7833*	8.0038*	281.523*
91	1.27000*	.0046*	.0831*	2.4162*	2.3444*	6.5391*	282.988*
92	1.42875*	.0079*	.1205*	2.5131*	2.7883*	5.1647*	284.363*
93	1.58750*	.0121*	.1627*	2.6303*	3.1519*	3.9281*	285.599*
94	1.74625*	.0173*	.2102*	2.7741*	3.4823*	2.8348*	286.692*
95	1.90500*	.0233*	.2587*	2.9370*	3.7975*	1.9233*	287.604*
96	2.06375*	.0299*	.3059*	3.1142*	4.1182*	1.1848*	288.342*
97	2.22250*	.0372*	.3507*	3.3021*	4.4557*	.5940*	288.933*
98	2.38125*	.0453*	.3941*	3.5062*	4.8303*	.0979*	289.429*
99	2.54000*	.0542*	.4340*	3.7157*	5.2302*	-.2575*	289.785*
100	2.69875*	.0635*	.4702*	3.9264*	5.6520*	-.5062*	290.033*
101	2.85750*	.0736*	.5037*	4.1421*	6.1073*	-.7029*	290.230*
102	3.01625*	.0839*	.5331*	4.3487*	6.5701*	-.8369*	290.364*
103	3.17500*	.0942*	.5584*	4.5416*	7.0296*	-.9216*	290.449*
104	3.33375*	.1050*	.5816*	4.7307*	7.5099*	-1.0043*	290.532*
105	3.49250*	.1146*	.6000*	4.8879*	7.9371*	-1.0025*	290.530*
106	3.65125*	.1223*	.6132*	5.0044*	8.2748*	-.9080*	290.435*
107	3.81000*	.1269*	.6208*	5.0690*	8.4751*	-.7023*	290.229*
108	Channel 2, Entrance Cell 24, Exit Cell 624						
109	.00000*	.0000*	.0000*	2.0203*	.0000*	15.9544*	273.573*
110	.15875*	.0000*	.0000*	2.0230*	.0000*	15.3370*	274.190*
111	.31750*	.0000*	.0000*	2.0295*	.1867*	13.8969*	275.630*
112	.47625*	.0002*	.0122*	2.0597*	.6513*	12.0267*	277.500*
113	.63500*	.0012*	.0362*	2.1144*	1.3375*	10.1298*	279.397*
114	.79375*	.0028*	.0608*	2.1711*	1.8368*	8.3738*	281.153*
115	.95250*	.0054*	.0926*	2.2456*	2.2919*	6.7139*	282.813*
116	1.11125*	.0093*	.1348*	2.3495*	2.7085*	5.1376*	284.390*
117	1.27000*	.0148*	.1871*	2.4904*	3.0849*	3.6904*	285.837*
118	1.42875*	.0215*	.2440*	2.6620*	3.4349*	2.4605*	287.067*
119	1.58750*	.0293*	.3009*	2.8572*	3.7915*	1.4641*	288.063*
120	1.74625*	.0381*	.3551*	3.0700*	4.1747*	.6748*	288.852*
121	1.90500*	.0477*	.4040*	3.2893*	4.5807*	.0734*	289.454*
122	2.06375*	.0579*	.4479*	3.5116*	5.0124*	-.3323*	289.859*
123	2.22250*	.0687*	.4867*	3.7321*	5.4652*	-.6031*	290.130*
124	2.38125*	.0801*	.5214*	3.9510*	5.9433*	-.7997*	290.327*
125	2.54000*	.0918*	.5517*	4.1616*	6.4353*	-.9387*	290.466*
126	2.69875*	.1039*	.5783*	4.3622*	6.9388*	-1.0419*	290.569*
127	2.85750*	.1164*	.6021*	4.5554*	7.4615*	-1.1339*	290.661*
128	3.01625*	.1290*	.6229*	4.7339*	7.9854*	-1.1982*	290.725*
129	3.17500*	.1414*	.6408*	4.8952*	8.5003*	-1.2345*	290.762*
130	3.33375*	.1537*	.6565*	5.0417*	9.0094*	-1.2588*	290.786*
131	3.49250*	.1646*	.6691*	5.1598*	9.4594*	-1.2122*	290.739*
132	3.65125*	.1734*	.6783*	5.2447*	9.8148*	-1.0804*	290.608*
133	3.81000*	.1783*	.6833*	5.2879*	10.0146*	-.8228*	290.350*
134	Channel 3, Entrance Cell 25, Exit Cell 625						
135	.00000*	.0000*	.0000*	2.0336*	.0000*	15.9544*	273.573*
136	.15875*	.0000*	.0000*	2.0346*	.0000*	15.6937*	273.834*
137	.31750*	.0000*	.0000*	2.0378*	.0000*	14.9666*	274.561*
138	.47625*	.0000*	.0000*	2.0424*	.0000*	13.9429*	275.584*
139	.63500*	.0000*	.0001*	2.0483*	.1885*	12.6850*	276.842*
140	.79375*	.0000*	.0045*	2.0612*	.3711*	11.1763*	278.351*

5. Output Descriptions

141	.95250*	.0008*	.0288*	2.1157*	1.1604*	9.5673*	279.960*	.012*	.416*	6.09*	6.38*	295.624	NCB
142	1.11125*	.0038*	.0733*	2.2170*	2.0499*	7.6228*	281.904*	.046*	.626*	5.00*	4.20*	296.280	NCB
143	1.27000*	.0084*	.1249*	2.3430*	2.6430*	5.7241*	283.803*	.071*	.717*	4.25*	3.63*	296.513	NCB
144	1.42875*	.0143*	.1834*	2.5007*	3.0847*	4.0392*	285.488*	.094*	.757*	3.73*	3.39*	296.610	NCB
145	1.58750*	.0217*	.2455*	2.6904*	3.4722*	2.6351*	286.892*	.115*	.774*	3.36*	3.25*	296.649	NCB
146	1.74625*	.0303*	.3076*	2.9093*	3.8696*	1.5018*	288.025*	.136*	.793*	3.06*	3.12*	296.691	NCB
147	1.90500*	.0398*	.3648*	3.1423*	4.2891*	.6347*	288.892*	.151*	.789*	2.82*	3.06*	296.682	NCB
148	2.06375*	.0501*	.4155*	3.3804*	4.7325*	-.0099*	289.537*	.163*	.783*	2.63*	3.02*	296.668	NCB
149	2.22250*	.0612*	.4607*	3.6221*	5.2071*	-.4351*	289.962*	.176*	.781*	2.46*	2.96*	296.665	NCB
150	2.38125*	.0729*	.5005*	3.8623*	5.7085*	-.7232*	290.250*	.187*	.790*	2.31*	2.86*	296.683	NCB
151	2.54000*	.0851*	.5351*	4.0951*	6.2283*	-.9203*	290.447*	.194*	.795*	2.18*	2.78*	296.695	NCB
152	2.69875*	.0977*	.5652*	4.3178*	6.7628*	-1.0606*	290.588*	.200*	.802*	2.06*	2.69*	296.712	NCB
153	2.85750*	.1108*	.5920*	4.5338*	7.3226*	-1.1811*	290.708*	.209*	.831*	1.95*	2.54*	296.775	NCB
154	3.01625*	.1240*	.6152*	4.7334*	7.8849*	-1.2635*	290.791*	.211*	.825*	1.85*	2.51*	296.763	NCB
155	3.17500*	.1371*	.6350*	4.9134*	8.4379*	-1.3110*	290.838*	.207*	.805*	1.77*	2.52*	296.719	NCB
156	3.33375*	.1499*	.6520*	5.0741*	8.9776*	-1.3335*	290.861*	.203*	.781*	1.69*	2.55*	296.665	NCB
157	3.49250*	.1612*	.6654*	5.2041*	9.4546*	-1.2840*	290.811*	.180*	.683*	1.63*	2.87*	296.429	NCB
158	3.65125*	.1702*	.6752*	5.2981*	9.8317*	-1.1473*	290.674*	.143*	.533*	1.59*	3.63*	296.014	NCB
159	3.81000*	.1753*	.6805*	5.3436*	10.0397*	-.8748*	290.402*	.082*	.281*	1.57*	6.85*	295.053	NCB

Channel 25, Entrance Cell 47, Exit Cell 647

164	.00000*	.0000*	.0000*	.6608*	.0000*	15.9544*	273.573*	.000*	.000*****n.a.
165	.15875*	.0000*	.0000*	.6608*	.0000*	15.8396*	273.688*	.000*	8.595*****n.a.
166	.31750*	.0000*	.0000*	.6609*	.0000*	15.5724*	273.955*	.000*	18.969*****n.a.
167	.47625*	.0000*	.0000*	.6612*	.0000*	15.1962*	274.331*	.000*	25.260*****n.a.
168	.63500*	.0000*	.0000*	.6615*	.0000*	14.7489*	274.778*	.000*	28.491*****n.a.
169	.79375*	.0000*	.0000*	.6619*	.0000*	14.2757*	275.252*	.000*	28.261*****n.a.
170	.95250*	.0000*	.0000*	.6622*	.0000*	13.7692*	275.758*	.000*	29.091*****n.a.
171	1.11125*	.0000*	.0000*	.6626*	.0000*	13.2252*	276.302*	.000*	30.785*****n.a.
172	1.27000*	.0000*	.0000*	.6630*	.0000*	12.6429*	276.884*	.000*	33.111*****n.a.
173	1.42875*	.0000*	.0000*	.6634*	.0000*	12.0466*	277.481*	.000*	33.886*****n.a.
174	1.58750*	.0000*	.0000*	.6638*	.0000*	11.4472*	278.080*	.000*	34.198*****n.a.
175	1.74625*	.0000*	.0000*	.6643*	.0000*	10.8441*	278.683*	.000*	34.965*****n.a.
176	1.90500*	.0000*	.0000*	.6647*	.0000*	10.2525*	279.275*	.000*	34.793*****n.a.
177	2.06375*	.0000*	.0000*	.6651*	.0000*	9.6745*	279.853*	.000*	34.674*****n.a.
178	2.22250*	.0000*	.0000*	.6656*	.0000*	9.1134*	280.414*	.000*	34.470*****n.a.
179	2.38125*	.0000*	.0000*	.6660*	.0000*	8.5622*	280.965*	.000*	35.018*****n.a.
180	2.54000*	.0000*	.0000*	.6664*	.0000*	8.0290*	281.498*	.000*	34.941*****n.a.
181	2.69875*	.0000*	.0000*	.6669*	.0000*	7.5135*	282.014*	.000*	34.921*****n.a.
182	2.85750*	.0000*	.0000*	.6673*	.0000*	7.0054*	282.522*	.000*	35.782*****n.a.
183	3.01625*	.0000*	.0000*	.6678*	.0000*	6.5214*	283.006*	.000*	35.193*****n.a.
184	3.17500*	.0000*	.0000*	.6682*	.0000*	6.0676*	283.460*	.000*	33.985*****n.a.
185	3.33375*	.0000*	.0000*	.6686*	.0000*	5.6339*	283.893*	.000*	33.588*****n.a.
186	3.49250*	.0000*	.0000*	.6690*	.0000*	5.2666*	284.261*	.000*	29.049*****n.a.
187	3.65125*	.0000*	.0000*	.6692*	.0000*	4.9882*	284.539*	.000*	22.316*****n.a.
188	3.81000*	.0000*	.0000*	.6692*	.0000*	4.8371*	284.690*	.000*	11.898*****n.a.

*** Peak Clad Temperature = 2.96790E+02 at Channel = 17 and Node = 18

Riser

Component 30 - Entrance Cell 648, Exit Cell 653

194	3.81000*	.1258*	.6106*	5.3719*	5.3719*	.4579*	289.069*	.000*
195	4.80280*	.1233*	.6106*	3.6773*	6.2238*	.4579*	289.069*	-32.989*
196	5.79560*	.1206*	.6059*	3.5843*	6.0368*	.6001*	288.927*	-43.356*
197	6.78840*	.1183*	.6016*	3.4797*	5.8395*	.6562*	288.871*	-47.526*
198	7.78120*	.1166*	.5980*	3.3659*	5.6382*	.6793*	288.848*	-49.291*
199	8.77400*	.1153*	.5953*	3.2454*	5.4351*	.6895*	288.838*	-50.107*

Minimum CPR = 1.474 in Channel 22 at Axial Position 3.810 m

Minimum CHF Ratio = 2.453 in Channel 20 at Axial Position 3.016 m

CORE AVERAGE BORON CONCENTRATION = 0.0000E+00 PPM

CORE INLET MIXING ZONE BORON CONC.= 0.0000E+00 M^3

5. Output Descriptions

211 Core Average In-Bundle Void Fraction: .33064

Node	Void
1	.00000
2	.00260
3	.01899
4	.04015
5	.06197
6	.08856
7	.12213
8	.16263
9	.20600
10	.25038
11	.29530
12	.33822
13	.37850
14	.41554
15	.44995
16	.48105
17	.50901
18	.53466
19	.55728
20	.57693
21	.59453
22	.60851
23	.61856
24	.62385

NEUTRONICS PRINTED OUTPUT

STEP	TIME	ST.2	NS	AV.FLUX	R.POW	R.FISS	AV.TEMP	COMP. TIMES	HYDR	NKIN	NPAR	F1	F2	FTEM	HAL
241	109	25.164	.3000	8	7.948E+13	.34264	.32422 4.408E+02		69.10	29.90	8.90	1.40	6.20	12.40	.0
242	REACTIVITY (FROM INVERSE REACTIVITY EQ.): -283.3 PCM														
243	REACTIVITY (FROM EXPLICIT INTEGRATION) : -149.2 PCM														
244	REACTIVITY COMPONENTS : SUM VOID MOD.TEMP. DOPPLER SCRAM (PCM)														
245	-283.3 -943.9 -41.8 504.2 .0														
246	RESIDUAL REACTIVITY (FROM IN HOUR EQS) : 198.2 PCM														
247	NORMALIZED TO INVERSE REACTIVITY : -943.9 -41.8 504.2 .0														

"SHORT" HYDRAULIC PRINTED OUTPUT

Time (s)	T.Power (W)	CW Level (m)	Steam Flow	FW Flow	FW Temp	Core Inlet Subc
251	2.5003E+01	1.5737E+09	-1.4868E+00	1.1834E+03	0.0000E+00	7.8041E+00
252	Pressure	JP Head	Tot Vap Gener	Core Flow	Riser Vap Gen	WLC Vap Upflow
253	7.8669E+06	3.0669E+03	1.2260E+03	5.4397E+03	0.0000E+00	0.0000E+00
254	RP Head	Rec Flow	RP Spd (rpm)	RP Torque	JP diff loss	Rel.C.Undr
255	1.5508E+05	1.9615E+03	5.0453E+02	0.0000E+00	2.2144E-03	1.0347E-03
256	DT (S)	DT1 (S)	DT2 (S)	TRUNC	F(LKRIT)	Y(LKRIT)
257	3.8746E-03	6.1351E-03	1.5498E-02	2.0058E-03		
258	KKRIT	LKRIT	INDLAM	COUNT		
259	1	0	28	1080		
260	Power, W	Flow In	Flow Out	Liq Vel In	Press Drop	Exit Qual
261	1.1485E+07	3.7419E+01	3.5454E+01	8.9538E-01	-4.2351E+04	1.9829E-01
262	9.8511E+06	2.6537E+01	2.4342E+01	8.7325E-01	-4.2519E+04	2.5628E-01
263	2.4551E+06	6.5911E+00	6.0766E+00	8.6746E-01	-4.2381E+04	2.5425E-01
264	4.4036E+06	1.3453E+01	1.2618E+01	8.8516E-01	-4.2317E+04	2.1523E-01
265	5.0079E+06	1.3246E+01	1.2102E+01	8.7159E-01	-4.2547E+04	2.6294E-01
266	1.1123E+07	3.3922E+01	3.1566E+01	8.9297E-01	-4.2503E+04	2.1977E-01
267	1.2468E+07	3.3047E+01	2.9839E+01	8.7503E-01	-4.2644E+04	2.6664E-01
268	2.4965E+07	8.2444E+01	7.7133E+01	9.0432E-01	-4.2499E+04	1.9986E-01
269	7.5864E+06	2.7843E+01	2.6257E+01	9.1623E-01	-4.2469E+04	1.7557E-01
270	1.2678E+07	4.1187E+01	3.8042E+01	9.0349E-01	-4.2564E+04	2.0728E-01
271	2.4151E+07	6.6994E+01	6.0662E+01	8.8169E-01	-4.2641E+04	2.5294E-01
272	1.3722E+07	5.2485E+01	4.9430E+01	9.2096E-01	-4.2480E+04	1.6776E-01
273	5.9871E+06	2.5831E+01	2.6303E+01	4.8566E-01	-4.3566E+04	1.3165E-01
274	1.0871E+07	2.9866E+01	2.7359E+01	8.7861E-01	-4.2550E+04	2.5154E-01
275						7.1399E-01

5. Output Descriptions

281	1.3253E+07	4.8750E+01	4.5955E+01	9.1659E-01	-4.2481E+04	1.7527E-01	6.5253E-01
282	2.9276E+06	1.2769E+01	1.3186E+01	4.8017E-01	-4.3498E+04	1.2679E-01	5.6386E-01
283	2.5093E+06	6.5524E+00	6.0280E+00	8.6236E-01	-4.2404E+04	2.6307E-01	7.2066E-01
284	6.3169E+06	2.8416E+01	2.7443E+01	9.3507E-01	-4.2356E+04	1.3371E-01	5.9972E-01
285	2.6127E+06	6.5819E+00	5.9404E+00	8.6625E-01	-4.2610E+04	2.8161E-01	7.2973E-01
286	1.2893E+06	3.2805E+00	2.9897E+00	8.6349E-01	-4.2506E+04	2.7470E-01	7.2662E-01
287	2.0429E+06	6.8819E+00	6.4818E+00	9.0573E-01	-4.2471E+04	1.9361E-01	6.7068E-01
288	2.6214E+06	6.5810E+00	5.9229E+00	8.6613E-01	-4.2639E+04	2.8379E-01	7.3065E-01
289	2.5211E+06	6.6430E+00	5.9718E+00	8.7429E-01	-4.2669E+04	2.6989E-01	7.2417E-01
290	9.1317E+05	3.6965E+00	3.7675E+00	4.8650E-01	-4.3591E+04	1.4200E-01	5.8830E-01
291	2.9507E+06	5.8949E+01	6.4280E+01	2.5141E-01	-4.3540E+04	1.2079E-02	1.1302E-01
292	0	TRANSIENT OUTPUT OF ISOLATION CONDENSER RESULTS					
293	0	TIME	STEAM	LIQUID	LIQUID	LIQUID	STEAM
294		TIME	PRESSURE	FLOW RATE	FLOW RATE	LEVEL	TEMPERATURE
295		(S)	(PA)	(KG/S)	(KG/S)	(M)	(C)
296	2.50034E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
297	0.00000E+00						
298							
299							

VESSEL MASS AND ENERGY BALANCE

308 *** Peak Clad Temperature = 2.99123E+02 at Channel = 23 and Node = 4
 309 Tot liq mass gain (loss) = -5750.83034321215382
 310 ***** WATER INVENTORY *****
 311
 312 TOTAL MASS ERROR, % = -2.3787 ENERGY=-2.85351910783E+09
 313 VESSEL MASS CONTENT, LIQUID = 1.97751634564E+05 VAPOR = 8.97583963137E+03
 314 VESSEL TOTAL ENERGY CONTENT = 2.00428534993E+10
 315
 316 TOTAL NEUTRONIC HEATING = 7.53713879388E+10
 317 INTEGRATED FEEDWATER, MASS = 4.11694369750E+03 ENERGY=-2.23893757694E+09
 318 INTEGRATED STEAM LOAD, MASS = 3.34049476442E+04 ENERGY= 5.02360777547E+10
 319
 320

COMPONENT	LIQ.MASS	VAPOR.MASS	TOTAL ENERGY
DOWNCMR1	9.00509E+04	1.37363E+03	6.1618070E+09
DOWNCMR2	4.26403E+03	1.85626E+01	2.3059646E+08
L.PLEN1	4.17697E+04	1.76447E+01	1.7634128E+09
L.PLEN2	2.78615E+04	0.00000E+00	4.8940749E+08
CORE	1.96700E+04	5.37128E+02	1.4475269E+09
RISER	1.28996E+04	1.44236E+03	2.5185837E+09
DOM	1.23590E+03	5.58651E+03	7.4315192E+09

327
328

RUN TIME STATISTICS

332
 333 TITLE RECORD - MSIV Closure ATWS Analysis: 1/8 core of a BWR4 (BF1)
 334
 335 DATE - Aug 4 94
 336
 337 TIME - 20:19:49
 338
 339
 340 NEXT NEUTRONIC STEP DATA
 341 STEP TIME ST.Z
 342 772 200.336 .2430
 343
 344
 345 Last Hydraulic Step Data
 346
 347

TIME (S)	QTOT (W)	WLEW (M)	WSL (KG/S)	WFW (KG/S)	TFW (DEGR.C)
2.0009E+02	1.2196E+09	-3.6587E+00	4.3325E+02	3.5972E+02	2.1110E+01

348
349
350

5. Output Descriptions

351	RESTART FILE WRITTEN AFTER LAST	NEUTRNCs STEP	
352			RUN TIME STATISTICS
353			
354			
355			
356		TIME FOR PRESENT CALCULATION =	4584.830
357			
358			
359		TOTAL TIME IN CALCULATION (DYN + NUMINT) =	4552.810
360			
361	HYDRAULICS		
362			
363			
364		TIME IN NUMINT (TIMES INCLUDE RESTART VALUES)=	1363.930
365			
366			
367		TIME IN HYDRAULIC (EXCLUDING STEAM LINE) =	.000
368			
369			
370		TIME IN STEAM LINE =	9.030
371			
372			
373		TIME IN HYDRAULIC OUTPUT(PRINT) =	.000
374			
375	NEUTRONICS		
376			
377			
378		TOTAL TIME IN DYN (TIMES INCLUDE RESTART VALUES)	3188.880
379			
380			
381		TIME PREPARING AND PREDICTING FLUX =	25.590
382			
383			
384		TIME PREDICTING FUEL TEMP(PREDYN)=	228.590
385			
386			
387		TIME IN TFDYN =	1190.340
388			
389			
390		TIME IN XEDYN AND MATDYN =	746.740
391			
392			
393		TIME IN F1DYN =	105.240
394			
395			
396		TIME IN F2DYN =	531.750
397			
398			
399		TIME PREDICTING AND CALCULATING FLUX(PREDYN+F1DYN+F2DYN)=	662.580
400			
401			
402		TIME IN NEUTRONIC OUTPUT(DYNLST) =	.000

PLOT VARIABLES: MAPS AND NAMES**(Description of the plotting program PAD can be found in Appendix C)**

```

1      PLOTFILE SUMMARY
2      TITLE RECORD -      MSIV Closure ATWS Analysis: 1/8 core of a BWR4 (BF1)
3
4      DATE -      Aug 4 94
5
6      TIME -      17:05:46
7
8
9      MESH RECORD 1 - 11 15 24 0.00E+00 1.52E+02 0.00E+00 2.13E+02 0.00E+00 3.65E+02
10     MESH RECORD 2 - 25
11     MESH RECORD 3 - 10
12     MESH RECORD 4 - 24 25
13     MAP RECORD 1 NENDMAP COREMESH      2424      1      3916
14     MAP RECORD 2 KMAXMAP COREMESH      24      1      3796
15     MAP RECORD 3 NPCMAP NPCMESH LENGTH 25
16     MAP RECORD 4 COMPMAP COMPESH LENGTH 10
17     MAP RECORD 5 TH2DMAP TH2D      600      1      600
18     MAP RECORD 6 NP2DMAP COREMESH      101      1      121
19
20     VAR.      NAME      MAP      TSET      NO.ELEMENTS
21     1      DTneut      NONE      ONE      1
22     2      clmltf      NONE      ONE      1
23     3      PowFiss      NONE      ONE      1
24     4      Pow(z)      KMAXMAP      ONE      24
25     5      Tf_aver      NONE      ONE      1
26     6      Tf_max      NONE      ONE      1
27     7      LHOTK      NONE      ONE      1
28     8      LHOTM      NONE      ONE      1
29     9      Hf_max      NONE      ONE      1
30     10     REACT      NONE      ONE      1
31     11     ROTOP      NONE      ONE      1
32     12     ROVP      NONE      ONE      1
33     13     ROTP      NONE      ONE      1
34     14     ROOP      NONE      ONE      1
35     15     ROSP      NONE      ONE      1
36     16     rorp      NONE      ONE      1
37     17     T_liq(z)      KMAXMAP      TWO      24
38     18     Tc_max      NONE      TWO      1
39     19     PCT_node      NONE      TWO      1
40     20     PCT_chan      NONE      TWO      1
41     21     FP_speed      NONE      TWO      1
42     22     PRS_cond      NONE      TWO      1
43     23     H_cond      NONE      TWO      1
44     24     FLOW_ftv      NONE      TWO      1
45     25     SP_ftv      NONE      TWO      1
46     26     PRS_hpt      NONE      TWO      1
47     27     CPR_min      NONE      TWO      1
48     28     LCPRMK      NONE      TWO      1
49     29     POSCPR      NONE      TWO      1
50     30     CHFR_min      NONE      TWO      1
51     31     CHFRMK      NONE      TWO      1
52     32     POSCHF      NONE      TWO      1
53     33     Prs_dome      NONE      TWO      1
54     34     W_cin      NONE      TWO      1
55     35     W_cout      NONE      TWO      1
56     36     W_dcin      NONE      TWO      1
57     37     W_dcout      NONE      TWO      1
58     38     Tliq_IC      NONE      TWO      1
59     39     Wliq_IC      NONE      TWO      1
60     40     Wstm_IC      NONE      TWO      1
61     41     Qual_IC      NONE      TWO      1
62     42     Pres_IC      NONE      TWO      1
63     43     Lev1_IC      NONE      TWO      1
64     44     Heat_IC      NONE      TWO      1
65     45     Cond_IC      NONE      TWO      1
66     46     Vliq_SLC      NONE      TWO      1
67     47     W_boron      NONE      TWO      1
68     48     Pres_SLC      NONE      TWO      1
69     49     Void_SLC      NONE      TWO      1
70     50     Level_SL      NONE      TWO      1

```

5. Output Descriptions

71	51	Heat_DC1	NONE	TWO	1
72	52	Heat_DC2	NONE	TWO	1
73	53	Heat_LP1	NONE	TWO	1
74	54	Heat_LP2	NONE	TWO	1
75	55	Heat_Rsr	NONE	TWO	1
76	56	Air_DC1	NONE	TWO	1
77	57	Air_DC2	NONE	TWO	1
78	58	Air_LP1	NONE	TWO	1
79	59	Air_Dome	NONE	TWO	1
80	60	Air_Tot	NONE	TWO	1
81	61	W_fw	NONE	TWO	1
82	62	T_fw	NONE	TWO	1
83	63	W_sl	NONE	TWO	1
84	64	PSI_tot	NONE	TWO	1
85	65	Void(z)	KMAXMAP	TWO	24
86	66	Void_inc	NONE	TWO	1
87	67	Void_tot	NONE	TWO	1
88	68	Mixt_lev	NONE	TWO	1
89	69	Clps_lev	NONE	TWO	1
90	70	Cori_sub	NONE	TWO	1
91	71	W_recp	NONE	TWO	1
92	72	JP_head	NONE	TWO	1
93	73	Pow_thrm	none	TWO	1
94	74	WIN	NPCMAP	TWO	25
95	75	MOMENT	NPCMAP	TWO	25
96	76	WEX	NPCMAP	TWO	25
97	77	DPJH	NONE	TWO	1
98	78	CNDH	NONE	TWO	1
99	79	Void_bp	NONE	TWO	1
100	80	BORON	NPCMAP	TWO	25
101	81	CBAVE	NONE	TWO	1
102	82	PRMSIV	NONE	TWO	1
103	83	PRM0	NONE	TWO	1
104	84	WRLSF	NONE	TWO	1
105	85	WTRBX	NONE	TWO	1
106	86	PRM2	NONE	TWO	1
107	87	WBYPX	NONE	TWO	1
108	88	PRM3	NONE	TWO	1
109	89	Pow_xyzt	NENDMAP	THREE	2424
110	90	Tf_xyzt	NENDMAP	THREE	2424
111	91	Pow_xyt	NP2DMAP	THREE	101
112	92	Wg_chan	TH2DMAP	THREE	600
113	93	Wl_chan	TH2DMAP	THREE	600
114	94	Void_chn	TH2DMAP	THREE	600
115	95	T_liq	TH2DMAP	THREE	600
116	96	Pow_chn	TH2DMAP	THREE	600
117	97	T_wall	TH2DMAP	THREE	600
118	PLOT HEADING RECORDS WRITTEN				

5.2 Plotting of Scalar and Space-Dependent Variables

5.2.1 Steady-State Calculation

RAMONA-4B does not provide a procedure for plotting of steady-state results. The user is advised to run a short null transient calculation (fraction of a second is sufficient) with the plotting window beginning from time zero (Cards 160000 through 162000). After the plot file is created (file fort.49), procedures similar to those described for the transient calculation in section 5.2.2 can be used.

5.2.2 Transient Calculation

Transient results of the RAMONA-4B calculation are plotted as a function of time. Most parameters of interest in a transient calculation have been included as a plot variable. A complete list of these plot variables are provided in Appendix A.

Since the volume of stored information available for plotting has been significantly increased, a new procedure of controlling the plotting was implemented in which all variables are arranged in two groups: scalar and multi-dimensional (2-D and 3-D) variables.

The first group includes the global system parameters, such as the total reactor power and core thermal power, system pressure, steamline and feedwater flow rates, core average fuel temperature, core average void fraction, and core reactivities. The scalars are plotted at every neutronic time step.

The variables from the second, multi-dimensional group, are also plotted at every neutronic time step during the transient periods (windows) specified by the user (see Section 4.3, Cards 160000 through 162000).

The plotted results of the transient calculation for the sample problem described in Chapter 4, Section 4.4 are given in Appendix B. The BNL plotting program PAD used to produce these plots are described in Appendix C.

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APPENDIX A

DEFINITIONS OF PLOT VARIABLES

APPENDIX A

DEFINITIONS OF PLOT VARIABLES

Variable	Dimension	Description
AIR_DC1	ZERO	Heat Lost to Air from Downcomer 1 (DC1) Surface, (W).
AIR_DC2	ZERO	Heat Lost to Air from Downcomer 2 (DC2) Surface, (W).
AIR_LP1	ZERO	Heat Lost to Air from Lower Plenum 1 (LP1) Surface, (W).
AIR_DOME	ZERO	Heat Lost to Air from Steam Dome Surface, (W).
AIR_TOTAL	ZERO	Total Heat Lost to Air from RPV Surface, (W).
BORON	NPC	Channel Averaged Boron Concentration in the Core, (ppm).
CBAVE	ZERO	Core Averaged Boron Concentration, (ppm).
CBDC1	ZERO	Boron Concentration in 1st Cell of DC1, (ppm).
CBDC2	ZERO	Boron Concentration in 1st Cell of DC2, (ppm).
CBLP1	ZERO	Boron Concentration in 1st Cell of LP1, (ppm).
CBLP2	ZERO	Boron Concentration in 1st Cell of LP2, (ppm).
CBRSI	ZERO	Boron Concentration at Riser Inlet, (ppm).
CBRSE	ZERO	Boron Concentration at Riser Exit, (ppm).
CHFRMK	ZERO	Channel with Minimum CHF Ratio.
CHFR_MIN	ZERO	Minimum CHF Ratio.
CLPS_LEV	ZERO	Collapsed Water Level in Downcomer or Steam Dome, (m).
CNDH	ZERO	Condensation Rate in Downcomer, (kg/s).
COND_IC	ZERO	Rate of Steam Condensation in Isolation Condenser (IC), (kg/s).
CORI_SUB	ZERO	Core Inlet Subcooling, ($^{\circ}$ C).
CPR_MIN	ZERO	Minimum Critical Power Ratio.
DEMAND_E	ZERO	Steam Demand Error From Pressure Regulator.
DPJH	ZERO	Effective Core Pressure Drop, (Pa).
DPSEPER	ZERO	Pressure Drop Across Steam Separator, (Pa).
DTACCU	ZERO	Hydraulic Time Step due to Accuracy Limit, (s).
DTHYDR	ZERO	Accepted Hydraulic Time Step, (s).

Appendix A Definitions of Plot Variables

Variable	Dimension	Description
DTSTAB	ZERO	Hydraulic Time Step due to Stability Limit, (s).
DTNEUT	ZERO	Neutronic Time Step, (s).
EFFLOA	ZERO	Effective L/A Ratio of Steam Separator, (m^{-1}).
FLOW_FTV	ZERO	Mass Flow Rate at Feedwater Turbine Valve, (kg/s).
FLOW_HTR	ZERO	Mass Flow Rate at Feedwater Heater Valve, (kg/s).
FLOW_LPT	ZERO	Mass Flow Rate at Exit of Low Pressure Turbine, (kg/s).
FLOW_TSV	ZERO	Mass Flow Rate at Exit of Turbine Stop Valve, (kg/s).
FP_SPEED	ZERO	Feedwater Pump Speed, (rpm).
GAMI_WET	ZERO	Vapor Generation Rate at Pool surface of Wetwell, (kg/s).
GAMV_DRY	ZERO	Vapor Generation Rate in Drywell of Containment, (kg/s).
GAMV_WET	ZERO	Vapor Generation Rate in Wetwell of Containment, (kg/s).
H_COND	ZERO	Mixture Enthalpy in the Condenser of BOP, (kJ/kg).
HEAT_DC1	ZERO	Heat Transfer with DC1 Fluid, (W).
HEAT_DC2	ZERO	Heat Transfer with DC2 Fluid, (W).
HEAT_IC	ZERO	Heat Transfer in Isolation Condenser (IC), (W).
HEAT_LP1	ZERO	Heat Transfer with LP1 Fluid, (W).
HEAT_LP2	ZERO	Heat Transfer with LP2 Fluid, (W).
HEAT_RSR	ZERO	Heat Transfer with Riser Fluid, (W).
HF_MAX	ZERO	Maximum Fuel Enthalpy, (J/kg).
HL_PSP	ZERO	Liquid Enthalpy in Pressure Suppression Pool (PSP), (kJ/kg), as Predicted by Simple Model for PSP.
HUM_DRYW	ZERO	Relative Humidity in the Drywell of Containment.
HUM_WETW	ZERO	Relative Humidity in the Wetwell of Containment.
JP_HEAD	ZERO	Jet Pump Pressure Head, (Pa).
LCPRMK	ZERO	Axial Node with Minimum CPR.
LEVL_IC	ZERO	Liquid Level in the IC Relative to IC Return, (m).
LEVEL_SLC	ZERO	Level of Boron Solution in the SLCS Tank, (m).
LHOTK	ZERO	Channel with Maximum Fuel Temperature.
LHOTN	ZERO	Axial Node with Maximum Fuel Temperature.
MAXEIGEN	ZERO	Maximum Eigenvalue of Hydraulic Jacobian Matrix for Stability Limit.

Variable	Dimension	Description
MGC1_DRY	ZERO	Total Mass of Gas Mixture in the Drywell of Containment, (kg).
MGC2_WET	ZERO	Total Mass of Gas Mixture in the Wetwell of Containment, (kg).
MIXT_LEV	ZERO	Mixture Level in Downcomer or Steam Dome, (m).
MOMENT	NPC	Loop Momenta for Channels, (kg-m/s).
MUG1_DRY	ZERO	Total Internal Energy of Gas Mixture in Drywell of Containment, (J).
MUG2_WET	ZERO	Total Internal Energy of Gas Mixture in Wetwell of Containment, (J).
MVC1_DRY	ZERO	Total Vapor Mass in the Drywell of Containment, (kg).
MVC2_WET	ZERO	Total Vapor Mass in the Wetwell of Containment, (kg).
PCT_NODE	ZERO	Location of Peak Clad Temperature (PCT) in Hot Channel.
PCT_CHAN	ZERO	Hot Channel Location for PCT.
PG_DRYWL	ZERO	Partial Gas Pressure in the Drywell of Containment, (Pa).
PG_WETWL	ZERO	Partial Gas Pressure in the Wetwell of Containment, (Pa).
POSCHF	ZERO	Axial Node with Minimum CHF Ratio, CHFRMN.
POSCPR	ZERO	Axial Node with Minimum CPR.
POW(Z)	KMAX	Core Average 1-D Power Distribution.
POWER_EL	ZERO	Electrical Power Produced by Turbines, (W).
POWFISS	ZERO	Relative Core Fission Power.
POW_CHN	NPC·KMAX	Thermal Power in Thermal Hydraulic Channels, (W).
POW_THRM	ZERO	Total Core Thermal Power, (W).
POW_XYT	KAN	Neutronic Channel Relative Fission Power.
POW_XYZT	KAN·KMAX	Neutronic Nodal Relative Fission Power.
PRES_IC	ZERO	Pressure Within Isolation Condenser (IC), (Pa).
PRES_SLC	ZERO	Pressure in the SLCS Accumulator, (Pa).
PRS_COND	ZERO	Pressure in the Condenser of BOP, (Pa).
PRS_DOME	ZERO	Steam Dome Pressure, (Pa).
PRS_HPT	ZERO	Pressure Downstream of High Pressure Turbine, (Pa).
PRS_TCV	ZERO	Pressure Downstream of Turbine Control Valve, (Pa).
PRM0	ZERO	Pressure at the Safety/Relief Valve Location, (Pa).
PRM2	ZERO	Pressure at the Turbine Stop Valve Location, (Pa).

Appendix A Definitions of Plot Variables

Variable	Dimension	Description
PRM3	ZERO	Pressure at the Bypass Valve Location, (Pa).
PRMSIV	ZERO	Pressure at the MSIV Location, (Pa).
PR_POOL	ZERO	Suppression Pool Pressure, (Pa), by Mechanistic Containment Model.
PSIR(Z)	NSEC(6)	Vapor Generation Rate Distribution in the riser, (kg/s).
PSI_TOT	ZERO	Total Vapor Generation Rate in the Reactor Pressure Vessel, (kg/s).
PST2_WET	ZERO	Saturation Pressure Corresponding to Wetwell Gas Temperature, (Pa).
PV_DRYWL	ZERO	Partial Pressure of Vapor in the Drywell of Containment, (Pa).
PV_WETWL	ZERO	Partial Pressure of Vapor in the Wetwell of Containment, (Pa).
QUAL_IC	ZERO	Steam Quality Inside the Isolation Condenser (IC).
REACT	ZERO	Total Reactivity from the Inverse In-Hour Equation, (pcm).
RKRISER	ZERO	Riser Inlet Form Loss Coefficient by Mechanistic Separator Model.
RL_CST	ZERO	Condensate Storage Tank Liquid Level, (m).
RL_POOL	ZERO	Suppression Pool Liquid Level, (m).
RL_SUMP	ZERO	Drywell Sump Liquid Level, (m).
RM_PSP	ZERO	Total Liquid Mass in the Pressure Suppression Pool by the Simple Containment Model, (kg).
RODP	ZERO	Doppler Reactivity from Perturbation Theory, (pcm).
RORP	ZERO	Residual Reactivity from Perturbation Theory, (pcm).
ROSP	ZERO	Scram or Control Rods Reactivity from Perturbation Theory, (pcm).
ROTOP	ZERO	Sum of the Reactivity Components from Perturbation Theory, (pcm).
ROTP	ZERO	Moderator Temperature Reactivity from Perturbation Theory, (pcm).
ROVP	ZERO	Void Reactivity from Perturbation Theory, (pcm).
SCOOP_TU	ZERO	Scoop Tube Position of the Motor/Generator Set.
SPEED_DR	ZERO	Rotational Speed of Drive Motor of the Motor/Generator Set, (rad/s).
SPEED_GE	ZERO	Rotational Speed of Generator of the Motor/Generator set, (rad/s).
SPEED_RC	ZERO	Recirculation Pump Speed, (rad/s).
SP_FTV	ZERO	Stem Position of Feedwater Turbine Valve (cm).
SW_CST	ZERO	Mass Flow Rate of Condensate Storage Tank, (kg/s).
SW_LPCI	ZERO	Mass Flow Rate of the LPCI System, (kg/s).
SW_RHR	ZERO	Mass Flow Rate of the Residual Heat Removal System, (kg/s).

Variable	Dimension	Description
TC_MAX	ZERO	Peak Clad Temperature in Hot Channel, (°C).
TEMP_HTI	ZERO	Feedwater Temperature at Heater Inlet, (°C).
TF_AVER	ZERO	Core Average Fuel Temperature, (°C).
TF_MAX	ZERO	Core Maximum Fuel Temperature, (°C).
TF_XYZT	KAN·KMAX	Nodal Fuel Temperature, (°C).
T_FW	ZERO	Feedwater Temperature, (°C).
TG_DRYWL	ZERO	Gas Temperature in the Drywell Gas Space, (°C).
TG_WETWL	ZERO	Gas Temperature in the Wetwell Gas Space, (°C).
TIC1_DRY	ZERO	Gas/Liquid Film Interface Temperature in the Drywell Gas Space, (°C).
TIC2_WET	ZERO	Gas/Liquid Film Interface Temperature in the Wetwell Gas Space, (°C).
T_LIQ	NPC·KMAX	Nodal Liquid (coolant) Temperature, (°C).
T_LIQ(Z)	KMAX	Plane-Averaged Liquid Temperature in the Core, (°C).
TLIQ_IC	ZERO	Condensate Temperature from IC, (°C).
TL_DC1I	ZERO	Liquid Temperature at DC1 Inlet, (°C).
TL_DC1E	ZERO	Liquid Temperature at DC1 Exit, (°C).
TL_DC2I	ZERO	Liquid Temperature at DC2 Inlet, (°C).
TL_DC2E	ZERO	Liquid Temperature at DC2 Exit, (°C).
TL_LP1I	ZERO	Liquid Temperature at LP1 Inlet, (°C).
TL_LP1E	ZERO	Liquid Temperature at LP1 Exit, (°C).
TL_LP2I	ZERO	Liquid Temperature at Lp2 Inlet, (°C).
TL_LP2E	ZERO	Liquid Temperature at LP2 Exit, (°C).
TL_RSRI	ZERO	Liquid Temperature at Riser Inlet, (°C).
TL_RSRE	ZERO	Liquid Temperature at Riser Exit, (°C).
TL_POOL	ZERO	Suppression Pool Temperature by the Mechanistic Containment Model, (°C).
TL_PSP	ZERO	Suppression Pool Temperature by the Simple Model, (°C).
TORQ_COP	ZERO	Fluid Coupler Torque of the Motor/Generator Set, (Nm).
T_SAT	ZERO	Saturation Temperature Corresponding to the System Pressure, (°C).
T_WALL	NPC·MAX	Hydraulic Channel-Averaged Wall Temperature, (°C).
TWALL_IC	ZERO	Tube Wall Temperature on IC, (°K).

Appendix A Definitions of Plot Variables

Variable	Dimension	Description
VLIQ_SLC	ZERO	Liquid Velocity from SLCS, (m/s).
VOID(Z)	KMAX	Plane-Averaged Core Void Fraction.
VOID_BP	ZERO	Channel-Averaged Void Fraction in the Bypass Channel.
VOID_CHN	NPC-KMAX	Void Fraction Distribution in the Core Thermal Hydraulic Channels.
VOID_INC	ZERO	In-Channel Core Void Fraction.
VOIDR(Z)	NSEC(6)	Void Fraction Distribution in the Riser.
VOID_SLC	ZERO	Void Fraction in the SLCS Accumulator.
VOID_TOT	ZERO	Total Core Void Fraction (Including Bypass Channel).
WBYPX	ZERO	Bypass Valve Steam Flow Rate, (kg/s).
W_BORON	ZERO	Mass Flow Rate of Boron Solution (kg/s).
WC12_WET	ZERO	Total Mass Flow Rate from Drywell to Wetwell, (kg/s).
WC21_DRY	ZERO	Total Mass Flow Rate from Wetwell to Drywell, (kg/s).
WEX	NPC	Channel Exit Total Mass Flow Rate, (kg/s).
WG_CHAN	NPC-KMAX	Channel Steam Mass Flow Rate, (kg/s).
WIN	NPC(NCC)	Channel Entrance Total Mass Flow Rate, (kg/s).
WL_CHAN	NPC-KMAX	Channel Liquid Mass Flow Rate, (kg/s).
WLIQ_IC	ZERO	Condensate Flow Rate from IC, (kg/s).
WRLSF	ZERO	Safety/Relief Valve Steam Flow Rate, (kg/s).
WSTM_IC	ZERO	Steam Flow Rate from IC, (kg/s).
WTRBX	ZERO	Turbine Control/Stop Valve Steam Flow Rate, (kg/s).
W_CIN	ZERO	Total In-Channel Mass Flow Rate at the Core Inlet, (kg/s).
W_COUT	ZERO	Total In-Channel Mass Flow Rate at the Core Outlet, (kg/s).
W_DCIN	ZERO	Downcomer 1 Inlet Mass Flow Rate, (kg/s).
W_DCOUT	ZERO	Downcomer 2 Outlet Mass Flow Rate, (kg/s).
W_FW	ZERO	Feedwater Mass Flow Rate, (kg/s).
W_HCI	ZERO	Mass Flow Rate of the HPCI System, (kg/s).
W_RECP	ZERO	Total Recirculation Loops Mass Flow Rate, (kg/s).
W_SL	ZERO	Total Steamline Mass Flow Rate, (kg/s).
XVC2_WET	ZERO	Vapor Mass Fraction in the Wetwell of Containment.

APPENDIX B

PLOTTED RESULTS FOR SAMPLE PROBLEM

APPENDIX B

PLOTTED RESULTS FOR SAMPLE PROBLEM

Plotted results corresponding to the sample input deck as described in Section 4.4 are presented here. Only selected transient plots from the MSIV closure ATWS simulation are shown here to serve as a guide for the user in Figures B.1 through B.12. More plotted results for a recirculation pump trip event simulation are presented in Chapter 6, Section .7 for balance of plant (BOP).

Figure B.1 System Pressure Response During the MSIV Closure ATWS Event

Figure B.2 Reactor Power Response During the MSIV Closure ATWS Event

Figure B.3 Feedwater Flow Response During the MSIV Closure ATWS Event

Figure B.4 Downcomer Collapsed Level Response During the MSIV Closure ATWS Event

Figure B.5 Total Core Inlet Flow Response During the MSIV Closure ATWS Event

Figure B.6 Core Inlet Flow Response of Individual Channels During the MSIV Closure ATWS Event

Appendix B Plotted Results for Sample Problem

Figure B.7 Core Exit Flow Response of Individual Channels During the MSIV Closure ATWS Event

Figure B.8 Core Average Void Response During the MSIV Closure ATWS Event

Figure B.9 Total Vapor Generation Rate Response During the MSIV Closure ATWS Event

Figure B.10 Fuel Temperature Responses During the MSIV Closure ATWS Event

Appendix B Plotted Results for Sample Problem

Figure B.11 Various Reactivity Behavior During the MSIV Closure ATWS Event

**Figure B.12 Suppression Pool Temperature Response During the MSIV Closure ATWS Event
Predicted by the New Mechanistic Containment Model**

**Figure B.13 Suppression Pool Level Response During the MSIV Closure ATWS Event
(Reference zero at midplane of the wetwell torus)**

Figure B.14 Wetwell and Drywell Pressure responses During the MSIV Closure ATWS Event

Appendix B Plotted Results for Sample Problem

Figure B.15 Wetwell and Drywell Gas Temperature Responses During the MSIV Closure ATWS Event

Figure B.16 Drywell Relative Humidity Response During the MSIV Closure ATWS Event

Figure B.17 Wetwell Relative Humidity Response During the MSIV Closure ATWS Event

APPENDIX C

PAD:

**A PROGRAM TO RETRIEVE, PROCESS, AND DISPLAY
SPACE AND TIME DEPENDENT VARIABLES**

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APPENDIX C

PAD: A PROGRAM TO RETRIEVE, PROCESS, AND DISPLAY SPACE AND TIME DEPENDENT VARIABLES

C.1 INTRODUCTION

PAD is a versatile and flexible program to retrieve, process and display array functions of the form $F(X, Y, Z; T)$. It is normally executed in a "post-processor" mode to operate on plot files generated by other codes. The semi-colon in the notation $F(X, Y, Z; T)$ refers to the method of data storage used by PAD. All the values of F for the same T -value are present in memory simultaneously. An array function is an array of real values. Each element of the array is associated with a point (X, Y, Z) belonging to a subset of a spatial mesh. The spatial mesh consists of all possible points (X, Y, Z) where X is chosen from an array of increasing real values, and Y , and Z , likewise. Similarly, T is an element of an array of increasing values.

The following points are relevant to the use of PAD. The details are discussed in later sections.

A data file must be generated for input to PAD. This data file is self-contained in the sense that all the information needed to describe the data is built into the data file. By reading the data file and without any input from the user except for an array identifying name, PAD is able to know where the array is stored, over what mesh the array is defined, and the coordinates of every point in the array. More than one data file may be used as input to PAD on the same run, and although the data files may have been generated from different programs or from different runs of the same program, it is possible for PAD to generate overplots to compare the arrays from one data file with the arrays from another.

PAD provides a systematic approach to generating plots for different applications. Any program that generates a PAD conforming data file may use the resources in PAD to manipulate and plot data arrays. In many applications the mesh description is suitable for more than one array function, so there is little modification needed to add additional arrays to the data file.

When the data arrays involve too many coordinate dimensions for plotting the arrays, PAD may be used to reduce the number of dimensions. For instance, the array function $F(X, Y, Z; T)$ has too many dimensions for conventional types of plotting. By fixing one or more of the coordinates or averaging the data along one or more of the coordinate axes, the amount of data and the number of dimensions may be reduced. In the process of reducing the data one may rescale and or translate along any of the axes.

PAD has provision for plotting an array function of one coordinate (2D plot), or an array function of two coordinates (3D plot). It may be necessary to first reduce the data dependence to one or two coordinates, as described above, before plotting. There are currently two plot routines available (one for 2D and one for 3D) but the number of routines may be increased as the need arises. The plot routines communicate with PAD by a few subroutine calls of no great complexity; necessary changes to PAD consist of adding one more lines of code to call each new plot subroutine.

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PAD is controlled by the user through a set of commands. These include a command to open a data file, a command to define a new array, a command to plot an array, and several commands of a control nature. Each command provides a number of options, most of which default to reasonable choices.

PAD is coded in FORTRAN 77. It requires a graphic package. On the IBM-RISC-6000 workstations at BNL, the graphic package used is DISSPLA, a proprietary software product of Computer Associates. On the SUN-SPARC-10 workstations at BNL, the graphic package used is NASADIG a non-commercial equivalent of DISSPLA developed by NASA.

Summary of Pad Features

1. Processes arrays of the general form $F(X, Y, Z; T)$
2. Uses a self-contained data file with sufficient information to completely describe all data arrays. Commands refer to data arrays by name only.
3. Organizes 2D and 3D plots into consecutive frames.
4. Allows more than one spatial mesh (X, Y, Z), and more than one T-mesh.
5. Permits more than one array to be plotted on the same frame.
6. Allows optional user specification of plot heading, axes and legend labels.
7. Allows new arrays to be defined from existing arrays by:
 - a. Weighted averaging.
 - b. Fixing or limiting the range of coordinates.
 - c. Linear transformation of data.
 - d. Any combination of the above.
8. Provides log or linear axes scaling.
9. Allows more than one data file to be processed for the same run, and allows plots from different data files to appear on the same frame.
10. Provides error diagnostics.

C.2 GENERAL DESCRIPTION

C.2.1 Data Arrays

PAD is concerned with the processing and plotting of data arrays that are functionally dependent upon spatial coordinates denoted by X, Y, Z and a non-spatial coordinate T. If F denotes the data array then we write $F(X, Y, Z; T)$ to represent the functional dependence. The semi-colon refers to the method of storage. In particular F is an array function; that is, a discrete set of values that are stored on the PAD data file in such a manner that all the values of F corresponding to one value of T are stored in one record of the file. Another feature of F is that the set of spatial points (X, Y, Z) over which F is defined is independent of T. The constant number of data values written to the data file for each T-value is the dimension of F. To emphasize this relationship we sometimes drop the T from the function notation and refer to $F(X, Y, Z)$ at time T; it being understood that this means $F(X, Y, Z; T)$.

C.2.2 Spatial Mesh

The question arises as to how the spatial points are specified and how the values for F are associated with the spatial coordinates. In PAD we define a mesh consisting of 3 coordinate arrays for X, Y, and Z that define the set of all possible spatial points, and an array may be defined over any subset of the mesh. The null subset is allowed in which case F is independent of the spatial mesh and has dimension one, being a function of T, only. If the subset consists of the points along the X-axis then F is of the form $F(X)$ and the dimension of F cannot exceed the dimension of the X-array. F need not have the dimension of X because F may not be defined for every possible value of X. In similar manner we may have $F(X, Y)$ as well as (X, Y, Z), the notation being only suggestive of the spatial dependence; the actual dependence is specified within the PAD data file.

C.2.3 Pad Input Files

Although data arrays are of primary concern to the user of PAD, it should be emphasized that a PAD user may not know nor care to know the structure of the data file. Provided that someone familiar with the details creates the PAD data file it is possible for other users, without knowledge of how the data are described and stored on the data file, to use the command statements to control what plots are produced and to define new arrays from existing arrays.

There are two phases to using PAD. In the first phase someone familiar with both the data and the PAD data file structure creates the PAD data file. For example, an existing application program contains a number of data arrays of the form $F(X, Y, Z; T)$ for which it is desired to produce plots. All such arrays are stored in the proper form at D-5 on the PAD data file. In the second phase PAD is executed using two files: (1) the PAD data file, and (2) an input file of commands to control what actions are performed by PAD.

C.2.4 Using the Command Statements

A user of PAD directs the program using a set of Command statements to 1) read a data file, 2) define new data arrays, and 3) produce plots. These three actions are performed using the READ command, DEF command and the PLOT

command, respectively. Additional commands exist, but for now these are the main ones we will be concerned with using. The READ command opens a data file; only one data file can be open at a time. A subsequent READ closes the current file and opens a new data file. While a file is open all the arrays, etc., for that file are available for use by PAD. The command cards that follow the READ command may make reference to any array on the open data file, but may not reference an array on any other data file whether previously open or not. Using the DEF command the user may define new arrays from existing arrays. Existing arrays are arrays on the open data file, or data arrays defined since the current data file was opened.

The commands are executed in consecutive order, assigning the space for new arrays as they are defined. The memory size of the computer may restrict the number of new arrays that can be created; however, the user may make more than one pass through the data file by using more than one READ command for the same file. Each READ frees the space used by the arrays defined on the previous READ, and no further reference may be made to these arrays.

Plots are created using the PLOT command, which defines a reference to a routine to produce the plot; but the routine will not be executed until after all the command statements have been checked and all data files have been read.

C.2.5 Frames and Plots

When a PLOT command is encountered, PAD assigns the plot to a FRAME. A frame is the abstraction of the final picture. For simplicity we may think in terms of the frames on a 35 mm roll of film, although no assumption should be made at this stage as to what device is to be used for the final plots. The frames are numbered consecutively starting with 1. The first PLOT command in the command deck is associated with the first frame; and each succeeding PLOT command is automatically assigned to the next consecutive numbered frame unless the user specifies that the data arrays be plotted on a previous frame.

There are various attributes of a frame that may be specified by the user; otherwise, PAD will assign them by default. For example, each frame has 1) a 3-line heading, 2) axes labels, 3) legend labels, 4) line style used in drawing curves, etc. The axes limits will be chosen automatically to allow the entire curve to be plotted. We view the data through D-6 a window that is just large enough to show the entire array. When more than one array is plotted on the same frame then the window is adjusted to encompass all arrays assigned to the frame. However, this attribute may be overridden, giving the user control of the axes limits.

The END command is the last command statement. At this point PAD makes a loop through each frame to execute the appropriate plot routine assigned to each frame. All of the attributes and data that have been declared for a frame are used to produce the final plot. Currently, there are two plot routines, one for 2D and one for a very simple type of 3D plot. The mechanism exists for increasing the number of plot routines so additional plot routines may be coded as needed.

In plotting a curve or surface we need to differentiate between the coordinates used to represent the data on the frame and the coordinates X, Y, Z, and T of the application. PAD uses the convention that the frame coordinates are X1, X2 for a 2D plot and X1, X2, X3 for a 3D plot. The orientation of the axes on the frame is determined by the plot routine used to produce the plot. To plot a function such as $F(T)$ one must assign one of the coordinates to the X1-axis and the other coordinate to the X2-axis. PAD uses the convention that the X1-axis is horizontal and is used for the independent variable T. The vertical axis X2 is reserved for the dependent variable.

For 3D plots we reserve both X1 and X2 for the independent coordinates, and X3 for the dependent coordinate. The one 3D plot routine currently available draws a set of horizontal and vertical boxes which contain the printed values for X3. Again X1 is displayed as the horizontal axis and X2 as the vertical.

C.2.6 Brief Description of Pad Data File

The PAD data file contains two parts. The first part consists of the descriptive records which contain all the information necessary to describe the data arrays contained in the second part. The descriptive records allow the PAD program to interpret user requests to process or plot any data array. The descriptive records are complete enough for PAD to know where every array is stored on the data file and how it relates to the spatial coordinates. Data arrays and coordinate arrays all have their own unique names; we have so far referred to the coordinates by the names X, Y, Z, and T but the actual names are stored as a part of the data description, so that in use what we have called "X" may optionally have any name the user wishes to assign to it. Similarly, the reference to data arrays as "F" is for convenience of this write-up; the actual names of each array are built into the descriptive records. On the command statements one refers to an array by its name which is all that PAD needs to determine its location on the data file.

Data arrays need not be defined over the same spatial mesh, nor over the same T- mesh. Two arrays defined for different mesh may still appear on the same frame, a common coordinate system will be used for both. It is the user's responsibility to know D-7 whether the result is physically meaningful. The coordinates that PAD uses are pure numbers, there are no physical units of dimension associated with the data.

In summary, the PAD data file contains all the data arrays and a complete description of the mesh geometry so that a user need only refer to the array name to enable PAD to process the array.

C.3 COMMAND STATEMENTS

C.3.1 General Form

A command statement has the general form

KEYWORD KEY = list,...

where the ellipses (...) indicate that the statement may contain more than one KEY = list combination. KEYWORD is a symbol that identifies the command statement. KEY is an option symbol, and list is a set of associated parameters. A parameter item may be a symbol, integer, real, character string, special character, or an arithmetic expression, depending upon the key used.

For example,

DEF ALPHA = BETA, X, T = 2, 100

In this example the KEYWORD is DEF. The KEYS are ALPHA, X, and T. BETA is a parameter associated with ALPHA. X has no parameters, and T has the integer parameters 2 and 100.

C.3.2 Items and Separators

Essentially, a command statement has the format

ITEM SEPARATOR...

repeated until end of statement. A SEPARATOR may be blank, equal sign, comma, asterisk, slash, plus sign, minus sign, or colon. There are 4 types of items with which we are concerned: SYMBOL, INTEGER, REAL, and CHARACTER STRING. A brief description of these follows:

TYPE	DESCRIPTION
SYMBOL	1-8 characters beginning with a letter. Contains only letters and/or digits. Used as KEYWORD, KEY, or NAME.
INTEGER	1-8 decimal digits and obeys the rules for a Fortran Integer.
REAL	1-15 characters contains a decimal point and/or the letter E-to D-9 to distinguish it from an integer, and obeys the rules for a Fortran real.
CHARACTER	One or more characters enclosed in double quotes. The number of STRING characters may be restricted by its usage (refer to the command descriptions for such restrictions.) The quotes denote the start and finish for the character string, but are not part of the character string.

C.3.3 General Rules for Command Statements

These general rules must be followed in constructing a command statement.

1. Command statements are in the form of 80 character records. The first item of the statement is the KEYWORD and may begin on the first or subsequent column of the card, followed by one or more blanks that precede the first KEY, if any, and its associated parameter list. Unless otherwise noted the order of the KEYS is not significant. The command statement may be contained entirely on one card, or it may be continued from one card to the next.
2. Blanks are never embedded within a symbol, integer, or real item since blanks as well as commas may be used to separate items. Between items blanks may be freely used to make a statement more readable. The equal sign and comma may be preceded and followed by blanks, as may any character used as a separator.
3. When a colon (:) appearing on a statement is not part of a character string the information that follows the colon is treated as comment only. The colon is considered to be a logical end-of-card. The entire card image is printed on the user's output listing, but the information following the colon is ignored by the program. The colon is optional. When the colon does not appear the logical end-of-card follows column 80. If the colon is the first non-blank character, the card contains only comments.
4. When a comma (not part of a character string) is the last non-blank character preceding the logical end-of-card the statement is continued onto the next card. Conversely, when the last non-blank character is not a comma, the statement is not continued onto the next card. It follows that an item may not be continued from one card onto the next; in particular a character string must be contained entirely on one card.
5. The dollar sign (\$) is used as a prefix for a symbol. When so used the dollar sign may not be separated from the symbol by blanks.
6. The arithmetic signs (+, -, *, /) are sometimes used in conjunction with symbols and numbers to denote an arithmetic expression; in which case blanks may be freely interspersed to make the statement more readable.
7. Blank cards are printed but otherwise ignored by PAD.
8. The first character of an item determines the type of item; i.e., symbol, integer, real or character string.
9. In a parameter list a null item is indicated by two successive commas, or by an asterisk.

C.3.4 Example

The following example illustrates one possible set of command statements to produce one plot frame. The KEYWORDS used are READ, DEF, PLOT and END. Although the command statements used have not yet been introduced it should be clear from the example that a plot like the one that follows the example is expected. The READ command is mandatory; it defines the data file. The DEF command is used to define a new array from an already existing array. The PLOT command requests the plot of the array defined by the DEF command. The END command indicates the end of the commands.

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READ MEKIN

DEF AX = AXPOW, Z, T = 1

END

The data file is defined by the logical names (IBM ddnames) MEKIN1, MEKIN2, ETC. Existing on the data file there is an array function AXPOW(Z,T) used to define the new array AX(Z)=AXPOW(Z,T₁). That is, AX is a "slice" of the array AXPOW for the first time step T. Headings, Labels, etc. appearing on the plot are the defaults chosen by PAD as described for the PLOT command.

The use of the special keys X1 and X2 is a way of describing to PAD the horizontal and vertical axes, respectively. Any one of the coordinate names for X, Y, Z or T may be assigned to the X1-axis. For a 2D plot the data array name must be assigned to the X2-axis. Similarly, for a 3D plot X1 and X2 are reserved keys for the coordinates X, Y, Z, T; and X3 is used for the data array name.

TEST CASE FOR PLOT FILE PWR 1/4 CORE

02/03/82

FRAME 1

C.4 COMMAND STATEMENT LISTING

In the following description of the command statements which are listed in alphabetical order it is suggested that one first read the description of the READ command and then the PLOT, DEF and END commands. With the aid of Example 3.4 this should be enough to get one started. Most of the KEYS are optional so it is not necessary to be overly concerned with the details of every option.

Capitalized items are the keys or keywords, and must be typed exactly as written. Non-capitalized items represent options that the user must supply.

C.4.1 BEGIN Command

This is an optional command to define the maximum permitted table sizes and hence the allocation of memory. When this command appears it should precede the first READ command. Once the first data file has been opened it is too late to change the maximum table sizes. Memory is also required for arrays, etc., so table sizes should not be increased unnecessarily.

The command may contain one or more keys in any order.

Format of the command is

BEGIN KEY = value

KEY	DEFAULT	DESCRIPTION
MAXFRM	40	Maximum number of frames
MAXPLT	50	Maximum number of arrays to plot
MAXTIM	1000	Maximum number of T-steps
MAXDEF	40	Maximum number of DEF commands
MAXBUF	10000	Maximum data file buffer size

EXAMPLE. A problem requires 2000 T-steps, but needs only 1000 words for the data file buffer. The following statement is the first command.

BEGIN MAXTIM=2000, MAXBUF=1000

C.4.2 DEF Command

The DEF command provides a means for defining new arrays from previously defined arrays. Currently, this command allows for the following transformations.

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1. Make a slice of the old data array through one of the coordinate axes.
2. Perform a linear transformation of the old data array.
3. Restrict the range of the coordinates.
4. Take an average of the data array along one or more of the coordinate axes.
5. Any combination of the above.

Format of the command is:

```
DEF new = old*s1+s2, $name 1 = 11, u1,  
$name2 = 12, u2,  
$name3 = 13, u3,  
$name4 = 14, u4
```

ITEM	TYPE	DESCRIPTION
new	symbol	Name of a new array defined by this command. Must be first item following DEF.
old	symbol	Name of an existing data array.
s1,s2	real	Optional values to linearly transform old into new. The * may be replaced by / for division. The + may be replaced by - for subtraction.
\$namek	symbol	Names of independent coordinates, in any order. The \$ is optional and when present immediately precedes the name. When \$ is used new is defined as the average of old over all values of the coordinate. When \$ is not present new is defined for each value of the coordinate.
lk,uk	real integer	Optional limits. When \$ is present the average is over all values of coordinate between lk and uk. When \$ is not present, a new array is defined for value of the coordinate between lk and uk, inclusive. When uk does not appear but lk does appear uk=lk; that is, new is a "slice" of old obtained by fixing the coordinate value. In this case \$ is not needed. When lk is an asterisk (*) lk defaults to 1, and when uk is an asterisk uk defaults to the last mesh index for the coordinate array namek. The expression=lk,uk is optional. The default is to use the whole array namek. The distinction between real lk (or uk) and integer lk (or uk) is significant. A real value refers to the value of namek, and an integer refers to the index of namek. Thus, x-3. (decimal point means real) implies the coordinate x is fixed at 3., while x=3 (no decimal point means integer) implies x is fixed at the value x(3).

C.4.2.1 Examples of DEF Command

EXAMPLE 1. To define TP1 (T) from the array TEMP(X, Y; T) by taking the average over X for a given Y-value of 12.

DEF TP1 = TEMP, \$X, Y = 12., T

EXAMPLE 2. Same as the last example but restrict the average to the range X(2) to X (30).

DEF TP2 = TEMP, \$X = 2, 30, Y = 12., T

EXAMPLE 3. If in the last example X (2)=10. and X(30)=15. then an equivalent definition would be as follows

DEF TP3 = TEMP, \$X = 10., 15., Y= 12., T

In this case PAD computes the indices 2 and 30 from the X-values 10. and 15. Round-off errors could make a difference in the results, although PAD rounds up as well as down.

EXAMPLE 4. Suppose we want to set only the lower bound in the preceding example, and average over the remaining values of X.

DEF TP4 = TEMP, \$X = 10., *, Y = 12., T

EXAMPLE 5. Now let's average over all X and Y. Compare this with the first example which fixed the value of Y.

DEF TP5 = TEMP, \$X = \$Y, T

EXAMPLE 6. If in the first example TEMP is in degrees Celsius and one wants TP6 in degrees Fahrenheit then use the following

DEF TP6 = TEMP \$ 1.8 + 32., \$X, Y=12., T

NOTE 1. In the preceding examples the T appearing by itself on the right-hand side is not required, but is included only as a reminder to the reader that TEMP, and hence TP, is a function of T.

NOTE 2. \$T is not available when T is the non-spatial coordinate.

NOTE 3. In these examples as in most examples, in this manual we use the spatial coordinate names X, Y, Z; and we use T for the non-spatial coordinate. The user whose application requires different names may assign them when the PAD data file is created.

C.4.2.2 Weighted Averages

Consider the following DEF command:

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DEF G = F, \$X = 3, 30, T

when the array F is associated with a weight array W. For this example suppose the X-mesh has 31 values: $X_1, X_2, \dots, X_{31}$. The DEF command defines the array G as a weighted average of F over the X-values from X_3 to X_{30} . That is

$$G(T) = \text{SUM} [W_k * F(X_k, T)] / \text{SUM } W_k,$$

where SUM means the summation from $k = 3$ to 30.

Note the following:

1. F is assumed to be a function of the spatial coordinate X and the non-spatial coordinate T.
2. The weight array W is defined on the data file, and is only used when a new array is defined using the DEF command. The new array has its own weight array. G in the example above has weight W_g where $W_g = \text{SUM } W_k$.
3. The length of the W array is the same as the length of F; both W and F are defined over the same spatial coordinates. Although the values of F change with T the weights are dependent only upon the spatial coordinates.
4. The limits imposed by $\$X=3,30$ refer to the index of the X-array. This is to be contrasted with the expression $\$X=3., 30.$ which implies that the summation is restricted to the values of X between 3 and 30.
5. When the weights are all unity the value computed for G(T) is the same as if F were an unweighted data array. G(T) is then the arithmetic average of the F array.
6. The weight array is not used by the PLOT command. An array to be plotted is not multiplied by its weight.
7. The use of the double average follows in a natural manner as long as one remembers that the summation is over the spatial points. For example,

DEF G = F, \$X, \$Y, T

implies that F and hence W are functions of both X and Y. The length of the W array is the same as the length of array F. The average is over all X and Y; that is, a double summation. Similarly, we may have an average over X, Y and Z, using triple summation.

C.4.3 END Command

This command is the last statement in the command deck. Any statements that follow are ignored by PAD. An end-of-file will act as an END command. When PAD encounters the END command the program proceeds to generate the plots for each frame.

The format of the command is

END

C.4.4 LET Command

This command defines the values for parameters to replace the default values. The new values become the default until reset by another LET command. More than one KEY may be specified on the same command.

The format of the command is

LET KEY = value [...]

C.4.4.1 Label Keys for LET Command

The following are optional Heading and Label keys that may be set by the LET command. Refer to the PLOT command for an explanation of the KEYS and defaults.

KEY	VALUE
L1	= "X1-axis label"
L2	= "X2-axis label"
L3	= "X3-axis label"
H1	= "first line of heading"
H2	= "second line of heading"
H3	= "third line of heading"

C.4.4.2 DISSPLA Keys for LET Command

The plot Frames are created using the DISSPLA graphics library. DISSPLA uses the convention that each graph is drawn on a page whose dimensions are measured in inches. In PAD the page size is 11" x 8.5" unless reset by the LET command. The following KEYS are provided to allow the user to alter the default values.

KEY	DEFAULT	DESCRIPTION
PAGEX	11.0	Width of page (horizontal)
PAGEY	8.5	Height of page (vertical)
XAXIS	8.5	Length of X1-axis
YAXIS	5.5	Length of X2-axis
ZAXIS	5.5	Length of X3-axis
XORG	1.5	Horizontal distance from lower left corner (LLC) to origin

KEY	DEFAULT	DESCRIPTION
YORG	.8	Vertical distance from LLC to origin
XPOS	.0	Horizontal distance to shift LEGEND. Plus for shift right, minus for shift left.
YPOS	.0	Vertical distance to shift LEGEND. Plus for shift up, minus for shift down.
HGHT	.14	Nominal character height. Each line of the Heading will hold about 60 characters using this height.
SLIDE	.0	Use special values for 35 mm slide if NOT zero.

C.4.4.3 SLIDE Key for LET Command

If the value of SLIDE is NOT zero then the following values are used. These values have been chosen for a 35 mm slide suitable for projection. Because of the larger character height, the heading will hold no more than 35 characters.

HGHT	= .28	
XORG	= 2.0	
YORG	= 1.5	
PAGEX	= 11.0	
PAGEY	= 8.5	
SLIDE	= 1.0	FONT= COMPLX
SLIDE	= 2.0	FONT= DUPLX
SLIDE	= 3.0	FONT= TRIPLX
SLIDE	= 4.0	FONT= SWISSL
SLIDE	= 5.0	FONT= SWISSM
SLIDE	= 6.0	FONT= SWISSB

C.4.5 PLOT Command

The PLOT command specifies the arrays to plot and permits the user to control the frame on which to plot (thus permitting overplots.) Other attributes of the plot may be specified such as logarithmic scaling, axes labels, heading and legend. The KEYs X1, X2 and X3 refer to the axes of a right handed coordinate system. A 2D plot uses only the keys X1 (horizontal axis) and X2 (vertical axis).

The format of the command is as follows,

PLOT LOG X1 = name1, LOG X2 = name2, LOG X3 = name3,
 FR = frame,
 PL = routine,
 ID = legend,
 TR = $X1*a1+b1$, $X2*a2+b2$, $X3*a3+b3$,
 H1 = "first line of heading",
 H2 = "second line of heading",
 H3 = "third line of heading",
 L1 = "X1-axis label",
 L2 = "X2-axis label",
 L3 = "X3-axis label"

Most of the KEYS are optional, and may appear in order. The examples to follow will show that the PLOT command is much simpler than the above expression would indicate. The interpretation of the KEYS follow,

KEY=VALUE	DESCRIPTION
LOG	Optional before the KEYS X1, X2 X3. Sets logarithmic (base 10) scaling. One or more blanks must separate LOG from Xk.
X1=name1	Required coordinate name for X1-axis. Chosen from the coordinate names X, Y, Z, or T.
X2=name2	(1) If 2D, then name2 is a list of one or more data array names to plot on this frame. Only one is required. Maximum of 6 names. Each array named with this key must be a function of the X1-coordinate named above. An alternative way to plot more than one array on a frame is by use of the FR key. (2) If 3D, then name2 is a second coordinate name.
X3=name3	Required for 3D plot only. List of data array names, each a function-of D-20 name and name2, to plot. Maximum of 3 names.
FR=frame	Optional frame number (positive integer.) When specified it is either the next frame number or the number of a previous frame on which to plot. This is the only way to overplot arrays from the different data files.
PL=routine	Name of a plot routine in PAD to process this frame. This field is provided for future plot routines.

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ID=legend	Symbol or character string of no more than 20 characters (may be further restricted by the font size) to be used in a LEGEND when more than one curve is plotted on the same frame. Default is the array name to plot. If name2 (or name3 if 3D) is a list then legend is a list of the same length with each entry representing the legend entry to use for the corresponding array.
TR= $X_k \cdot a_k + b_k$	Optional linear transformation applied to X_k -axis. a_k and b_k are both real numbers. The * for multiply may be replaced by / for division, and the + may be replaced by -. The forms $X_k \cdot a_k$ and $X_k + b_k$ are acceptable.
H1	Optional key for first line of heading.
H2	Optional key for second line of heading.
H3	Optional key for third line of heading.
L1	Optional key for X1-axis label.
L2	Optional key for X2-axis label.
L3	Optional key for X3-axis label.

Frame numbers are assigned in consecutive order starting with 1. Each plot command refers to a single frame; either the next consecutive frame by default or to a previous frame when the FR key is used. When more than one PLOT command refers to the same frame then only one of the commands is needed to define labels. Otherwise the last definition prevails. The legend ID must appear on the same PLOT command as the corresponding data arrays.

The maximum number of frames available is limited to 40 which can be reset to a larger value by the parameter MAXFRM on the BEGIN command. The total number of arrays that can be plotted (regardless of how many frames are used) is limited to 50 which can be reset to a larger value by the parameter MAXPLT on the BEGIN command.

A plot frame is 3-dimensional when the X3 KEY is used on the command. All plots assigned to that frame should be 3D. Since data arrays on the data file may depend upon 1 to 4 coordinates, it may be necessary to use a DEF command to reduce the dimension of the data array prior to plotting.

Each PLOT command is independent of any other PLOT command that references a different frame number. Thus, labels specified for one frame are not carried over from one frame to the next frame. However, some attributes of a frame including labels may be assigned global to all frames by use of the LET command which can be used to define default labels (overriding the previous defaults) to be used when unspecified by the PLOT command.

Similarly, other attributes of a frame may be assigned globally by the LET and WINDOW commands. These global attributes of a frame are used whenever the PLOT command does not specify the attribute.

C.4.5.1 Titles and Labels for Plot Frames

The KEYs H1, H2, H3, L1, L2, L3 on the PLOT command define the frame heading and axes labels. These are optional KEYs and in their absence defaults are chosen according to the following hierarchy. Any KEY specified by option 1 overrides option 2. Similarly, option 2 overrides option 3, and option 3 overrides option 4. When the KEYs are used

on the LET command they define the default for all the following frames until redefined by another LET command. The maximum number of characters for each option depends upon the nominal character height.

OPTION	ACTION
--------	--------

1.	The PLOT command may define H1, H2, H3, L1, L2, L3.
2.	The LET command may define H1, H2, H3, L1, L2, L3.
3.	H1 = First title on data file. H2 = Second title on data file. H3 = Third title on data file. L1 = "name1" where name is the X1-coordinate name specified on the PLOT command. L2 = "name2" on the PLOT command. L3 = "name3" on the PLOT command.
4.	H1 = DATE from PAD data file. H2 = TIME from PAD data file. H3 = "FRAME xx" where xx is the frame number.

C.4.5.2 Examples of PLOT Command

EXAMPLE 1. To plot the array TEMP(T) on the next frame. Use default heading and axes labels.

PLOT X1=T, X2=TEMP

EXAMPLE 2. To plot the array TEMP(T) on the first frame, overplotting other plots on the same frame.

PLOT X1=T, X2=TEMP, FR=1

EXAMPLE 3. Continuation of last example. Identify the array TEMP in legend with "TEMP FOR RUN2" rather than default "TEMP". Note how the statement is continued from one line to the next.

PLOT X1=T, X2=TEMP, FR=1, :Comment.
ID= "TEMP FOR RUN 2" :continuation line.

EXAMPLE 4. Now, change second line of heading, and relabel the axes.

PLOT X1=T, X2=TEMP, FR=1,
ID= "TEMP FOR RUN 2",
H2= "TEMPERATURE COMPARISON RUN 1 VERSUS RUN 2",
L1="TIME IN SECONDS",
L2="TEMPERATURE IN DEGREES CELSIUS"

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EXAMPLE 5. Repeat first example with time in hours and temperature in Fahrenheit. Use logarithmic scale T-axis. Note that the key TR has two parameter expressions.

```
PLOT LOG X1=T, X2=TEMP, TR=X1/360., X2*1.8 + 32.,  
      L1 = "TIME IN HOURS",  
      L2 = "TEMPERATURE IN DEGREES FAHRENHEIT"
```

EXAMPLE 6. To plot arrays TEMP and TP on the next frame. The Legend will distinguish the two curves by their names "TEMP" and "TP"

```
PLOT X1=T, X2=TEMP, TP
```

EXAMPLE 7. Same as last example, but use different legend ID's.

```
PLOT X1=T, X2=TEMP, TP,  
  
ID="ENTRY FOR TEMP", "ENTRY FOR TP"
```

EXAMPLE 8. The previous example could also be done using the following two PLOT commands; we suppose the frame number is 1.

```
PLOT X1=T, X2=TEMP, ID="ENTRY FOR TEMP"  
PLOT X1=T, X2=TP, ID="ENTRY FOR TP", FR=1
```

This method is the only way to plot arrays defined on different data files; that is, when the two PLOT commands are separated by a READ command.

C.4.6 READ Command

The READ command opens the data file for the commands that follow until the next read command.

The format of the command is,

READ check, PR = pr, REC = r1, r2, r3

ITEM	TYPE	DESCRIPTION
check	symbol	Checkword must agree with checkword defined on data file. Required.
pr	integer	Print control option. From 0 to 5. 0 for least printout. Default is 1.
rk	integer	program reads data records starting with record r1 until record number r2 in steps of r3. Default is to read all the records.

The data file is defined by the ddnames check1, check2, etc. After the last record on check1 is read (followed by end-of-file) then if check2 has been declared by a FILEDEF command the next data record begins on check2.

The PR option controls the amount of printout produced by the program between one READ command and the next READ command. PR=0 produces the least print output and PR=5 produces the most. PR=1 is the default and produces a short digest of the data file description. PR=5 prints the contents of each data record exactly as it is read; for large data files this would produce too much print output. PR=0 suppresses all printout except for the list of user commands and error messages.

The REC option provides a means for skipping data records. The effect is similar to the Fortran DO loop. Thus REC=100, 5000, 10 is interpreted as: read data records starting with the 100th until the 5000th in steps of 10. That is only data records numbered 100,110,120 ... 5000 are processed; all others are ignored. Records on the data file such as the descriptive records and comment records are not included in the count of data records. Data records of one T-set are not distinguished from records of another T-set during the count.

The READ command must precede any reference to array names on the data file. Array names known to PAD prior to the last READ statement are no longer available. Array in different data files with the same name may be processed on the same run; PAD only knows about the arrays referenced by the most recent READ statement. The user may wish to distinguish the arrays using the ID KEY on the PLOT command to avoid having two legend entries by the same name.

A buffer array to hold the data read from the file has default length 10000 words, but may be preset using the MAXBUF key on the BEGIN command.

C.4.6.1 Examples of the READ Command

EXAMPLE 1. To open the data file with ddname AUGUST1. If the checkword in the data file is not AUGUST then the program will terminate.

```
READ    AUGUST
```

EXAMPLE 2. For minimal print output in the last example then

```
READ    AUGUST, PR=0
```

EXAMPLE 3. To restrict the last example to the first 100 data records

```
READ    AUGUST, PR=0, REC=1, 100
```

EXAMPLE 4. Suppose we want every other data record until end-of-information.

```
READ    AUGUST, REC=1, *, 2
```

C.4.7 STOP Command

This command cause PAD to stop execution immediately. Plot generation is suppressed. This command is normally used only for debug purposes.

The format of the command is,

```
STOP
```

C.4.8 WINDOW Command

The Window command controls the axis limits for all plots that follow the command until the next WINDOW command. In the absence of a WINDOW command the program calculates the minimum and maximum axis limits from the points plotted. That is, each frame whether it contains one or more curves will (in the absence of a WINDOW command) automatically have a window calculated that completely encloses all the points.

The format of the command is,

WINDOW x1 = lo1, hi1, x2= lo2, hi2, x3= lo3, hi3

where

ITEM	TYPE	DESCRIPTION
lok	real *	Minimum Xk axis limit. An asterisk restores automatic calculation of the minimum.
hik	real *	Maximum Xk axis limit. An asterisk restores automatic calculation of the maximum.

The use of the WINDOW command turns off the automatic calculation of the axes limits for each KEY (X1, X2, or X3) that appears on the command. However, if an asterisk (*) is used in place of a real lower or upper bound then the automatic calculation is turned on for that limit. That is, X1 = *, 30. uses automatic calculation for the lower bound but sets the upper limit at 30; while, X1 = 30., * does the reverse.

In the absence of a KEY the program uses automatic calculation for both the lower and upper bounds. A blank WINDOW (that is, one with no parameters) turns on the automatic calculation for all axes.

Once a window has been set it remains in effect until the next WINDOW command. Any points plotted on a frame must be within the window limits; and conversely, any points which lie outside the window are not plotted. This may be used to good effect when it is desired to zoom in on a local area of a curve to show detail. One should remember, however, that the WINDOW command does not exclude points from an array so the effect of a point may still be "seen" even when the point lies outside the window. The rising peak of a curve for instance may be clipped by the window but the points outside the window still exist on the curve even though they lie outside the window.

C.5 SAMPLE CASES

There are two files produced by PAD that are of interest to the user. The first is the plot file. Processing of this file is discussed in Section 10.

The second file of interest is the OUTPUT file containing a listing of the command cards and related information. Section 5.1 contains a typical example of the output produced. Note that the command cards are printed exactly as they are read, while related print lines from PAD have a leading decimal point to make identification easier. Looking at the example, one will see following the READ command a number of lines that begin with the phrase

.DATA FILE FOR ..

and terminate with

.FINISHED DATA FILE DESCRIPTION.

These statements form a short digest of the descriptive records on the data file referenced by the READ command. This information is the default output corresponding to the option PR=1 on the READ command, and may be suppressed by using PR=0. This digest is, however, very useful for checking the commands for possible errors.

On the first line following READ we find the checkword MEKIN and the creation data and time for the data file. This is followed by the coordinate names X, Y, Z and T, the first three being the spatial coordinate names.

Consider the array named DNRPT that appears towards the end of the data description. We see from the list that DNRPT is associated with the MAP record T-H3D and the WEIGHT record named T-HW3D. DNRPT belongs in the T-set named TWO, and has dimension 48. Checking back we locate the WEIGHT T-HW3D and find that it is associated with the MESH record T-HMSH, the dimension of the weight array is 48 in agreement with DNRPT. Checking back further we find the MAP T-H3D is associated with the same MESH record and also has dimension 48. PAD checks consistency when reading the data file and will print an appropriate error message should the map and weight arrays not be associated with the same mesh.

The axes lengths for the MESH records refer to the lengths of the X, Y and Z arrays. Thus T-HMSH involves a totality of $392 = 7 * 7 * 8$ points in X * Y * Z space.

In the listing of the command statements we find the message UNUSED

MEMORY...

This message always appears in pairs, and occurs whenever the DATA records in the data file are processed. In this instance the pair appears twice, once after the second READ command when the first data file is processed, and after the END command when the second data file is processed. PAD must process the data records on one file before it opens a second file. The pair of messages then give a clue to what activity is occurring should an error message be produced between UNUSED MEMORY messages. The memory requirement monitored by the program may be of interest should one need to reduce memory.

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Following the processing of all data files the program enters into its second and final phase of plotting the frames one by one. The number of arrays per frame should agree with the plot requests made by the PLOT commands. It is possible that no data exists for one of the data arrays, and then the number of arrays on the frame will be less than the number requested. When this occurs PAD will print an appropriate warning message.

For the sample case in Section 5.1, the optional BEGIN command precedes the first READ command, and sets the maximum number of T-steps to 500. The READ command opens the data file on file fort.1 followed by file fort.2. To aid the reader we provide a frame by frame description of the commands.

- FRAME 1. Simple plot of the data array TOTPOW versus the coordinate T. Heading and axes labels by default because no user specification appears on the PLOT command. In this case the first line of the heading comes from the data file. The second line of the heading is the data on the data file, and the third line of the heading is the frame number. The axes labels are the array names TOTPOW and T. The descriptive ARRAY listing for TOTPOW shows that TOTPOW has no MAP and hence is a function of T only.
- FRAME 2. Prior to the second PLOT command there appear two LET commands. The first redefines the default first line of heading. The second LET shifts the legend to the left by 6 inches ($XPOS = -6$) to avoid overwriting the curves on the next frame. Following the PLOT command, XPOS is reset to zero. The default position for the legend is in the upper right-hand corner of the frame. The default ID's for the legend are the array names. There are four curves plotted on this frame, all versus T. The labels L1 and L2 are assigned to the X1 and X2 axes, and the second line H2 of the heading is specified.
- FRAME 3. AXPOW is a function of Z and T. The DEF command fixes T at its first value and limits the range of Z. The integer limits on Z and T refer to the coordinate indices. The resulting array AX is a function of Z. The PLOT command uses the TR key to subtract 60.96 from the values on the X1 axis to shift the origin for a better physical interpretation. H1 is unspecified on the PLOT command, so its value comes from the previous LET command. Note that H3 replaces the default "FRAME 3" with "FIGURE 3" for this frame only. None of the remaining commands reference H3.
- FRAME 4. This is a 3D example. COTPT is a function of X, Y, Z and T. Z is fixed by index, and T is fixed by value.
- FRAME 5. This example refers to the same array COTPT as in the previous example. The data is reduced by fixing X, Y and T. The ID sets the legend entry. Following the next READ command another curve will be plotted on this frame and because both curves have the same name the ID is used here to distinguish the current data array from the one to be added later.
- FRAME 6. Four curves are defined for $T = 0$, taken from the same data array PTPWER, for 4 different values of X, Y. The scale factor .22654 changes the units used to display the data. The curves are distinguished by appropriate ID's. The WINDOW command is used to extend the X1-axis beyond the bounds of the data. Compare the X1-axis for FIGURE 3 (no window) with FRAME 6 (with window). The blank WINDOW follows this frame to restore PAD calculated window limits.
- FRAME 5 CONTINUED. The READ command appearing just before this frame is defined is not necessary, but is used to illustrate the action that occurs when more than one READ command is used. PAD completes reading the old data file at this point, closes the data file, and opens a new data file. The new data file happens to be the same file (file fort.1 + file fort.2.) PR=0 suppresses the listing of the descriptive

records for the second READ. The UNUSED MEMORY messages occur before and after reading the data records from the old data file.

On the PLOT command note the use of the FR key to refer to the existing FRAME 5. The ID is used to identify the array in the legend. The name COOLT1 is the same name used in the previous reference to this frame, but there is no name conflict because the READ command has already closed the old data file and any names previously defined may now be redefined. Note that the data has been plotted only over a part of the range.

FRAME 7. The SLIDE option is used for the remaining frame, and results in larger characters in a different FONT. Three arrays are defined for different T-values by averaging over all X and Y values (indicated by use of \$ before both X and Y.) The values on the X1-axis are normalized using the TR option.

FRAME 8. This is another 3D plot that assigns 3 arrays to the same frame. The data is reduced by averaging on Z over the limits indicated and by fixing T. The END command that follows completes the PAD run.

C.5.1 Sample Output Listing

BEGIN HAXTIM-500

READ MEKIN

```
.DATA FILE FOR MEKIN      CREATED    02/03/82      AT    17.49.04.
      COORDINATE NAMES ' X      Y      Z      T
      NMESH - 2 NMAP -    5 NWGT=    2      NRAY ' 37 NSET = 2
```

.TITLE = TEST CASE FOR PLOT FILE PWR 1/4 CORE

```
.MESH REACTORMSH      AXES LENGTHS -    7      7      7
```

```
.MESH T-HMSH      AXES LENGTHS =    7      7      8
```

```
.MAP REACTOR3D      MESH = REACTORMSH      MAP LENGTH = 42
```

```
.      X      FROM 3 TO    5
.      Y      FROM 3 TO    5
.      Z      FROM 1 TO    7
```

```
.MAP T-H3D      MESH - T-HMSH      MAP LENGTH = 48
```

```
.      X      FROM 3 TO    5
.      Y      FROM 3 TO    5
.      Z      FROM 1 TO    8
```

```
.MAP REACTORID      MESH - REACTORMSH MAP LENGTH = 7
```

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.	X	FROM 1 TO	1
.	Y	FROM 1 TO	1
.	Z	FROM 1 TO	7

.MAP T-HID	MESH - T-HMSH	MAP LENGTH = 8
------------	---------------	----------------

.	X	FROM 1 TO	1
.	Y	FROM 1 TO	1
.	Z	FROM 1 TO	8

.MAP T-H2D	MESH - T-HMSH	MAP LENGTH = 6
------------	---------------	----------------

.	X	FROM 3 TO	5
.	Y	FROM 3 TO	5
.	Z	FROM 1 TO	1

.WEIGHT REACTORW3D	MESH - REACTORMSH	WEIGHT LENGTH = 42
--------------------	-------------------	--------------------

.WEIGHT T-HW3D	MESH - T-HMSH	WEIGHT LENGTH = 48
----------------	---------------	--------------------

.ARRAY	MAP	WEIGHT	TSET	LENGTH
.RHOTOTAL	NONE	NONE	ONE	1
.RHODOPPL	NONE	NONE	ONE	1
.RHOSCRAM	NONE	NONE	ONE	1
.RHOVOID	NONE	NONE	ONE	
.RHOMDTMP	NONE	NONE	ONE	
.RHODIFF	NONE	NONE	ONE	
.GENTIME	NONE	NONE	ONE	
.AVTF	NONE	NONE	ONE	
.AVAL	NONE	NONE	ONE	
.AVTC	NONE	NONE	ONE	
.TCMAX	NONE	NONE	ONE	
.TFMAX	NONE	NONE	ONE	
.PEAKH	NONE	NONE	ONE	
.TOTPOW	NONE	NONE	ONE	
.TCLDAV	NONE	NONE	ONE	
.HFMAX	NONE	NONE	ONE	
.AVRHO	NONE	NONE	ONE	
.AXPOW	REACTORID	NONE	ONE	7
.HTFLX	T-HID	NONE	ONE	8
.AXTF	T-HID	NONE	ONE	8
.AXVOID	T-HID	NONE	ONE	8
.AXTC	T-HID	NONE	ONE	8
.TM	T-HID	NONE	ONE	8

.AXDEN	T-HID	NONE	ONE	8
.EXITQU	T-H2D	NONE	ONE	6
.EXITMF	T-H2D	NONE	ONE	6
.EXITHC	T-H2D	NONE	ONE	6
.RADPOW	T-H2D	NONE	ONE	6
.VOIDFR	T-H3D	T-HW3D	ONE	48
.PTPWER	REACTOR3D	REACTORW3D	TWO	42
.COTPT	T-H3D	T-HW3D	TWO	48
.HFXPT	T-H3D	T-HW3D	TWO	48
.CLDTPT	T-H3D	T-HW3D	TWO	48
.CLDTMX	T-H2D	NONE	TWO	6
.CLFPT	T-H3D	T-HW3D	TWO	48
.DNBRPT	T-H3D	T-HW3D	TWO	48
.DNBMIN	T-H2D	NONE	TWO	6

.FINISHED DATA FILE DESCRIPTION.

PLOT XI-T, X2-TOTPOW :fram 1

LET HI-"SMALL UARTER CORE CASE TO TEST PLOTTING OPTIONS"

LET XPOS--6.0

PLOT XI-T, X2-RHOTOTAL,RHODOPPL,RHOSCRAM,RHOVOID, :frame 2

LI-"TIME (S)", L2-"REACTIVITY (DELTA K/K)",

H2-"REACTIVITY COMPONENTS VS. TIME"

LET XPOS-O.O

DEF AX-AXPOW, Z-2,6, T-1

PLOT XI-Z, X2AX, :fram 3

TR-XI-60.96,

LI-"CORE HEIGHT (CM)", L2-"LOCAL/AVERAGE POWER",

H2-"AVERAGE CHANNEL LOCAL/AVERAGE AXIAL POWER AT T-O.O",

H3-FIGURE 3

DEF COOL-COTPT, X, Y, Z-7, T-0.0

PLOT XI-X, x2r, X3-COOL, :frame 4

LI-"X COORDINATE",

L2-"Y COORDINATE",

H2-CORE EXIT COOLANT TEMPERATURE (DEG. F) AT T-0.0"

LET YPOS--4.0

DEF COOLTI-COTPT, X33, Y-3, Z, T-0.0 :frame 5

PLOT XI-Z, X2-COOLTI,

ID-"O.O s"

LI-"REACTOR HEIGHT (CM)",

L2-"COOLANT TEMPERATURE (DEG. F)",

H2-"CENTRAL CHANNEL COOLANT TEMPERATURE"

LET ypos=oo

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WINDOW XI-0.0,302.4

DEF P33-PTPWER/0.22654, X-3, Y-3, Z=2,6, T=0.0

DEF P34-PTPWER/0.22654, X-3, Y-4, Z=2,6, T=0.0

DEF P35-PTPWER/0.22654, X-3, Y-5, Z=2,6, T=0.0

DEF P44PTPWER/0.22654, X=4, Y=4, Z=2,6, T=0.0

PLOT XI-Z, X2-P33,P34,P35,P44,

:frame 6

TRxl-6os6

LI-"CORE HEIGHT (CH)", L2-"POWER (WATTS/CC)",

IDp(33) p(34) p(3s) p(44)

H2-AXIAL POWER DISTRIBUTION IN SELECTED CHANNELS AT T-0.0"

WINDOW

READ MEKIN, PR-O

.UNUSED MEMORY BEFORE TLOOP. SCH - 114704 OCTAL.

.UNUSED MEMORY AFTER TLOOP. SCM - 114704 OCTAL.

LET YPOS--4.0

DEF COOLTI-COTPT, X-3, r3, Zs2,7, T-0.5

PLOT XI-Z, X2-COOLTI,

:frame 7

ID"os

FRs

LET yposoo

LET SLIDE-l.

WINDOW XI-0.0,1.0

DEF pTlpTpWER/o226s4 sx sr, Z-2,6, T=0.0

DEF PT2-PTPWER/0.22654, sx sy Z-2,6, T-0.25

DEF PT3-PTPWER/0.22654, sx sy Z-2,6 T-0.50

PLOT XI-Z, X2-PTI,PT2,PT3,

:frame 8

ID-"O.O S", "0.25 s", "o.so"

TRXl/302,4-0.2,

LI-"NORMALIZED CORE HEIGHT",

L2-"POWER (WATTS/CC)",

HI-"SHALL QUARTER CORE TEST CASE",

H2-"AVERAGE CHANNEL AXIAL POWER SHAPE"

WINDOW

DEF POWI-PTPWER/0.22654, X, Y, \$Zs2,6, T-O.O

DEF POW2-PTPWER/0.22654, X, Y, SZ=2.6 T-0.25

DEF POW3-PTPWER/0.22654, X, Y, 3Zs2,6 T-0.50

PLOT XI-X, X2-Y, X3-POWI,POW2,POW3

:frame 9

ID"O.O S", "0.25 S", "0.50 S"

HI-"SMALL QUARTER CORE TEST CASE",

H2-"CHANNEL AVERAGE POWER (WATTS/CC)",

LI-"X DIRECTION COORDINATE",

L2-"Y DIRECTION COORDINATE"

END

.UNUSED MEMORY BEFORE n ooP. SCM - 114704 OCTAL.
 .UNUSED MEMORY AFTER TLOOP. SCM - 114704 OCTAL.

.FRAME	1 CONTAINS	1 ARRAYS.
.FRAME	2 CONTAINS	4 ARRAYS.
.FRAME	3 CONTAINS	1 ARRAYS.
.FRAME	4 CONTAINS	1 ARRAYS.
.FRAME	5 CONTAINS	2 ARRAYS.
.FRAME	6 CONTAINS	4 ARRAYS.
.FRAME	7 CONTAINS	3 ARRAYS.
.FRAME	8 CONTAINS	3 ARRAYS.

C.5.2 Sample Case Using WINDOW and Log Scaling

The following commands illustrate the use of the WINDOW command and logarithmic scaling. Three plots are generated for the same array POWER which is a function of TIM. The commands are listed as they would be submitted to PAD using a data file on file fort.1 with checkword BNLTWIGL. For simplicity, we suppress PAD responses to the commands.

Frame 1. Linear X1 and X2 axes.

Frame 2. Linear X1 an Log X2.

Frame 3. Linear X1 and X2 axes with WINDOW.

READ BNLTWIGL

LET H1="BWR SAMPLE PROBLEM",
 H2="CORE THERMAL POWER TRANSIENT BEHAVIOR",
 L1="TIME (S)", L2="POWER (GW)"

DEF POW = POWER/1.E3
 PLOT X1 = TIM, X2=POW

PLOT X1 = TIM, LOG X2=POW

WINDOW X1= .46, .76
 PLOT X1 = TIM, X2=POW

END

C.6 ERROR MESSAGES

Fatal errors detected by PAD have the following form. The first line of the error message gives the name of the subroutine where the error was detected. This is followed by a line with the error message, and sometimes by a second line containing either a NUMBER, a NAME, or NAME=NUMBER when NAME, NUMBER, or both may give a clue to understanding the cause of the error.

```
$$$$$$$ ERROR DETECTED BY ROUTINE MAPBND $$$$$$  
MAP BOUNDS EXCEEDED
```

This error indicates that a MAP array from the data file exceeds the corresponding MESH X-coordinate dimension of 100. This message would follow any printout for the offending MAP. If the MAP array is incorrect, the only remedy would be to regenerate the data file with a corrected MAP array. Another possible cause for the above error could be that the MAP is associated with the wrong MESH. If there is more than one MESH record a mixup of the names could result in the above error.

Error messages that follow the READ command and which precede the message "FINISHED DATA FILE DESCRIPTION" are in all probability due to errors in the data file, except for a possible error on the READ command itself. The data file must conform to the rules of Section 7.

Errors are printed immediately after the offending command card image on the output listing. For example, consider the following error message,

```
$$$$$$$ ERROR DETECTED BY ROUTINE REDBGN $$$$$$  
INVALID CHECKWORD  
$$$ ALPHA
```

This error message would immediately follow the READ command and means the checkword ALPHA on the data file does not agree with the checkword on the READ command. The user must decide whether something is wrong with the data file or if the checkword on the READ command is wrong.

Every command card contains entries of the form KEY=LIST, and PAD checks both KEY and LIST for validity. For example,

```
READ MEKIN, PR=0
```

This command has a proper format. The KEYs are MEKIN and PR which has a one item valid LIST. The following invalid variation illustrates the type of checking PAD performs.

The following command,

```
READ MEKIN, P = 0
```

has an invalid KEY (P rather than PR.)

UNRECOGNIZED KEY \$\$\$ P

When PAD detects an error that appears to be a programming error then the message printed is "PROGRAM ERROR". The solution is for someone familiar with the PAD code to make the necessary code correction and re-compile the program.

Occasionally the problem being run requires table sizes that are larger than the default used by PAD. The message that appears is

EXCEEDED TABLE BOUNDS

followed by the name of a variable that should be reset to a larger value. Refer to the BEGIN command for a list of table sizes that can be reset. The table size must be preset prior to the first READ command; otherwise, PAD uses the default size, and once set for the first data file the size cannot be changed. Each table uses memory space needed for data arrays, so one should be careful not to use too large a value.

Sometimes table space is exhausted when there are too many DEF and PLOT commands. In such cases the user can make another pass through the data file by inserting another READ command for the same data file. This frees some of the table space used by the previous commands. However, PAD will not remember any arrays created by the previous READ command and hence no reference should be made to such arrays. The Frame count continues without interruption and all of the previous plots will be produced.

Tables are stored in memory (SCM) and must compete for space with arrays that are created dynamically. When all space has been allocated then any attempt to use additional space results in the following message:

ARRAY EXCEEDS AVAIL. SCM

Sometimes, using another READ command as described above will eliminate the error. Naturally, large arrays with a dimension over 1000 words are the main culprit, and it may help to assign such arrays to a T-set by themselves.

Another source of errors are duplicate or missing names. Names are given to the following objects: MESH, MAP, WEIGHT, ARRAY and T-set. Therefore, it is important to make reference to them by the correct name, and not attempt to create more than one by the same name. PAD checks each new name against the appropriate Name Table; a conflict results in the following error message:

DUPLICATE NAME \$\$\$ name

Name conflicts between tables are not possible, a MESH entry and a MAP entry will never be confused and consequently PAD only checks for conflicts within a table. Therefore, a MAP may have the same name as its associated MESH; similarly, an ARRAY may have the same name as its associated MAP; and a T-set may have the same name as any array in the T-set.

Names are built into the PAD data file, and once the data file is generated the user of PAD need only make reference to ARRAY names on the command statements. The correspondence of ARRAY with MAP, and MAP with MESH, etc., are defined on the data file, and so there is no need to reference MESH, MAP, WEIGHT, or T-set on any command card.

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On any command card, a user may make only one of two possible name errors; either an attempt to define a new array with the same name as an existing array, or a reference made to a non-existent array. The former error we have listed above, the latter is given by

NAME UNDEFINED
\$\$\$ name

C.7 PAD DATA FILE DESCRIPTION

C.7.1 File And Record Structure

The PAD data file consists of 1 to 20 Fortran files; the record structure of each file consists of a sequence of Fortran unformatted records of the form produced by WRITE(unit) KEYWD,

NRF, NWDS, (LIST(I), I = 1, NWDS)

The last record written to one file is followed logically by the first records of the next file. The means of indicating to PAD that the data file is continued onto another file is by the READ command statement which specifies the files and their order.

The items written to the file for each record have the following interpretation.

ITEM	DESCRIPTION
KEYWD	Keyword to identify the record. Refer to KEYWD table below.
NRF	Integer flag. Non-zero if the next record is a continuation record. Zero if the next record is not a continuation record.
NWDS	Integer count (at least one) of the length of LIST. NWDS must not exceed MAXBUF. MAXBUF may be reset by the BEGIN command.
LIST	Array of length NWDS, the description of which is determined by KEYWD. When the data type is REAL, it refers to single precision only.

The PAD data file is self describing and this description must first be interpreted before any data arrays can be processed. For this reason the data file has two parts. The first part contains the data description records, and the second part contains the data records. The first part begins with the BEGIN record (the first record on the data file has KEYWD = BEGIN) and ends with the END record (which represents the end of the data description). Between the BEGIN and END records must appear the data descriptive records: MESH, MAP, WEIGHT, ARRAY, and TITLE records. Any data descriptive records that follow the END record are ignored by PAD. DATA records may not appear before the first END record. After the first END record only DATA records are processed.

Within the first part of the data file the rule that governs the order of the records is that a record must be written prior to another record that makes reference to it.

C.7.2 Keyword List

Each record in the data file is identified by the keyword KEYWD for which the following is a brief summary:

KEYWD	DESCRIPTION
BEGIN	The first record on the data file. Defines coordinate names, checkword and various constants. The BEGIN record should not be confused with the BEGIN command.
TITLE	Title records define the default heading lines H1, H2, H3 in that order. Additional TITLE records are ignored.
MESH	Defines the spatial mesh arrays X, Y, Z for geometry dependent arrays. Each of the arrays X, Y, Z is an array of increasing real values.
MAP	Defines the subset of a spatial mesh at which data arrays are defined. Refers to a previously defined MESH record.
WEIGHT	Defines the real weights for one or more weighted arrays. Must have the same length as any associated data array.
ARRAY	Defines the name of the next data array assigned to a T-set. Also associates the name with a MAP and or WEIGHT array, if needed.
END	Signifies the end of the data descriptive record. All data records must follow the END record.
DATA	Contains the data values for all arrays in one T-set in the order that they appear in ARRAY records. All values in the DATA record are for the same T-value. The DATA records for a T-set are ordered by increasing T-value.
SKIP	All records with the SKIP keyword are ignored by PAD. May appear anywhere in the data file.

The following sections give a more complete description of each record type, listed in alphabetical order by KEYWD.

C.7.3 KEYWD = ARRAY

An ARRAY record defines a data array. There must not be any previous reference to the array by another ARRAY record. The ARRAY record defines the existence of the array by giving the array a name and associating the array with MAP and WEIGHT records if needed, and assigns the array to a T-set. No data values are assigned to the array by this record; only a DATA record can assign data values to the array.

The ordered values T for which the array is defined is called the T-mesh. A T-set is the set of all arrays defined over the same T-mesh. The T-set to which the array is assigned has a unique name that is used by the DATA records to reference a T-set. There is one DATA record for each value of T in the T-mesh. The order of the arrays in the T-set is the order in which the arrays were defined by their respective ARRAY records. That is, the first data array in a T-set is the one defined by the first ARRAY record that references the T-set. This defines the order of the data on the DATA records for that T-set.

The number of arrays must not exceed NRAY defined on the BEGIN record.

NWDS = 9 for ARRAY records.

LIST(I)	DESCRIPTION
NAMRAY	Array name
NAMMAP	MAP record name or 'NONE' if not defined over a spatial mesh.
NAMWGT	WEIGHT record name or 'NONE' if unweighted array.
NAMSET	T-set name. Each new name defines a new T-set. This is the same name that is used on the DATA record. The number of T-sets must not exceed NSET defined on the BEGIN record.
LRAY	Array length (integer > 0). Must be same length as for WEIGHT records if any. If there is no MAP then LRAY=1.

C.7.4 KEYWD = BEGIN

The BEGIN record defines the coordinate names for the X, Y, Z and T mesh arrays. This record also contains the checkword used by the READ command, and defines various table sizes.

NWDS = 19 for a BEGIN record.

LIST(I)	DESCRIPTION
ICHECK	checkword
IDATE	character*8
ITIME	character*8
NAMEX	X-coordinate name.
NAMEY	Y-coordinate name.
NAMEZ	Z-coordinate name.
NAMET	T-coordinate name.
NMESH	integer maximum number of MESH records.
NMAP	integer maximum number of MAP records.
NWGT	integer maximum number of WEIGHT records.
NRAY	integer maximum number of ARRAY records.
NSET	integer number of T-sets.

C.7.5 KEYWD = CONT

The CONT record is a continuation record. When any of the records is very large it may be broken up into smaller chunks using the CONT record. PAD reads the initial record and each succeeding CONT record as one record. The NRF flag of the preceding record must be non-zero; and the NRF flag of the last CONT record must be zero. Only the LIST portion of a record is continued onto the next CONT record.

Example. Consider the following FORTRAN statement for a DATA record with a data LIST of 5000 words.

DATA and CONT are character*8 with DATA = 'DATA', CONT = 'CONT'

```
WRITE(unit) DATA, 0, 5000, (A(I), I = 1, 5000)
```

If we break the record into 3 smaller records using CONT records or continuation we have,

```
WRITE(unit) DATA, 1, 2000, (A(I), I=1, 2000)
WRITE(unit) CONT, 2, 2000, (A(2000+I), I = 1, 2000)
WRITE(unit) CONT, 0, 1000, (A(4000+I), I = 1, 1000)
```

C.7.6 KEYWD = DATA

A DATA record defines the values for all arrays in one T-set for one value of T. Let F_k denote the k-th array in the record and let L_k denote the length of F_k . If $L_k = 1$ then F_k is an array function of T only; otherwise F_k must be associated with a MAP record that defines the dependence of F_k on the coordinates X, Y, Z.

Let N be the number of arrays in the record so that $k = 1$ to N. There must be exactly N ARRAY records, one for each F_k in the T-set.

The DATA records are ordered by increasing values of T. That is, each succeeding DATA record for the same T-set must have a T-value larger than the previous DATA record. This rule does not apply to DATA records for different T-sets; the T-values for differing T-sets have no relationship to one another.

$NWDS = L_1 + L_2 + L_3 + \dots + L_N + 3$ for the DATA record.

LIST	DESCRIPTION
NAMSET	T-set name.
T	Real value of T.
F1(L1)	L1 real values of first data array.
F2(L2)	L2 real values of second data array.
...	
F _n (L _n)	L _n real values of last data array.

C.7.7 KEYWD = END

The END record signifies the end of the descriptive records. The DATA records follow the END record. List consists of the one data value zero.

C.7.8 KEYWD = MAP

A MAP record defines the subset of spatial mesh at which a data array is defined. Every data array $F(Z, Y, Z)$ with length greater than 1 must be associated with a MAP record, and each MAP record must be associated with a MESH record. Thus F is associated with a MESH record only indirectly through its associated MAP record. Note that the correspondence of F with T is defined by the DATA records; the MAP record does not involve T .

The number of MAP records must not exceed NMAP defined on the BEGIN record. $NWDS = LMAP + 5$ for the MAP record.

LIST(I)	DESCRIPTION
NAMMAP	MAP name.
NAMMSH	MESH name. A MESH record with this name must have been previously defined.
LMAP	Length of MAP record (integer > 1)
MAP	Packed MAP array created by the PAD routine CTOMAP. Defines the X, Y, Z coordinates of every point in the subset. To pack the L-th element of the array MAP with the indices IX,IY,IZ into the X,Y,Z arrays, respectively, use

CALL CTOMAP(MAP(L), IX, IY, IZ)

PAD uses the corresponding routine MAPTOC to retrieve the coordinates.

C.7.9 KEYWD = MESH

A MESH record defines a spatial mesh of (X, Y, Z) points. There may be more than one MESH record and each is identified by its unique name. A data array F may be defined at every point of the mesh but normally an array F is defined over some subset of the spatial mesh, as determined by a MAP record. The T-mesh is defined by the DATA records; the MESH record involves only the X, Y, Z coordinates.

The number of MESH records must not exceed NMESH defined on the BEGIN record.

$NWDS = IXMAX + IYMAX + IZMAX + 5$ for the MESH record.

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LIST(I)	DESCRIPTION
NAMMSH	MESH name.
IXMAX	Length of X-array (integer > 0)
IYMAX	Length of Y-array (integer > 0)
IZMAX	Length of Z-array (integer > 0)
X(IXMAX)	Real values of X array ordered by increasing size.
Y(IYMAX)	Real values of Y array ordered by increasing size.
Z(IZMAX)	Real values of Z array ordered by increasing size.

C.7.10 KEYWD = SKIP

The SKIP record is a record containing data that is not used by PAD. It may contain comments or anything (real, integer or character) the user wishes to write to the data file, so long as its record structure is standard. List consists of the one data value zero.

C.7.11 KEYWD = TITLE

The TITLE record contains a plot file title. There may be zero to three such records in the plot file.

NWDS = 20

LIST(I)	DESCRIPTION
TITLE	Descriptive title, 80 characters or less.

C.7.12 KEYWD = WEIGHT

A WEIGHT record defines the weights used to average data values in the DEF command. The length of the weight array must be the same as the length of any associated data array.

The number of WEIGHT records must not exceed NWGT defined on the BEGIN record.

NWDS = LWGT + 5 for the WEIGHT record.

LIST(I)	DESCRIPTION
NAMWGT	WEIGHT name.
NAMMSH	MESH name. A data array and its associated weight array must be defined over the same spatial points.
LWGT	Length of WGT array (integer > 1)
WGT(LWGT)	Real valued weight array

C.7.13 Data File Example

This example is to illustrate the basic structure of the PAD data file. It is not intended to be a typical example; in fact the geometry description is kept simple to avoid unnecessary complexity. The data file is generated with the checkword 'ABLE'.

Three arrays VRAY, WRAY and FRAY belong to the one and only T-set named 'ONE'. The arrays VRAY and WRAY have no spatial dependence, and the array FRAY is an unweighted function of the spatial coordinates 'XNAME' and 'YNAME'. The Z-coordinate is not used, and because every spatial mesh requires 3 coordinates we arbitrarily assign a zero value to Z and give it the name 'NO-Z'. The array FRAY is defined over a circular subset of the square mesh.

We use the 2 subroutines PLTBGN and PLTDAT to generate the data file. The first writes the descriptive records, and the second writes the DATA records. Routine PLTBGN is called once to initialize the data file. Routine PLTDAT is called for each T-value in the T-mesh along with the corresponding values of VRAY, WRAY and FRAY. The number of values in T-mesh is arbitrary but must be in increasing order. Program TSTPAD controls the assignment of values to the arrays and calls PLTBGN and PLTDAT to write the data file.

C.7.13.1 Program to Generate Data Files

```

C ...   TEST PROGRAM FOR PAD.
        COHHON/HESHS/IXMAX, IYMAX, IZMAX
        DIMENSION F(400), X(21), Y(21)
        LOGICAL EXT
        EXT(I,J)(I-10)*2+(J-10)2 .GT. 36

C ...   CREATE THE DATA DESCRIPTIVE RECORDS ON DATA FILE. CALL PLTBGN(X, Y, F, LMAX)

C ...   DATA FILE CONTAINS DATA FOR THE ARRAYS V, W, F.
        C V(T) - SIN(T)
        C W(T) - COS(T)
        C F(X,Y,T) - X*2 SIN(T) - Y2 COS(T)

PI - 4.ATAN(I)

```

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C LOOP TO GENERATE DATA ARRAYS FOR 101 T-VALUES.
DO 40 IT - 1, 101

T - (IT .02PI
V - SIN(T)
W - COS(T)

IXMAX - 21
IYMAX - 21
IZMAX - 1
L = 0

C THE FOLLOWING LOOP TO GENERATE F MUST CONFORM WITH THE MAP ARRAY DEFINED IN
ROUTINE PLTBGN.

DO 20 IY - 1, IYHAX
DO 20 IX - 1, IXMAX
IF(EXT(IX,IY)GOTO 20
L - L + 1
F(L) - VX(IX)2 - WY(IY)*2

20 CONTINUE
IF(L .NE. LMAX)Stop

C ... CREATE NEXT DATA RECORD ON DATA FILE.
CALL PLTDAT(T, V, W, F, LMAX)

40 CONTINUE
END

SUBROUTINE PLTBGN(X, Y, MAP, LMAX)
COMMON/MESHS/IXMAX, IYMAX, IZMAX

C ... ROUTINE TO CREATE THE DATA DESCRIPTIVE RECORDS ON DATA C FILE.
DIMENSION X(21), Y(21), MAP(400)

LOGICAL EXT
CHARACTER BEGIN, TITLE, MESH, MAP, ARRAY, END, DATA, ICHECKX, XNAME,
+YNAME, NAME, NAME, NAMMSH, NAMMAP, NONE, NAMSET, VRAY, WRAY, FRAY,
+IDATE, TIME
DATA BEGIN/'BEGIN'/, TITLE/'TITLE'/,

+MESH/'MESH'/,MAP/'MAP'/,A MAY/'ARRAY'/, END/'END'/, DATA/'DATA'/
EXT(I,J) 10)2+(J-10)2 .GT. 36

C ... BEGIN
ICHECKX - 'ABLE'
CALL DATE(IDATE)
CALL TIME(TIME)
NAME = 'XNAME'
NAME = 'YNAME'
NAME = 'NAME'
NAME = 'NAME'

```

NMESH = 1
NMAP = 1
NWGT = 0

NRAY - 3
NSET ' 1
NRF - 0
NWDS - 19
WRITE(I) BEGIN,NRF,NWDS,ICHECK,IDATE,TIME,
+ NAME,NAME,NAME,NAME,
+ NMESH,NMAP,NWGT,NRAY,NSET

C...  TITLE.....
      NWDS - 20
      WRITE(I) TITLE,NRF,NWDS,HAD TEST EXAMPLE

C...  MESH.....
      NAMMSH - 'MESH'
C      SQUARE MESH
      DO 10 IX - 1, IXMAX
      XX - (IX .05
      X(IX) - XX
      Y(IX) - XX
      10 CONTINUE

      Z = 0
      NWDS = IXMAX + IYMAX + 6
      WRITE(I) MESH,NRF,NWDS,NAMMSH,IXMAX,IYMAX,IZMAX,
+      (X(IX), IX - 1, IXMAX),
+      (Y(IY), IY - 1, IYMAX), Z

C...  MAP .....
      NAMMAP - 'CIRCLE'
      L - 0
C      THE FOLLOWING LOOP TO GENERATE THE MAP ARRAY MUST C
      CONFORM WITH THE LOOP TO GENERATE THE ARRAY F IN C
      THE MAIN PROGRAM TSTPAD.
      DO 20 IY - 1, IYMAX
      DO 20 IX - 1, IXMAX
C      F DEFINED OVER INTERIOR OF CIRCLE
      IF (EXT(IX,IY)GOTO 20
      L - L + 1
      CALL CTOMAP(MAP(L), IX, IY, 1)
C      ROUTINE CTOMAP PACKS THE INDICES INTO THE MAP C
      ARRAY. PAD USES ROUTINE MAPTOC TO UNPACK THE C
      ARRAY.

20    CONTINUE

```

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LHAX - L

NWDS = LMAX + 5

WRITE(I) HAD,NRF,NWDS,NAMMAP,NAMMSH,LMAX,(MAP(I),I,LHAX)

C ... ARRAY
 NONE - 'NONE'

NAHSET = 'ONE'

LRAV = 1

LRAW = 1

LRAF = L

NWDS = 9

VRAY = ' VRAY'

WAY = ' WRAY'

FRAY = 'FRAY'

WRITE(I) ARRAY,NRF,NWDS,VRAY,NONE,NONE,NAMSET,LRAV

WRITE(I) ARRAY,NRF,NWDS,WAY,NONE,NONE,NAMSET,LRAW

WRITE(I) ARRAY,NRF,NWDS,FRAY,NAMMAP,NONE,NAMSET,LRAF

C... END
 WRITE(I) END, O,I,O
 RETURN
 END

SUBROUTINE PLTDAT (T, V, W, F, LMAX)

C ... ROUTINE TO WRITE THE NEXT DATA RECORD FOR T-SET "ONE".
 CHARACTER 'NAMSET'
 DIMENSION F(LMAX)
 DATA NAMSET/'ONE'/
 NWDS - LMAX5
 NRF - O

WRITE(I) DATA,NRF,NWDS,NAMSET,T,V,W,(F(I),I-1,LMAX)

RETURN

END

Commentary on Previous Example

1. To add another spatial MESH to the data file involves adding 1 to the value of NMESH and writing one additional MESH record. Similarly, for MAP, WEIGHT and ARRAY records. It is particularly easy to append new data arrays that reference existing MAP and WEIGHT records; this requires adding a 9-word ARRAY record for each new data array and appending the new data values to the corresponding DATA record.
2. Note the hierarchy of the records. The ARRAY record refers by name to a previously defined MAP and or WEIGHT record, if any. The MAP and WEIGHT record refer to a previously defined MESH record.

3. A T-set is created by the first reference to its name on an ARRAY record. All arrays that reference the same T-set name become members of the same T-set in the order of definition. A DATA record is associated with a T-set and all arrays in the same T-set must appear in the same DATA record. NSET determines the maximum number of T-sets.
4. The geometry of a data array is determined by the corresponding MAP array.

This example illustrates how a function FRAY(X) need not be defined at all points of the MESH. An array may be defined over any subset of the MESH. Routine CTOMAP defines the correspondence of FRAY with its coordinates.

C.7.13.2 Commands And Sample Plots For Example Data File

```
BEGIN MAXTIM=200
READ ABLE
```

```
DEF FA=FRAY, $XNAME, $YNAME, NAME
PLOT X1=NAME, X2=VRAY, WRAY, FA
```

```
DEF FB=FRAY, XNAME, YNAME, NAME=1
PLOT X1=XNAME, X2=YNAME, X3=FB
```

```
DEF GA=FRAY, $XNAME, NAME=1
DEF GB=FRAY, $XNAME, NAME=50
PLOT X1=YNAME, X2=GA, GB
```

```
DEF HA=FRAY, XNAME=11, YNAME=11, NAME
DEF HB=FRAY, XNAME=11, YNAME=15, NAME
PLOT X1=NAME, X2=HA, HB
```

C.8 CODE OUTLINE

The following is a brief outline of the program as an aid to anyone who needs to know how the code is structured. No attempt is made to be complete; only a few primary subroutines are mentioned to provide a broad view of the program flow.

C.8.1 Flow Diagram

C.8.2 Brief Purpose of Each Routine

PAD	Main program makes a single call each to subroutine COMMAND and FRMPLT.
COMMAND	Processes command statements. Calls NXTCMD, REDCHK, REDBGN, PLTCHK, DEFCHK, TLOOP.
NXTCMD	Fetches next command statement from input deck. Calls NXTSTMT.
NXTSTMT	Reads next command statement and cracks the statement into ITEMS and SEPARATORS.
REDCHK	Checks READ command and sets appropriate parameters.
REDBGN	Opens new data file. Must be preceded by a call to REDCHK. Calls SITCOM, INIAL, REDDES.
SETCOM	Sets up table space for next data file.
INITAL	Initialize tables for next data file.
REDDES	Reads Descriptive records from data file, and creates MAP, MESH, WEIGHT, ARRAY, and Name Table entries.
PLTCHK	Checks PLOT command and creates appropriate table entries.
DEFCHK	Checks DEF command and creates appropriate table entries.
TLOOP	Processes all DATA records from the current data file, and closes the data file. Calls ORDERL, READTL, LASTTL.
ORDERL	Allocates storage space and determines the processing order for arrays within each T-set.
READTL	Reads T-set data and processes the arrays in the order defined by ORDERL.
LASTTL	Terminates processing of data file and fills unfinished tables.
FRMPLT	Loops through the frames and calls the appropriate plot routines.
PLT2CV	Routine for 2D plot.
PLTA3TA	Routine for 3D table plot.

C.9 CODING NEW PLOT SUBROUTINES

C.9.1 To Modify the Existing Subroutines

The current PLOT routine names are PLT2CV and PLT3TA. The first is 2D and the second is 3D. One may substitute for either of these routines by a routine with the same name.

C.9.2 To Code New Subroutines With Different Names

If one wishes to use a plot routine with a name different from the standard routines the subroutine FRMPLT must be modified, and the PL key must be specified on each PLOT command that requires the new routine. The name specified by the PL key is stored by PAD in the common block /FRAMES/ in the word NAMPLT. Subroutine FRMPLT loops through each frame. This loop must be modified to accept the new plot routine name by adding one more test statement for each new routine. Use the existing statements as a guide.

C.9.3 Rules to Follow in Coding a New Plot Routine

Whether one uses step 9.1 or 9.2 the plot routine should be coded using the DISSPLA library according to the following criteria. (If one wishes to substitute a different Graphics Library for DISSPLA it is necessary to rewrite routine FRMPLT to initialize the device drivers, etc.)

- (a) Each call to the plot routine should do all plotting for one frame.
- (b) The first call to DISSPLA should be to routine BGNPL to initialize the frame. The last call to DISSPLA should be to routine ENDPL to terminate the frame.
- (c) The routine has five arguments NCURVS, NDIM, LOGX1, LOGX2, and LOGX3, respectively. All are input only. NCURVS is the number of curves (surfaces) to plot on the frame. NDIM is either 2 or 3 for 2D or 3D. 2D means the routine is to plot data arrays F(X1, X2). LOGXK is 0 for linear XK-axis, and 1 for log XK-axis.
- (d) Communication with PAD is by means of the subroutines ERROR, XTRMUM, LABELS, GETCRV, and GETDAT, or the common block /OPTION/.

C.9.4 Interaction With PAD

The following Fortran subroutines in the PAD program library are needed to produce a compatible plot routine.

- I. SUBROUTINE ERROR (PLTNAME, NAME, VALUE, MESSAGE)

This subroutine is used to produce a PAD fatal error message.

PLTNAME = 1-6 character name of plot routine, for traceback.

NAME = A name of something associated with the error. Blank if not used.

VALUE = Real value of something associated with the error, or zero.

MESSAGE = Error message to be printed.

The error message produced will have the form

```

$$$$$$ ERROR DETECTED BY ROUTINE (pltname) $$$$$$
(message from call)
$$$ (name) (value)

```

II. SUBROUTINE XTRMUM (XIMIN,XIMAX,X2MIN,X2MAX,X3MIN,X3MAX)

This routine returns the axis limits for the X1, X2 and X3 axes. The values are calculated from the data unless they have been replaced by the WINDOW parameters.

III. SUBROUTINE LABELS (CODE, LABEL, LGTH)

This routine returns the label corresponding to the requested code.

ICODE = 1 to 7 for L1, L2, L3, H1, H2, H3, ID, respectively. (input)

LABEL = Character label of length LGTH characters. (output)

IV. SUBROUTINE GETCRV (NPTS, MAXPTS, F, X1, X2, NX, XI, XJ)

Routine to fetch the next curve (or surface) to plot.

NPTS= Maximum number of points to fetch (input) Actual number of points fetched (output)

MAXPTS = Total number of points on curve (output)

F = Array of NPTS real data values to plot.

X1 = Array of NPTS real values for X1 coordinates.

X2 = Array of NPTS real values for X2 coordinates, 3D only.

NX = Maximum dimension of XI and XJ work arrays (same as mesh length).

XI = Work array of NPTS dimension for X1-mesh.

XJ = Work array of NPTS dimension for X2-mesh.

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NOTE:

- (a) For a 2D curve the points are (X1(I), F(I)) for I = 1 to NPTS, and the arrays X2 and XJ are not used.
- (b) For a 3D surface the points are (X1(I), X2(I), F(I)).
- (c) When fewer than MAXPTS are fetched in the call to GETCRV (NPTS MAXPTS) subsequent points are fetched by a call to routine.

SUBROUTINE GETDAT (NPTS, F, X1, XI, X2, XJ)

which uses the same parameters as GETCRV except for MAXPTS and NX which are not needed. The work arrays XI and XJ must not be changed between calls.

- (d) There is a minimum number of points that can be fetched by a call to GETCRV; that is, the number of points per T-step. Normally, for a 2D curve one transfers the entire curve in one call to GETCRV; for a 3D surface it may be necessary to transfer the surface in chunks due to limited memory.

C.9.5 Common Block Needed for Communication with PAD

The common block /OPTION/ contains the values needed by the DISSPLA routines for the current frame. These values should not be reset by a user written plot routine. Refer to LET command for further details. The common block is accessible using the UPDATE library for PAD with *CALL OPTION

WORD	DESCRIPTION
KDFALT	For PAD use only.
KOPTON	For PAD use only.
XAXIS	Length of X-axis in inches.
YAXIS	Length of Y-axis in inches.
XPOS	Relative X-shift of Legend in inches.
YPOS	Relative Y-shift of Legend in inches.
XORG	X-coordinate of physical origin in inches.
YORG	Y-coordinate of physical origin in inches.
PAGEX	Length of Page in X-direction in inches.
PAGE	Length of Page in Y-direction in inches.
HGHT	Nominal character height in inches.
SLIDE	Slide option parameter.
WINDOW(6)	Window option parameters.

C.10 EXAMPLES OF PAD USAGE

C.10.1 Running PAD on IBM-RISC-6000 Workstations

To run PAD on a IBM-RISC-6000 workstation, enter the following command at the UNIX prompt:

```
UNIX> runpad device <padinp>& padout &
```

where UNIX> is the UNIX prompt, runpad is the script file to run the PAD program (see Table C.1), device specifies the printer device to be used (e.g., post specifies a HP laser jet III Si printer in postscript, and talaris specifies a TALARIS 1590 printstation at BNL), padinp is the input file name for PAD, padout is the output file name for PAD, the first ampersand & asks to print error messages, if any, and the second ampersand & requests that the PAD run be executed as a background job. An example of the PAD input file called padinp.eoc is given in Table C.2 as a user's guide.

The PAD run with DISSPLA will produce a plot file called post.dat which is then sent to a laser printer to obtain the printed graphic plots defined by the input file padinp.

Table C.1 PAD Script File RUNPAD for DISSPLA

```
# Execute PAD program.
set pad_directory = "/u21/necs02.dne.bnl.gov/berry/pad"
set echoe = $pad_directory/echoe # writes to standard error
if ($#argv == 0) then
    $echoe "Usage: pad device <pad_command_file>pad_output_file"
    $echoe " device = device name: talaris, etc."
    exit
endif
if (-e $pad_directory/$argv[1]) then # check if device file exists
    set argv[1] = $pad_directory/$argv[1] # define the full path to device
else
    $echoe "The device $argv[1] is not defined."
    exit
endif

$pad_directory/pad $argv
rm fort.60
exit
```

Table C.2 PAD Input File PADINP.EOC for DISSPLA

```

BEGIN MAXTIM=100000,MAXBUF=200000

READ ramona, PR=1

LET H1="SBWR MSIV CLOSURE ATWS WITH 1/4 CORE MODEL at EOEC"
LET H2=""

DEF PWZ=Pow(z), X=1, Y=1, Z, TIME=0.0
PLOT X1=Z, X2=PWZ, TR=X1/274.32+0.0277778,
H3="INITIAL CORE-AVERAGE AXIAL POWER DISTRIBUTION AT EOEC",
L1="FRACTION OF CORE HEIGHT",
L2="RELATIVE POWER"

DEF POW1=Pow_xyz, X, Y, $Z, TIME=0.0
PLOT X1=X, X2=Y, x3=POW1,
H3="INITIAL RADIAL POWER DISTRIBUTION AT EOEC",
L1="I - COORDINATE",
L2="J - COORDINATE"

PLOT X1=TIME, X2="PowFiss",
H3="RELATIVE FISSION POWER",
L1="TIME (S)",
L2="FRACTION OF RATED"

PLOT X1=TIME, X2=ROTP/ROVP/ROSP/RODP/ROTOP,
ID="MODERATOR"/"VOID"/"SCRAM"/"DOPPLER"/"TOTAL",
H3="TIME BEHAVIOR OF REACTIVITIES",
L1="TIME (S)",
L2="REACTIVITY (pcm)"

PLOT X1=TIME, X2="Prs_dome",
H3="AVERAGE VESSEL PRESSURE",
L1="TIME (S)",
L2="PRESSURE (PA)"

DEF WFW2=W_fw/1064.0
DEF WSL2=W_sl/1064.0
PLOT X1=TIME, X2=WFW2/WSL2,
ID="Feedwater Flow"/"Steam Flow",
H3="FEEDWATER AND STEAM MASS FLOW RATE",
L1="TIME (S)",
L2="FRACTION OF RATED"
PLOT X1=TIME, X2="PSI_tot"/"W_sl",
ID="Total Vapor Generation"/"Steam Flow",
H3="STEAM FLOW RATE AND TOTAL VAPOR GENERATION RATE IN RPV",

```

Table C.2 PAD Input File PADINP.EOC (Cont'd.)

L1="TIME (S)",
L2="VAPOR GENERATION RATE (KG/S)"

WINDOW
PLOT X1=TIME, X2="T_fw",
H3="FEEDWATER TEMPERATURE",
L1="TIME (S)",
L2="TEMPERATURE (C)"

PLOT X1=TIME, X2="Cori_sub",
H3="CORE INLET SUBCOOLING",
L1="TIME (S)",
L2="SUBCOOLING (C)"

PLOT X1=TIME, X2="Void_inc",
H3="CORE AVERAGE VOID FRACTION",
L1="TIME (S)",
L2="VOID FRACTION"

DEF FWDC=W_dcout/7560.
PLOT X1=TIME, X2="FWDC",
H3="TOTAL CORE INLET MASS FLOW RATE",
L1="TIME (S)",
L2="FRACTION OF RATED"

DEF FWIN=W_cin/7560.
PLOT X1=TIME, X2="FWIN",
H3="CORE CHANNEL INLET MASS FLOW RATE",
L1="TIME (S)",
L2="FRACTION OF RATED"

DEF V1=WIN, X=17, TIME
DEF V2=WIN, X=184, TIME
PLOT X1=TIME, X2=V1/V2,
ID="Channel 17"/"Channel 184",
H3="INLET MASS FLOW RATES AT CHANNELS 17 AND 184 (BYPASS)",
L1="TIME (S)",
L2="FLOW RATE (KG/S)"

PLOT X1=TIME, X2="Mixt_lev"/"Clps_lev",
H3="MIXTURE LEVEL AND COLLAPSED WATER LEVEL RESPONSE",

ID="Mixture Level"/"Collapsed Level",
L1="TIME (S)",
L2="WATER LEVEL (M)"

Table C.2 PAD Input File PADINP.EOC (Cont'd.)

```

PLOT X1=TIME, X2=Tf_aver/Tf_max,
ID="Ave Channel"/"Hot Channel",
H3="AVERAGE AND HOT CHANNEL FUEL TEMPERATURES",
L1="TIME (S)",
L2="TEMPERATURE (C)"

```

```

PLOT X1=TIME, X2="Tc_max",
H3="PEAK CLAD TEMPERATURE",
L1="TIME (S)",
L2="TEMPERATURE (C)"

```

```

END

```

C.10.2 Running PAD on SUN-SPARC-10 Workstations

The SUN-SPARC-10 workstations at BNL do not have the proprietary DISSPLA graphic package installed. However, we have installed the NASADIG graphic package developed by NASA. To run PAD on a SUN-SPARC-10 workstation using NASADIG, enter a similar command as for DISSPLA at the UNIX prompt as follows:

```

UNIX> padx <padxinp> & padxout &

```

where padx is the script file to run PAD using NASADIG (see Table C.3), padxinp is the input file name (an example is given in Table C.4), and padxout is the output file name. The function of the ampersands & is the same as before. Note that the first line 12 in Table C.4 is essential and must be present for using NASADIG.

The PAD run with NASADIG will produce a plot file called POSTSC_LIS which is then sent to a laser printer to obtain the printed graphic plots defined by the input file padxinp.

Table C.3 PAD Script File PADX for NASADIG

```

# Execute PAD program.
rm POST* pad.trace
set pad_directory = "~berry/pad"
set echoe = $pad_directory/echoe # writes to standard error
if ($#argv > 0) then
    $echoe "Usage: padx <pad_command_file> <pad_output_file>"
    exit
endif

```


Table C.3 PAD Script File PADX for NASADIG (Cont'd.)

```
$pad_directory/pad $argv
rm fort.60
```

Table C.4 PAD Input File PADXINP for NASADIG

```
12
BEGIN MAXTIM=100000,MAXBUF=200000

READ ramona, PR=1

LET H1="SBWR RESPONSE TO A 0.5 BAR PRESSURE PULSE AT RATED CONDITION"
LET H2=""

DEF PWZ=Pow(z), X=1, Y=1, Z, TIME=0.0
PLOT X1=Z, X2=PWZ, TR=X1/274.32+0.0277778,
H3="INITIAL CORE-AVERAGE AXIAL POWER DISTRIBUTION AT T=0.0",
L1="FRACTION OF CORE HEIGHT",
L2="RELATIVE POWER"

WINDOW X1=0.0,10.0 X2=200.0,230.0
PLOT X1=TIME, X2="T_fw",
H3="FEEDWATER TEMPERATURE",
L1="TIME (S)",
L2="TEMPERATURE (C)"

DEF WFW2=W_fw/1064.0
DEF WSL2=W_sl/1064.0
WINDOW X1=0.0,10.0, X2=0.9,1.1
PLOT X1=TIME, X2=WFW2/WSL2,
ID="Feedwater Flow"/"Steam Flow",
H3="FEEDWATER AND STEAM MASS FLOW RATE",
L1="TIME (S)",
L2="FRACTION OF RATED"

WINDOW X1=0.0,10.0, X2=500.0,1500.0
PLOT X1=TIME, X2="PSI_tot"/"W_sl",
ID="Total Vapor Generation"/"Steam Flow",
H3="STEAM MASS FLOW RATE AND TOTAL VAPOR GENERATION RATE IN RPV",
L1="TIME (S)",
L2="VAPOR GENERATION RATE (KG/S)"
```

Table C.4 PAD Input File padxinp for NASADIG (Cont'd.)

WINDOW X1=0.0,10.0, X2=7.0E6,7.4E6
 PLOT X1=TIME, X2="Prs_dome",
 H3="AVERAGE VESSEL PRESSURE",
 L1="TIME (S)",
 L2="PRESSURE (PA)"

WINDOW X1=0.0,10.0, X2=5.0,15.0
 PLOT X1=TIME, X2="Cori_sub",
 H3="CORE INLET SUBCOOLING",
 L1="TIME (S)",
 L2="SUBCOOLING (C)"

WINDOW X1=0.0,10.0, X2=0.39,0.42
 PLOT X1=TIME, X2="Void_inc",
 H3="CORE AVERAGE VOID FRACTION",
 L1="TIME (S)",
 L2="VOID FRACTION"

DEF FWDC=W_dcout/7560.
 WINDOW X1=0.0,10.0, X2=0.9,1.1
 PLOT X1=TIME, X2="FWDC",
 H3="TOTAL CORE INLET MASS FLOW RATE",
 L1="TIME (S)",
 L2="FRACTION OF RATED"

DEF FWIN=W_cin/7560.
 WINDOW X1=0.0,10.0, X2=0.75,0.90
 PLOT X1=TIME, X2="FWIN",
 H3="CORE CHANNEL INLET MASS FLOW RATE",
 L1="TIME (S)",
 L2="FRACTION OF RATED"

WINDOW X1=0.0,10.0, X2=0.8,1.2
 PLOT X1=TIME, X2="PowFiss",
 H3="RELATIVE FISSION POWER",
 L1="TIME (S)",
 L2="FRACTION OF RATED"

DEF V1=WIN, X=11, TIME
 DEF V2=WIN, X=19, TIME
 WINDOW X1=0.0,10.0, X2=0.0,500.0
 PLOT X1=TIME, X2=V1/V2,
 ID="Channel 11"/"Channel 19",
 H3="INLET MASS FLOW RATES AT CHANNELS 11 AND 19",
 L1="TIME (S)",

Table C.4 PAD Input File padxinp for NASADIG (Cont'd.)

L2="FLOW RATE (KG/S)"

WINDOW X1=0.0,10.0, X2=0.0,3.0

PLOT X1=TIME, X2="Mixt_lev"/"Clps_lev",

H3="MIXTURE LEVEL AND COLLAPSED WATER LEVEL RESPONSE",

ID="Mixture Level"/"Collapsed Level",

L1="TIME (S)",

L2="WATER LEVEL (M)"

WINDOW X1=0.0,10.0, X2=500.0,1500.0

PLOT X1=TIME, X2=Tf_aver/Tf_max,

ID="Ave Channel"/"Hot Channel",

H3="AVERAGE AND HOT CHANNEL FUEL TEMPERATURES",

L1="TIME (S)",

L2="TEMPERATURE (C)"

WINDOW X1=0.0,10.0, X2=294.0,296.0

PLOT X1=TIME, X2="Tc_max",

H3="PEAK CLAD TEMPERATURE",

L1="TIME (S)",

L2="TEMPERATURE (C)"

WINDOW X1=0.0,10.0, X2=-100.0,100.0

PLOT X1=TIME, X2=ROTP/ROVP/ROSP/RODP/ROTOP,

ID="MODERATOR"/"VOID"/"SCRAM"/"DOPPLER"/"TOTAL",

H3="TIME BEHAVIOR OF REACTIVITIES",

L1="TIME (S)",

L2="REACTIVITY (pcm)"

END

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11. ABSTRACT (200 words or less)

This document is the User's Manual for the Boiling Water Reactor(BWR), and Simplified Boiling Water Reactor (SBWR) systems transient code RAMONA-4B. The code uses a three-dimensional neutron-kinetics model coupled with a multichannel, nonequilibrium, drift-flux, two-phase flow model of the thermal hydraulics of the reactor pressure vessel. The code is designed to analyze a wide spectrum of BWR and SBWR core and system transients. Chapter 1 gives an overview of the code's capabilities and limitations. Chapter 2 describes the code's structure, lists major subroutines, and discusses the computer requirements. Chapter 3 provides the instructions for installing and running the RAMONA-4B code on sun SPARC and IBM workstations. Chapter 4 contains component descriptions and detailed card-by-card input instructions. Chapter 5 gives samples of the tabulated output for the steady-state and transient calculations and discusses the plotting procedures for the steady-state and transient results. Three appendices contain important user and programmer information: lists of plot variables (Appendix A), listings of input deck for sample problem (Appendix B), and a description of the plotting program PAD (Appendix C).

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