ANL/NE-12/4

The SAS4A/SASSYS-1 Safety Analysis Code System

Nuclear Engineering Division

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The SAS4A/SASSYS-1 Safety Analysis Code System

Chapter 2:
SAS4A/SASSYS-1 User's Guide

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2.1 Introduction

This chapter contains information that will aid the user in understanding the program architecture of the SAS4A/SASSYS-1 computer code, and the relationship between its modeling concepts and the program logic and data flow. The code structure is described in terms of modules and subroutines, as are the data management features employed to communicate input and calculated data among modules. Programming language and machine-related features are discussed to facilitate computer code installation. The contents and organization of standard input and output files are described, and results from simplified example problems are included and illustrated.

2.2 Modeling Concepts and Code Structure

2.2.1 Code Structure Basis

The code structure of SAS4A/SASSYS-1 is constructed to reflect the physical modeling assumptions employed. In the core models, the basic geometric modeling element is a fuel pin, its cladding, and the associated coolant and structure, with the structure field representing wire wraps, grid plates, and/or hex cans. In the SAS4A/SASSYS-1 terminology, the term "channel" is used to denote collectively this basic element of fuel, cladding, coolant, and structure. In a single-pin model, a single average channel is used to represent the average of many pins in the reactor, and multiple channels are used to extend the model to all the pins in the reactor. In a multiple-pin model, each channel represents one or more pins in a subassembly, and multiple-pin subassembly models are joined with single-pin subassembly models to cover the whole reactor core. A single SAS4A/SASSYS-1 channel may therefore represent either one pin, or a large number of pins in many subassemblies. In either case, the elementary unit from a code structure and data management stand-point is an individual channel.

The code structure of SAS4A/SASSYS-1 is also the result of the programming language employed and the functional requirements of the phenomenological models. The programming language used for SAS4A/SASSYS-1 is ANSI FORTRAN [2-1], and the organization of the code follows the FORTRAN convention of a MAIN program with a number of subroutines and functions. For the purpose of this discussion, the subroutines and functions of SAS4A/SASSYS-1 are grouped according to purpose into one of the sixteen modules listed in Table 2.2-1. These modules are aligned in a one-to-one fashion with the phenomenological models of SAS4A/SASSYS-1, each of which is described by a chapter in this report. (The D3IF module is still in a developmental stage, and is not documented in this report, but will be described in a future volume as Chapter 17). The subroutines and functions of SAS4A/SASSYS-1 are listed in Appendix 2.1, and for each is given an assignment to a particular module and a description of the calculation performed or service provided.

Table 2.2-1: SAS4A/SASSYS Modules

Module	Purpose
ROOT	Logic path control, data management, and material properties services.
TSCL0	Single phase liquid coolant thermal/hydraulics and fuel element heat transfer.
TSPK	Reactor point kinetics and first order perturbation theory reactivity feedbacks.
PRIMAR-4	Primary and secondary coolant loops and components thermal/hydraulics and heat transfer.
CNTLSYS	Reactor and plant control and protection systems simulation.
BOP	Balance-of-plant systems and components thermal/hydraulics and heat transfer.
DEFORM-4	Oxide fuel/cladding fuel element mechanics.
DEFORM-5	Cladding mechanics for metallic-fuel elements.
SSCOMP	Metallic-fuel pre-transient characterization and material properties.
FPIN2	Metallic fuel/cladding fuel element mechanics.
TSBOIL	Two-phase (boiling) coolant thermal/hydraulics and fuel element heat transfer.
CLAP	Molten cladding relocation and heat transfer.
PLUTO2	Post-cladding-failure oxide fuel/liquid coolant interactions with fuel/coolant thermal/hydraulics.
PINACLE	Molten metallic fuel relocation and heat transfer prior to cladding failure.
LEVITATE	Post-cladding-failure oxide and metallic fuel relocation with fuel/cladding heat transfer.
D3IF	Interface to DIF3D for TSPK input data generation or DIF3D-K space/time neutronics.

In execution, the SAS4A/SASSYS-1 MAIN program makes calls to subroutines that perform a) data management initialization, b) input data reading, c) the steady state calculation, and d) the transient calculation. A flowchart for the MAIN program is shown in Fig. 2.2-1, and Fig. 2.2-2 is a flow diagram for subroutine INPDRV, the input driver routine. Figures 2.2-3 and 2.2-4 present flow diagrams for SSTHRM and TSTHRM, the steady-state and transient driver subroutines.

2.2.2 Standard Input Data Reading

INPDRV calls subroutine READIN, which reads card images from the ASCII standard input file (logical unit number 5, see Section 2.5). A complete description of the

contents of the standard input file is contained in Appendix 2.2. If called for, READIN will call subroutine RESTAR to read a binary restart file (logical unit 18). Subroutine READIN prints input data card images as they are read. Once all input has been read, subroutine DATOUT prints a copy of the final input deck as card images. If control system input has been provided, subroutine CTLIN3 will perform checking of the input data. Subroutine PMCHEK performs a similar function for input material property data. If specified, subroutine INPEDT will print a formatted version of the input data blocks. Subroutine SSIN01 initializes a number of constants used in the calculations and subroutine PRECAL prepares correlations of metallic fuel material properties (density, specific heat, and thermal conductivity) based on the Integral Fast Reactor Handbook [2-2, 2-3], if specified.

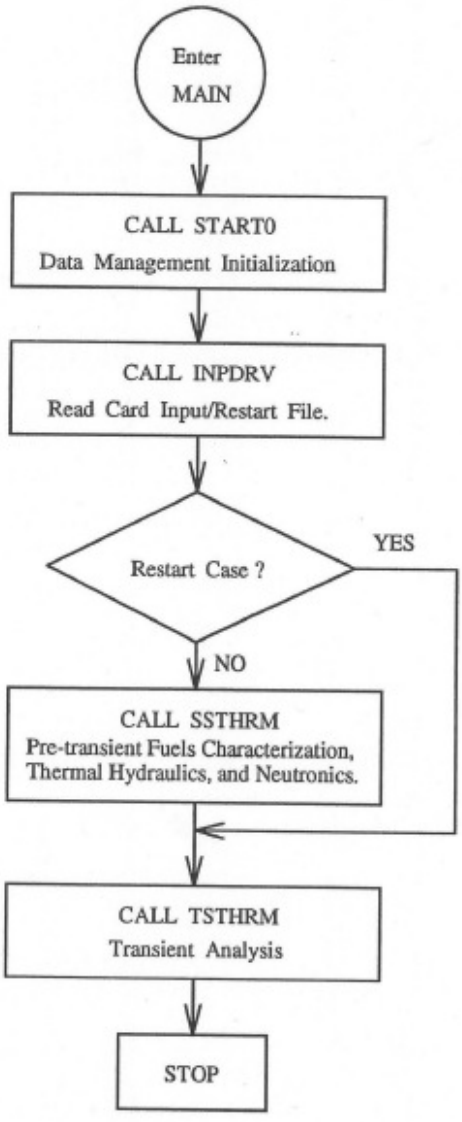


Fig. 2.2-1: MAIN Program Flow Diagram

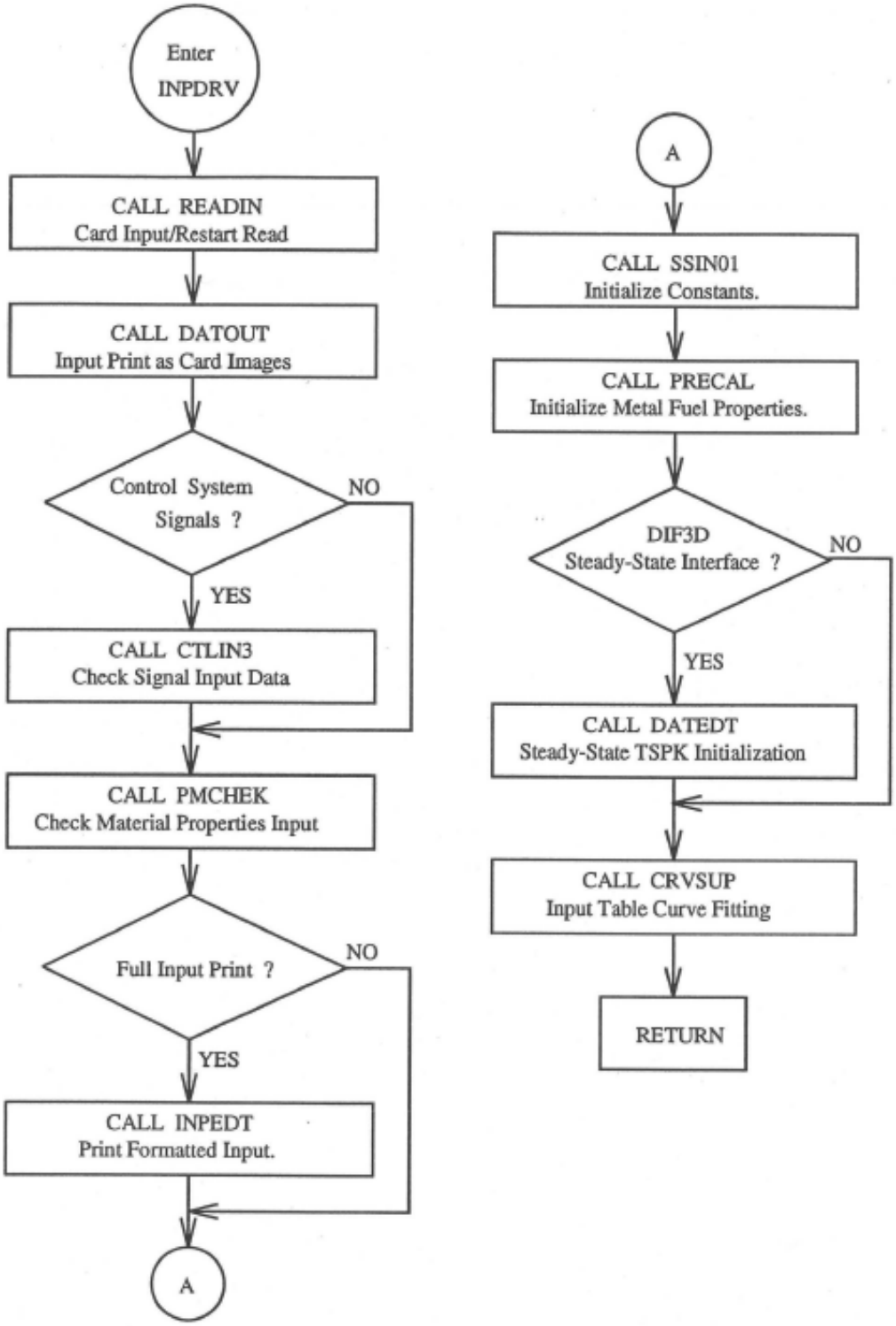


Fig. 2.2-2: INPDRV Subroutine Flow Diagram

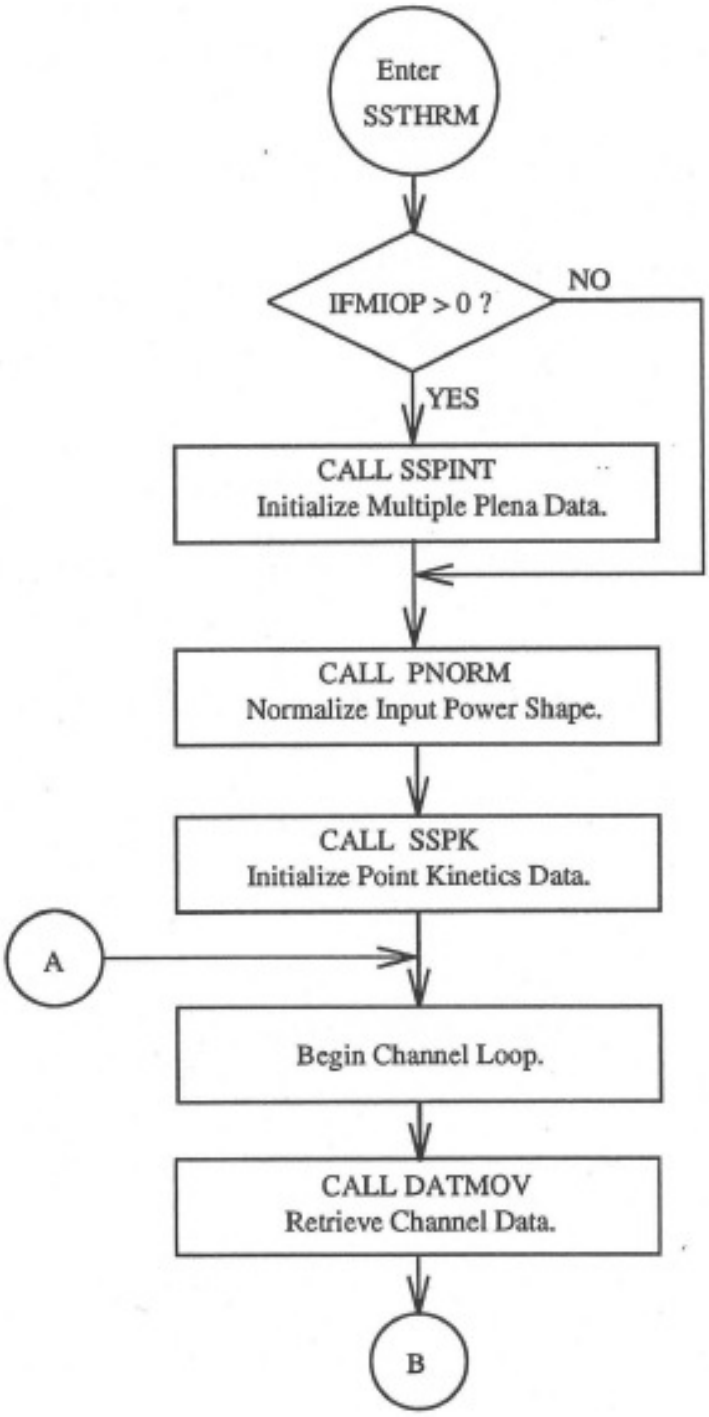


Fig. 2.2-3: SSTHRM Subroutine Flow Diagram

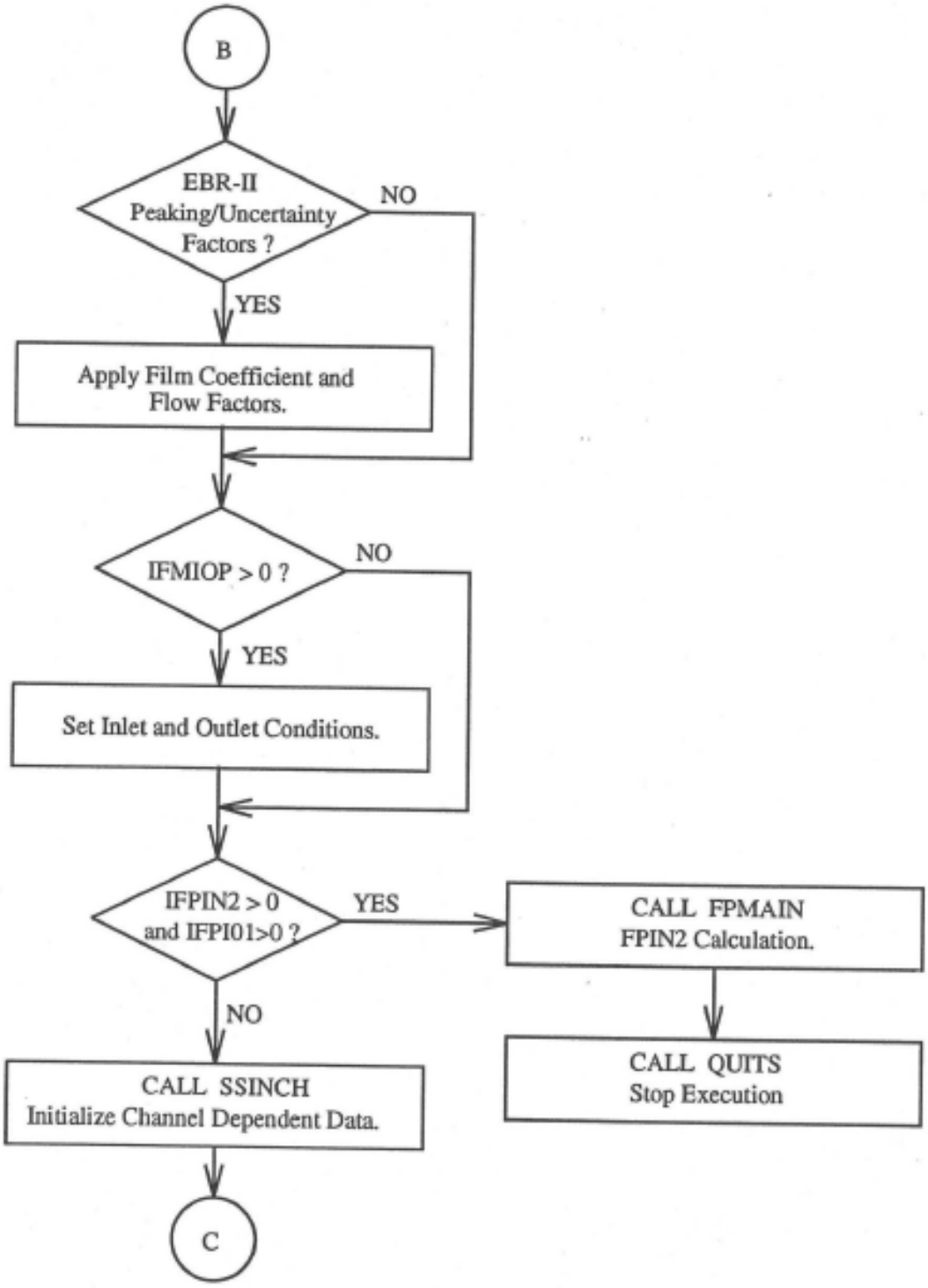


Fig. 2.2-3: SSTHRM Subroutine Flow Diagram (Cont'd)

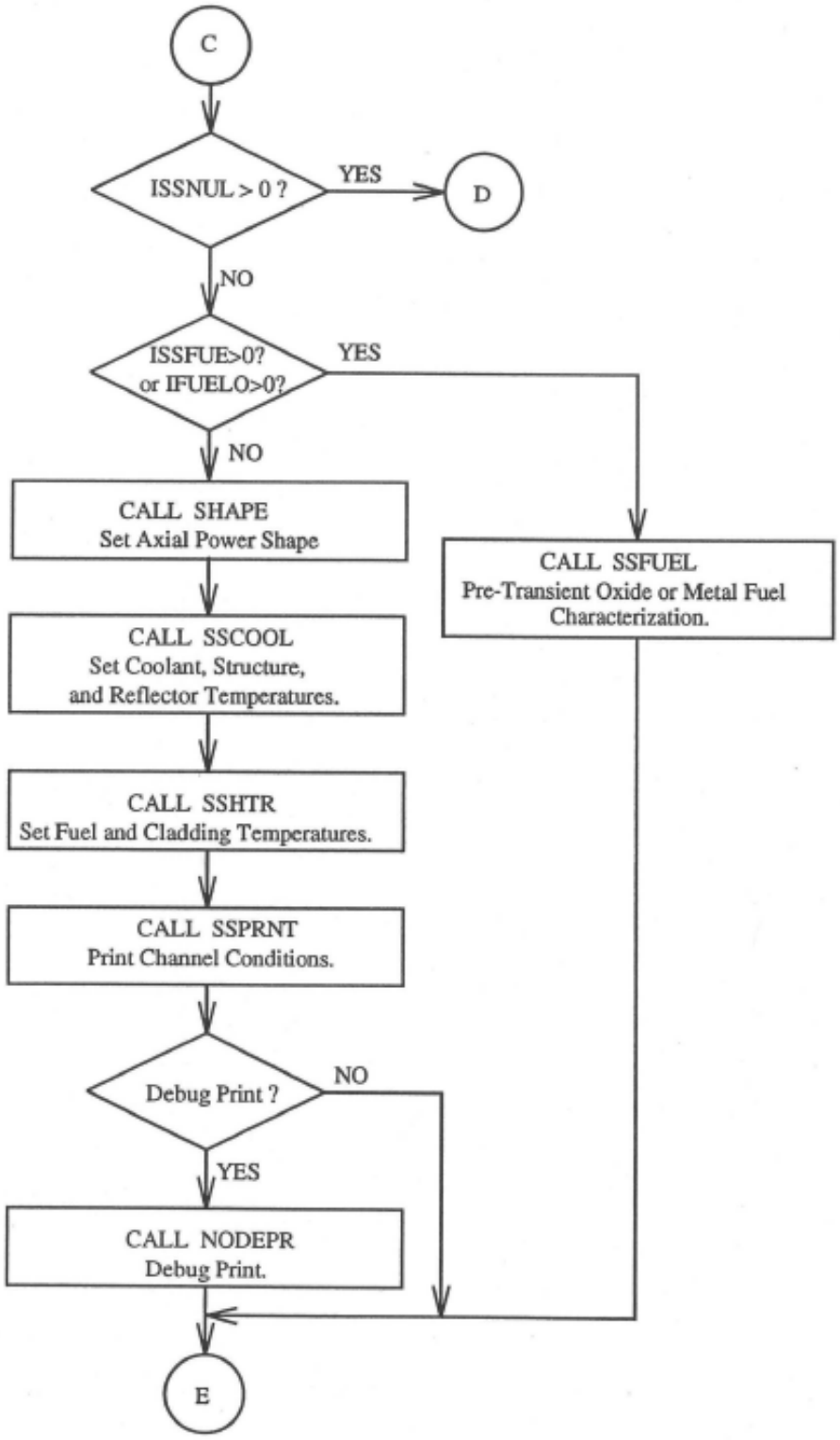


Fig. 2.2-3: SSTHRM Subroutine Flow Diagram (Cont'd)

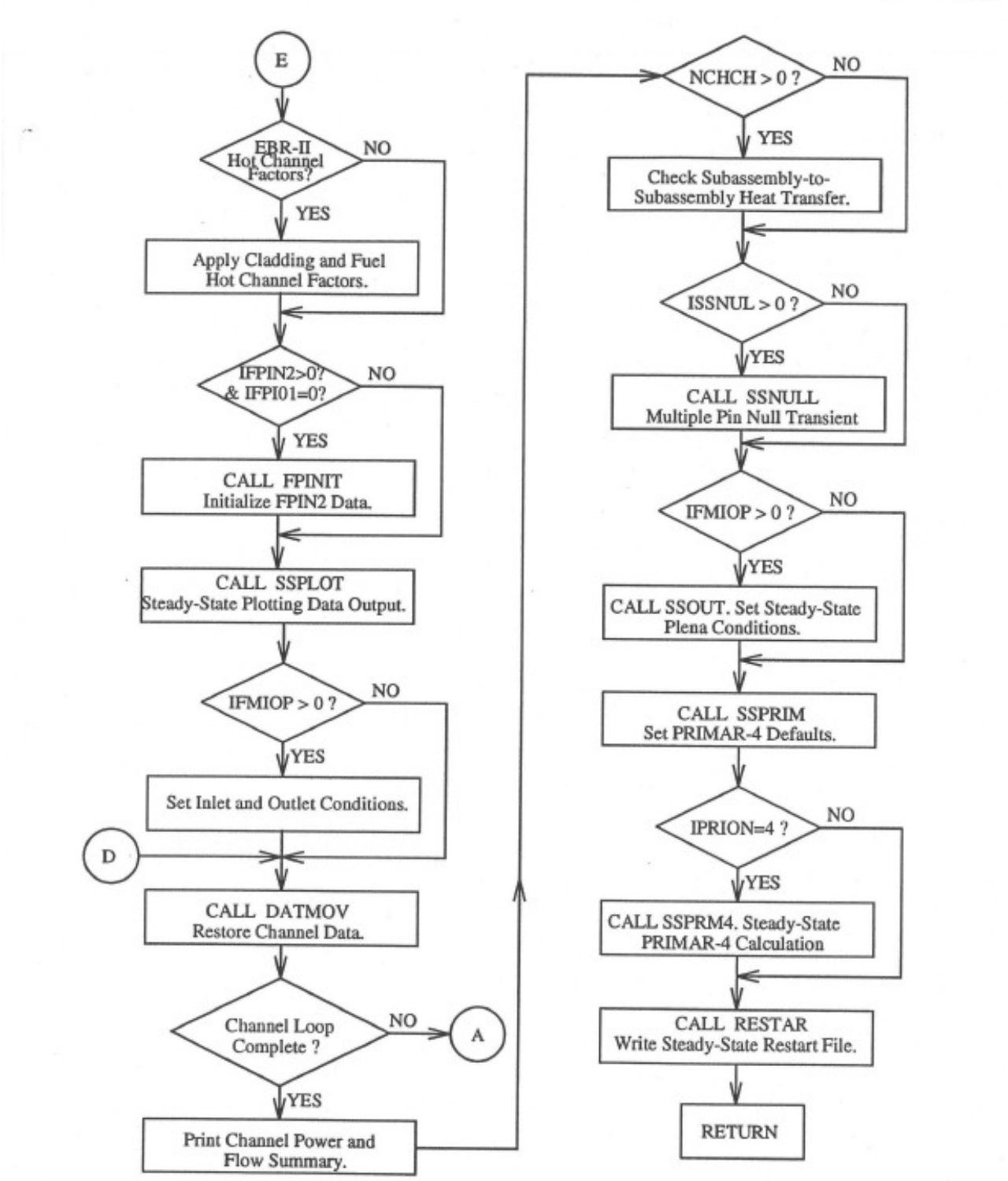


Fig. 2.2-3: SSTHRM Subroutine Flow Diagram (Cont'd)

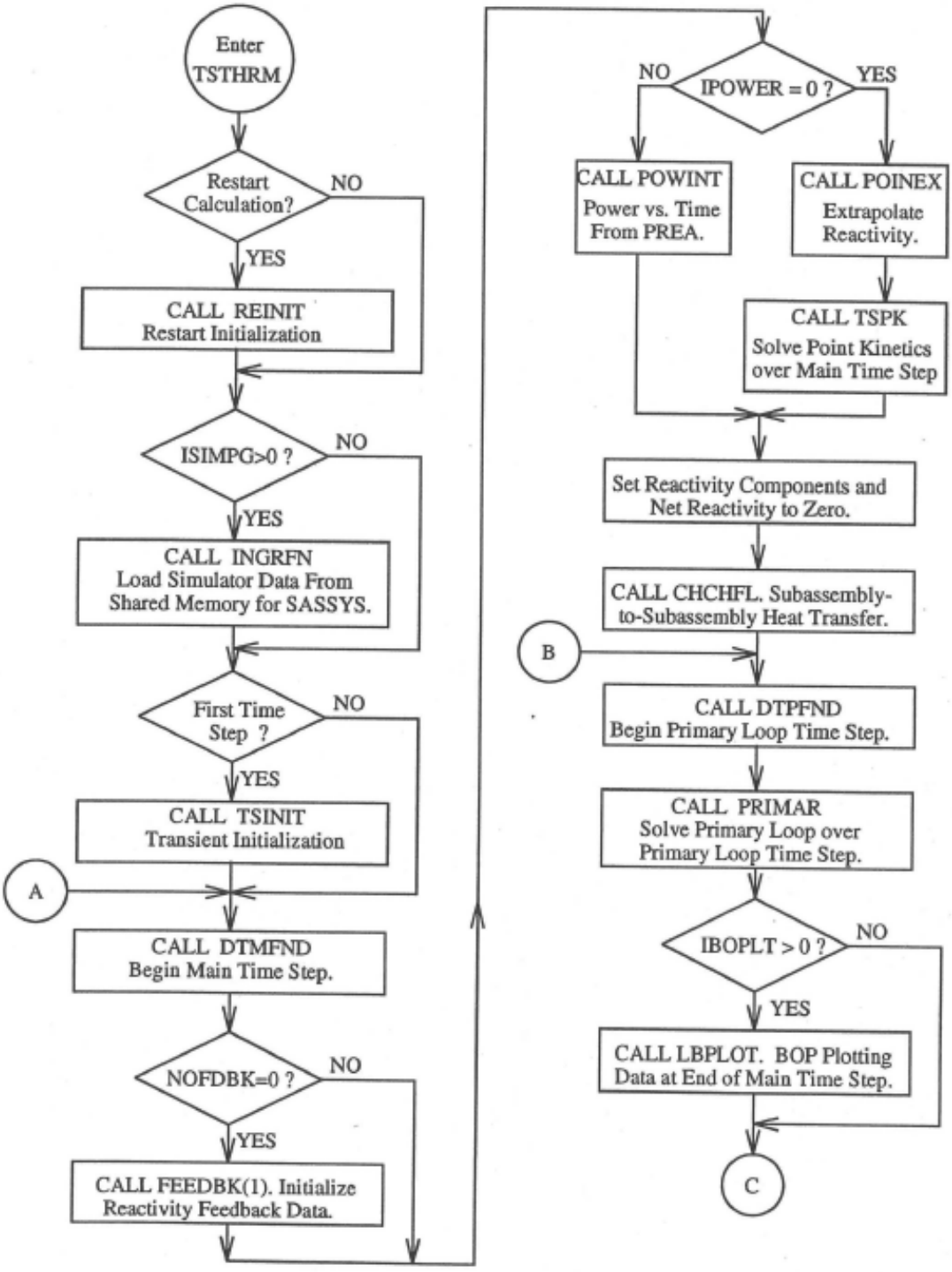


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram

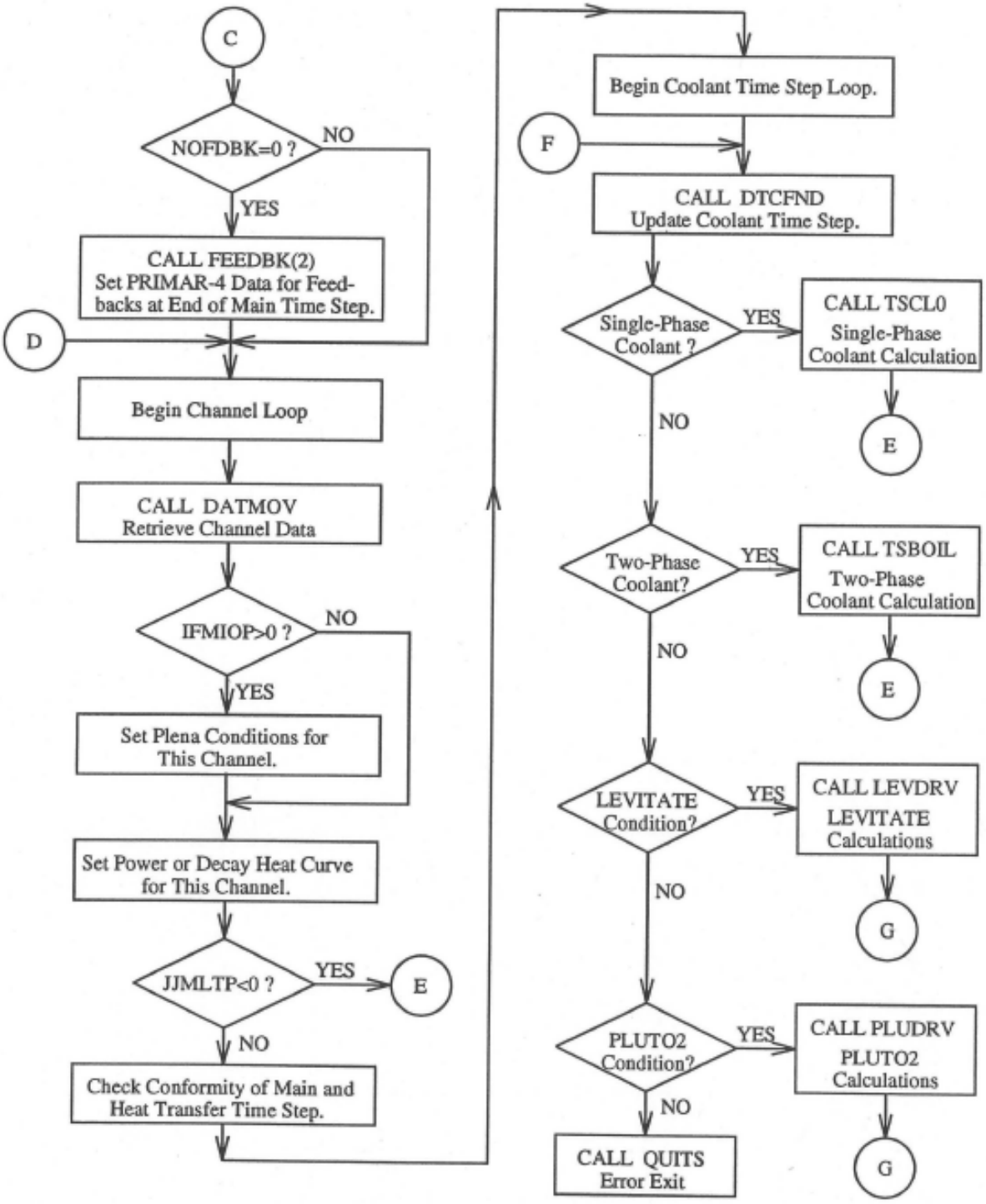


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

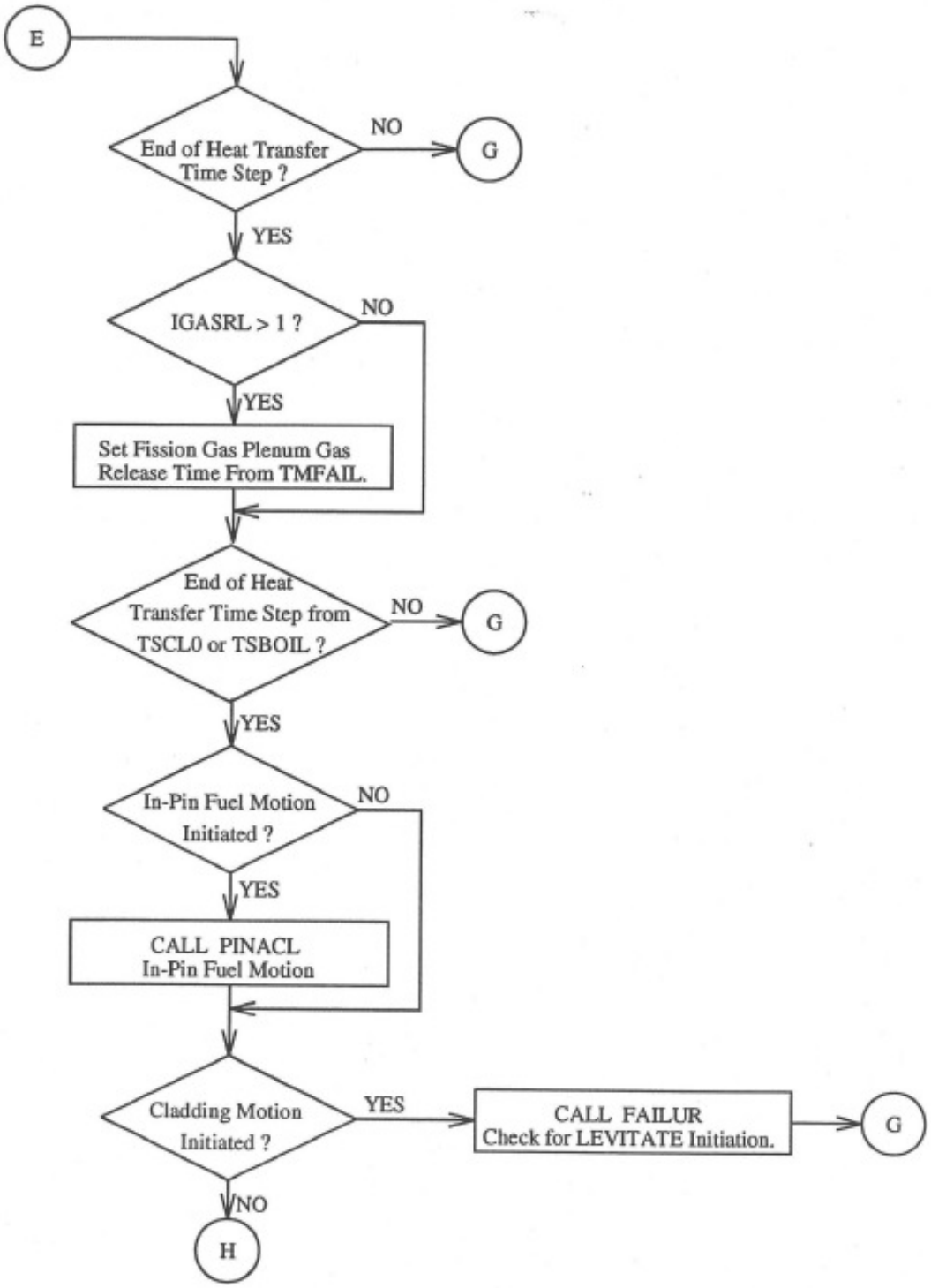


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

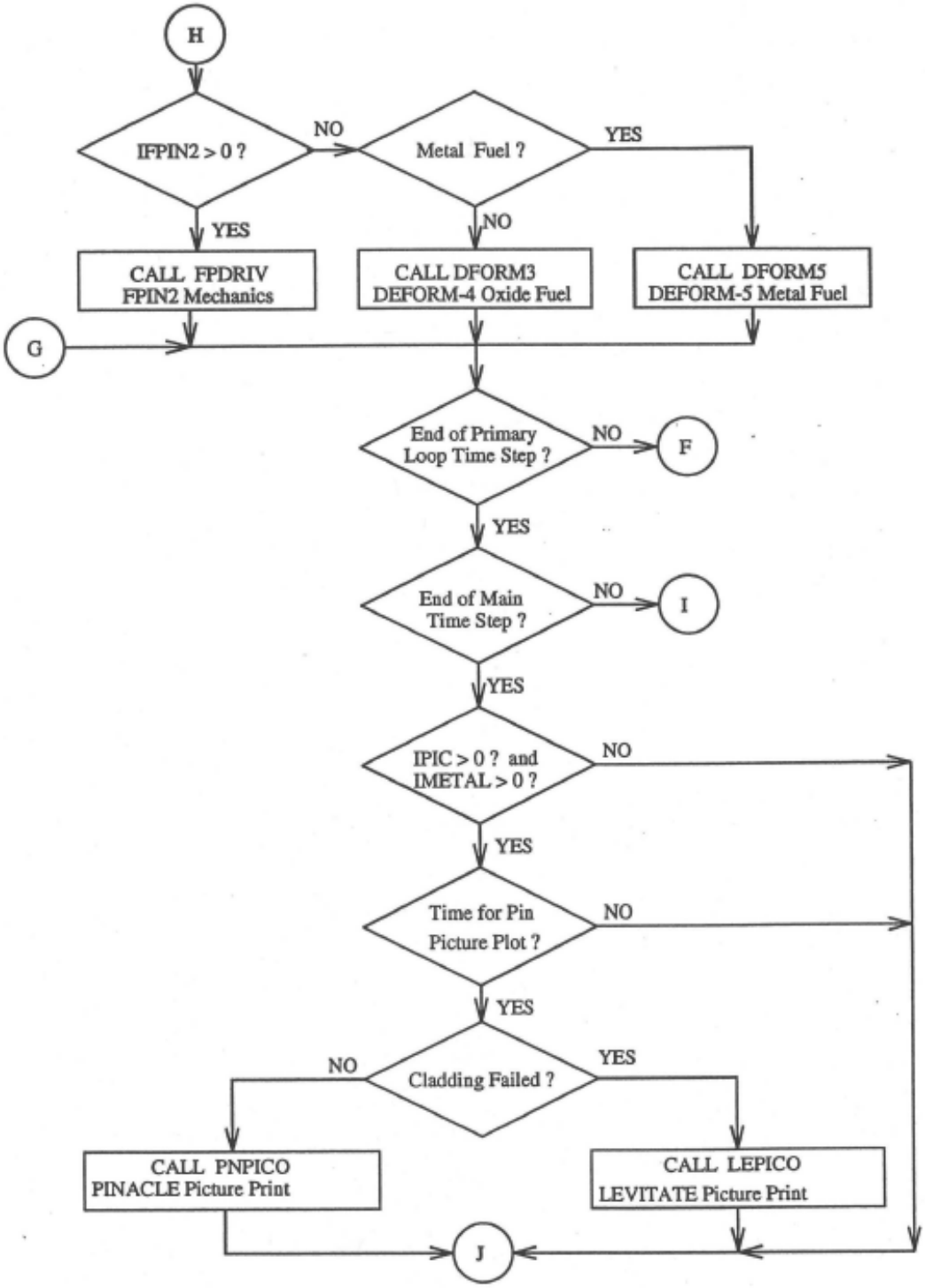


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

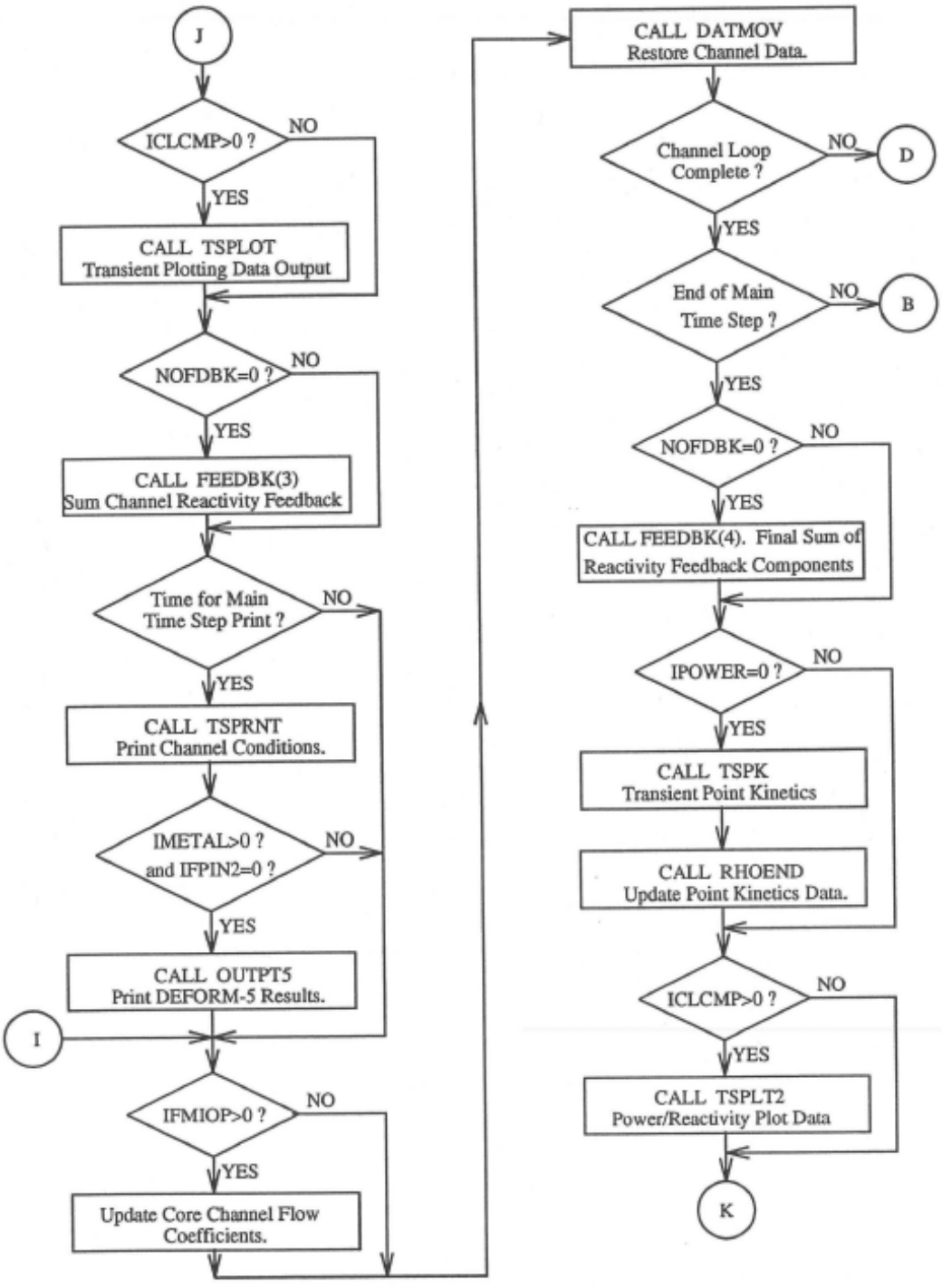


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

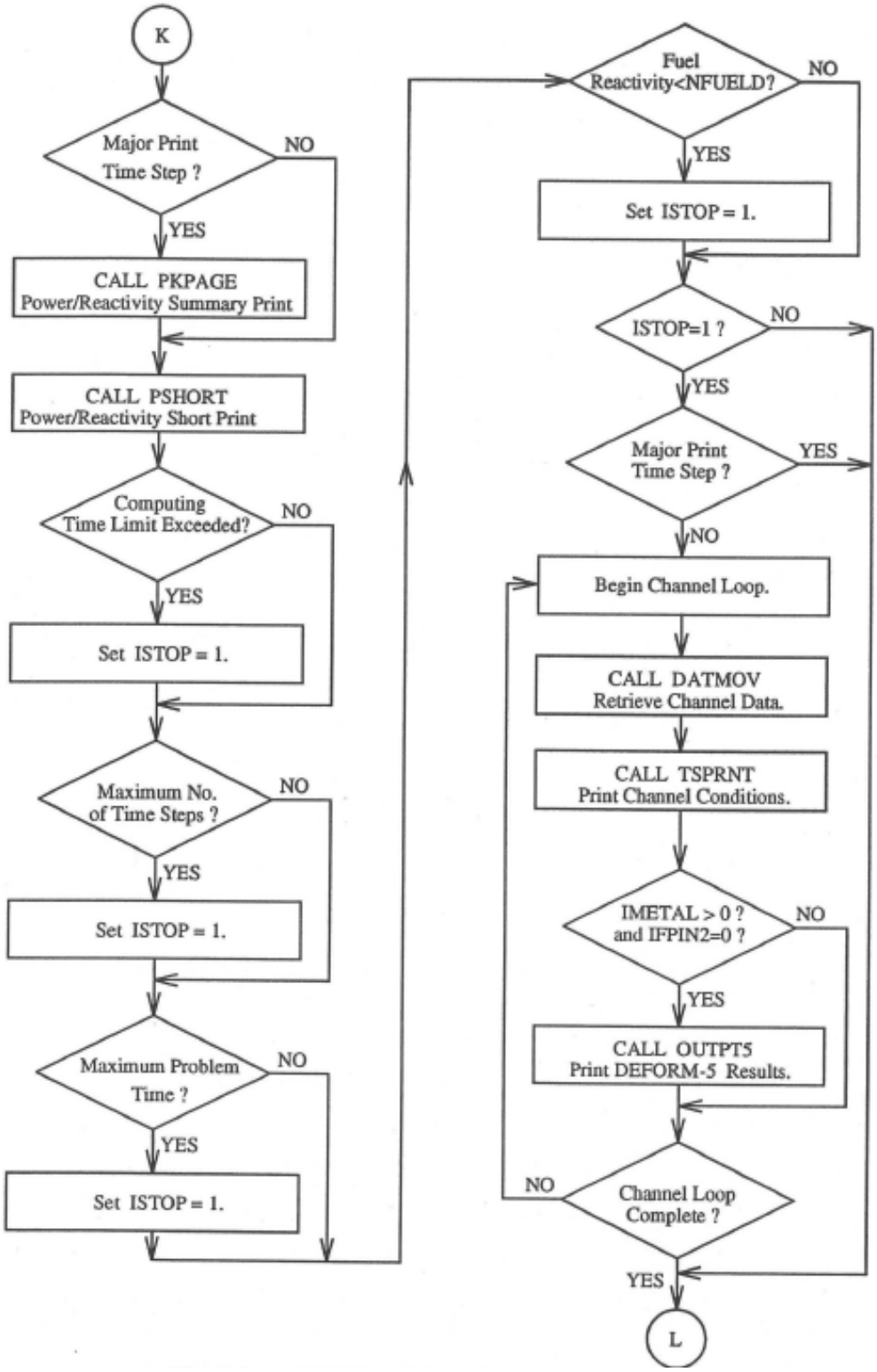


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

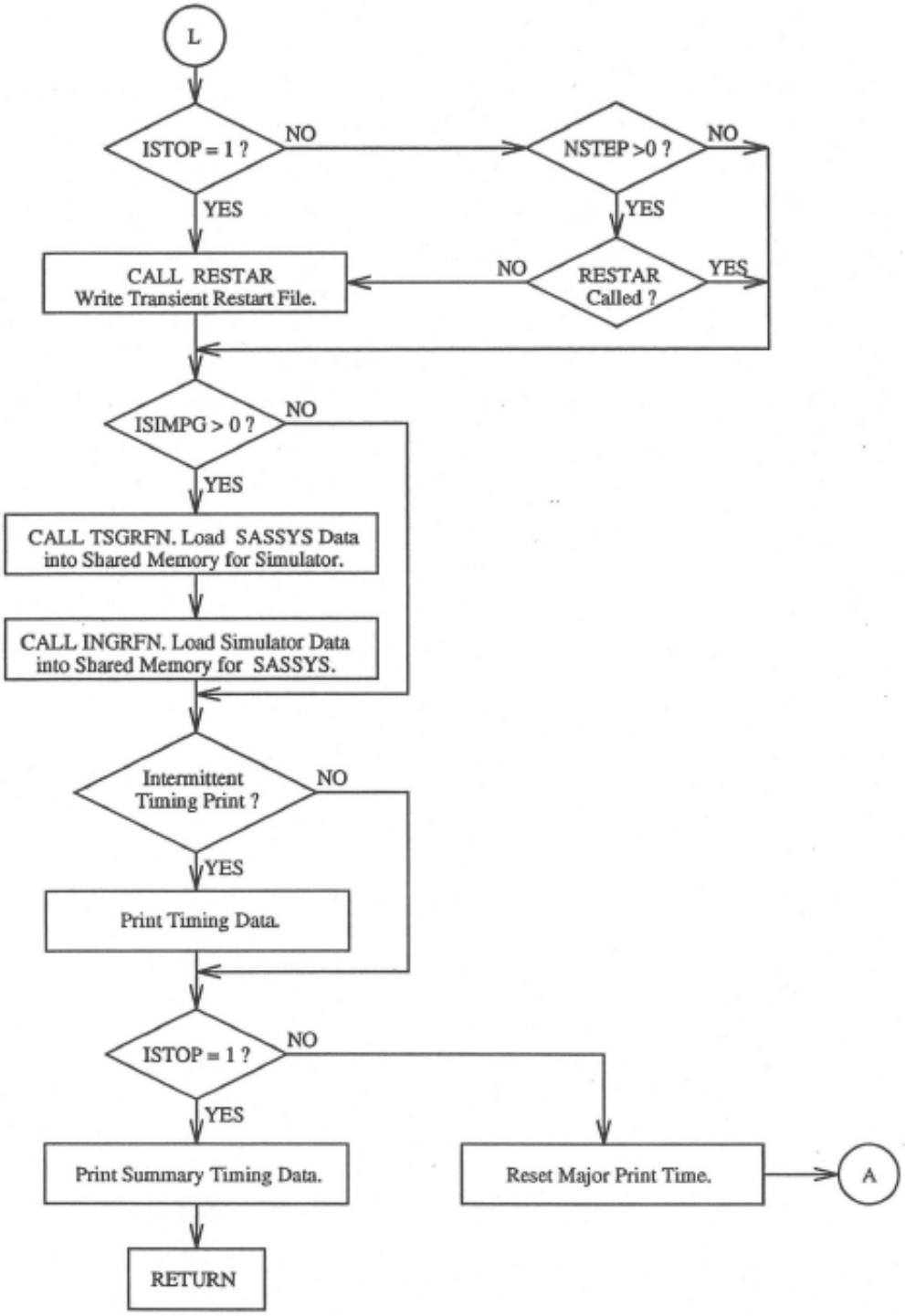


Fig. 2.2-4: TSTHRM Subroutine Flow Diagram (Cont'd)

A developmental interface to the DIF3D neutron diffusion theory code [2-4] is provided for by a call to subroutine DATEDT. When fully operational, DATEDT will manage the calculation of the reactor power distribution, reactivity feedback, and point kinetics data for the TSPK module. (Future plans call for implementation of the DIF3D-K space-time neutronics code [2-5] in SAS4A/SASSYS-1). Finally, INPDRV calls CRVSUP to supervise the fitting of various input data tables to correlations.

2.2.3 Steady-State Calculation

Figure 2.2-3 presents a flow diagram for the steady-state (pre-transient) driver subroutine, SSTHRM. SSTHRM begins by making calls to SSPINT, which initializes data for the multiple-plenum option in PRIMAR-4, to PNORM, which normalizes the reactor power distribution to the specified condition, and to SSPK, which initializes data for the point kinetics solution module, TSPK. Within a loop over all channels, SSTHRM performs optional initializations for applications of EBR-II thermal/hydraulic uncertainty factors and the multiple-plenum option. Next, an optional path to a single-channel, stand-alone execution of the FPIN2 computer code [2-6] is provided. Subroutine SSINCH performs channel-dependent data initialization, and subroutine SSFUEL manages the pre-transient thermal, hydraulic, and mechanics calculation for oxide (DEFORM-4) and metallic (SSCOMP) fuels. (The SSCOMP capability is currently limited to un-irradiated fuel material properties; irradiation effects such as swelling, porosity migration, fission gas generation and release, and fuel/cladding interactions are being added). Should the SSFUEL option not be elected, SSTHRM calls a) subroutine SHAPE to set the axial channel power distribution, b) subroutine SSCOOL to calculate the coolant, structure, and reflector temperatures, c) subroutine SSHTR to calculate the fuel and cladding temperatures, d) subroutine SSPRNT to print the steady-state temperature, geometry, and neutronics results, and e) subroutine NODEPR for an optional diagnostic print of the fuel/cladding temperature calculation. Once all temperatures have been determined, an option is available to apply hot channel factors. If the FPIN2 model is specified for the current channel, subroutine FPINIT provides the interface to the SAS4A/SASSYS-1 temperature calculation. Subroutine SSPLOT provides an entry for the writing of channel-dependent, steady-state results for subsequent plotting. The final actions in the channel loop are optional initialization of data for the multiple-plenum model and restoration of the channel data, including the calculated quantities, to the data container (the data management strategy used in SAS4A/SASSYS-1 is explained in Section 2.3). Following the channel loop, a summary of the reactor power and flow data for all channels is printed, and the optional subassembly-to-subassembly input data is checked for consistency. If the multiple-pin subassembly model has been invoked, subroutine SSNULL performs a constant power and flow transient calculation to bring the participating channels to an equilibrium temperature condition. If the multiple-plena PRIMAR-4 option is used, steady-state plena conditions are then set by a call to subroutine SSTOUT. PRIMAR-4 default values are set in a call to SSPRIM, and the optional primary loop, secondary loop, and balance-of-plant steady-state conditions are set by a call to subroutine SSPRM4. Finally, SSTHRM calls subroutine RESTAR to write a restart file on logical unit 17 defining the steady-state condition.

2.2.4 Transient Calculation

The flow diagram for subroutine TSTHRM, the transient calculation driver routine, is given in Fig. 2.2-4. If the problem is beginning from a restart file, subroutine REINIT is called to perform necessary restart initialization. Next, subroutine INGRFN is called to initialize transient driving conditions from the shared memory segment for the simulator option.

The transient problem time domain is divided into time steps as depicted in Fig. 2.2-5. Reactivity feedbacks and solutions to the point kinetics equations are obtained on the main time steps. The primary loop, secondary loop, and balance-of-plant thermal/hydraulics solutions are obtained on the primary loop time step, which is a substep of the main time step. Recalculations of the core channel temperatures are carried out on the heat transfer time steps, and solutions of the channel hydraulics equations are obtained on the coolant time steps. The heat transfer time step is a substep of the main time step, and the coolant time step is a substep of the primary loop time step. A coolant time step may not span the end of a heat transfer time step. Heat transfer and coolant time steps may vary from channel to channel for single-pin modeling, or from subassembly to subassembly for multiple-pin modeling. The time step accounting algorithm maintains consistency among the time step levels while adjusting the various step lengths to preserve power, reactivity, and temperature change limits as set by default or in the input to preserve accuracy.

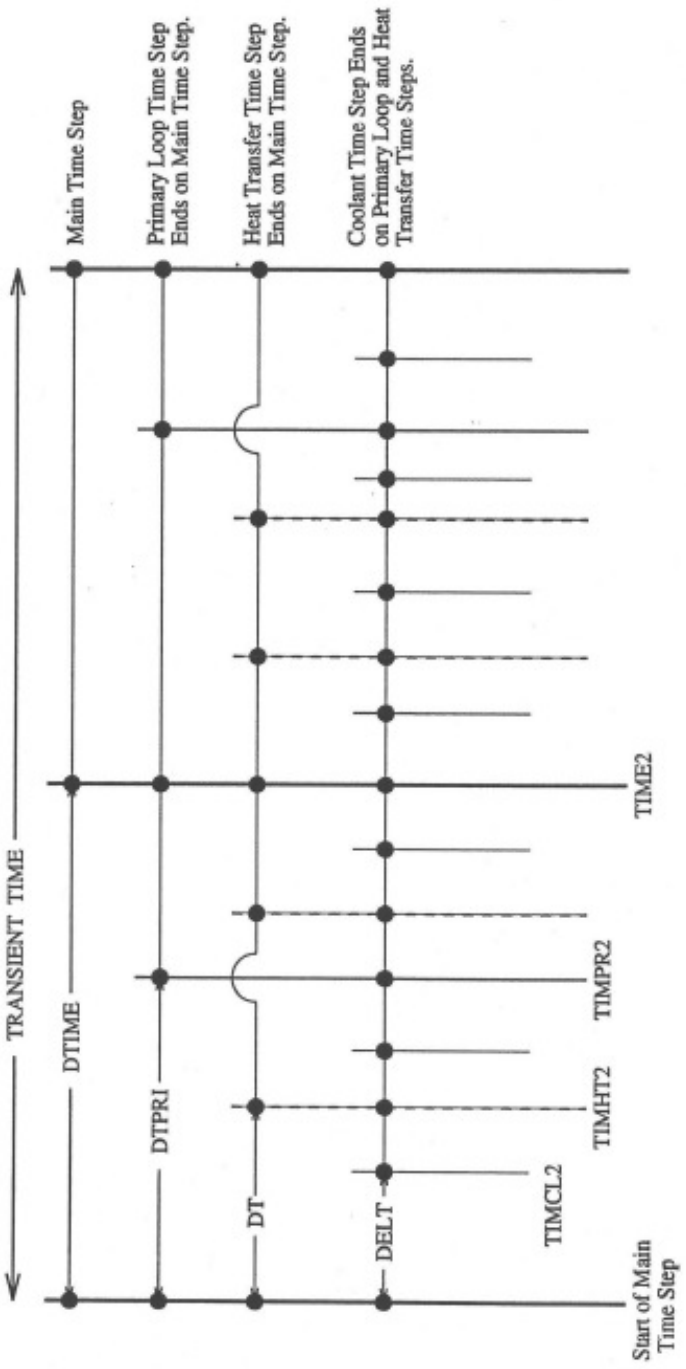


Fig. 2.2-5: SAS4A/SASSYS Time Step Hierarchy

Before the first transient main time step, subroutine TSINIT is called to perform initialization. Each main time step begins with a call to subroutine DTMFND to set the time step length, and subroutine FEEDBK is called to initialize the reactivity feedback calculation. For the power vs. time option, subroutine POWINT is called to set the reactor power variation over the time step; for the reactivity vs. time option, subroutine POINEX extrapolates the reactivity and subroutine TSPK calculates the reactor power. If the subassembly-to-subassembly heat transfer option has been specified, subroutine CHCHFL is called to calculate the channel-to-channel heat fluxes. The primary loop time step, a substep of the main time step, begins with a call to subroutine DTPFND, which sets the primary loop time step length. Subroutine PRIMAR supervises the thermal/hydraulic calculations for the primary and secondary loops and the balance-of-plant, setting temperature and flow boundary conditions for the core. Subroutine LBPLOT provides optional writing of selected balance-of-plant plotting data on the last primary loop time step in a main time step, and subroutine FEEDBK then retrieves PRIMAR-4-calculated data for calculation of reactivity feedbacks. At this point, a loop over channels is begun with a series of calls to subroutine DATMOV to fetch data for a particular channel from the data container into blank common. Optional multiple-plena conditions are then set, as is the channel decay heat or power curve. At this point, if the current channel is one of the pins in the multiple-pin subassembly model, but not the first channel, then a skip is made around the subsequent channel thermal/hydraulics driver subroutines (i.e. TSCL0, TSBOIL, LEVDRV, and PLUDRV), since this channel's thermal hydraulics solution has already been obtained within the multiple-pin model. (At present, the multiple-pin model is limited to single-phase coolant flow, but may be extended to coolant boiling and pin disruption modeling in the future). On the other hand, if this is a single-pin channel or the lead multiple-pin channel, subroutine DTCFND is called to set the coolant time step length (a subset of the primary loop time step and variable from one channel to another in the single-pin model and from one subassembly to another in the multiple-pin model). The channel coolant hydraulics solution is obtained on the coolant time step. TSTHRM then calls one of the channel thermal/hydraulics driver subroutines (TSCL0, TSBOIL, LEVDRV, or PLUDRV), depending on the thermal/hydraulics conditions in the channel. One of these driver subroutines then advances the channel calculation to the end of the current coolant time step, checking the current time along the way to determine whether a recalculation of the pin temperatures is necessary.

At this point in subroutine TSTHRM, a check is made to determine if the current coolant time step has ended on a heat transfer time step. If not, the calculation proceeds to the next coolant time step. If the end of the heat transfer has been reached, newly-determined channel temperatures are available, and this triggers tests on the need for fuel element mechanics (DEFORM-4, DEFORM-5, FPIN2) or in-pin fuel relocation (PINACLE) calculations. But first, a test is made to determine whether the input has specified the approach of a fission-gas-plenum cladding failure time, and subsequent gas release into the coolant channel. Next, a check is made to determine whether this channel has experienced cladding failure; if so, subsequent tests for fuel pin mechanics or in-pin fuel relocation are skipped. If cladding failure has not occurred, the PINACLE module is invoked if conditions are met for in-pin fuel relocation, and

subroutine FAILUR is called to check for cladding failure. If one of the fuel pin mechanics options has been specified, it is executed at this point. This brings the calculation to the bottom of the primary loop and main time step branches.

At the end of a primary loop time step, a check is made to determine whether the end of the main time step has been reached. If not, another primary loop time step will be made to advance the calculation. However, if the end of the main time step has been reached, a series of tests are made to check for the writing of plotting file data (subroutines PNPICO, LEPICO, and TSPLOT), to sum a channel's contribution to the net reactivity (subroutine FEEDBK), and to print channel conditions (subroutines TSPRNT and OUTPT5). This brings the calculation to the bottom of the channel loop, and the DATMOV subroutine is called to restore the current channel's data to the data container. A test is made to determine whether all channels have been advanced to the end of the primary loop time step; if not, the next channel is calculated, but if so, a test is made on the current time to check for the end of the main time step. If the end of the main time step has not been reached, subsequent primary loop time steps are made until the end of the main time step is found. Then, subroutine FEEDBK is called to total the net reactivity, and for the reactivity vs. time option, subroutines TSPK and RHOEND are called to solve the point kinetics equations over the main time step. If specified, the reactor power and reactivity data are added to the plotting file (entry TSPLT2), and subroutine PKPAGE is called to print the power and reactivity summary page on a time step interval set by input. Subroutine PSHORT produces a short-form power and reactivity print on each time step, followed by tests for problem termination on the basis of computing time limit, maximum number of time steps, maximum problem time, or minimum fuel motion reactivity. If a termination condition is found, a test is made to produce the major channel prints (subroutine TSPRNT) in the event they were not made on the current time step. If a termination condition is not found, the calculation continues following checks for a) the writing of restart file from subroutine RESTAR, b) the optional transfer of data to and from the shared memory segment in conjunction with the simulator option, and c) the optional print of a computing time summary. At termination, the restart file is written automatically and the final computing time summary is printed, followed by the return to program MAIN, where a summary of all subroutines entered in the calculation is printed and execution halts.

2.3 Data Management

2.3.1 Two-Level Data Storage

The data management strategy employed in SAS4A/SASSYS-1 is based on a two-level data storage concept in which the computer memory is divided into a relatively small working memory and a large storage container. This concept was originally implemented to reflect the then-existing hardware architecture of large-scale, scientific computers. With the introduction of workstation computers with large, single-level memories, the data management strategy has been upgraded to enhance computational efficiency, while retaining flexibility in adjusting to new hardware environments.

In the two-level memory layout, the working memory consists of a number of named common blocks and blank common. The named common blocks contain channel-independent input and calculated data, and the blank common contains the channel-dependent input and calculated data for one channel. The named common blocks for SAS4A/SASSYS-1 are listed in Table 2.3-1. At the second level, the storage container contains all data for all channels, with the storage for each channel arranged just as the data are arranged for the single channel in blank common. Thus, the storage area for each channel is an exact image of blank common, and the storage area is dynamically allocated at the time of execution to contain as many channels of data as the problem treats. The total number of channels is limited only by the available computer memory size; with virtual memory, the number of channels is, in principle, limited only by the operating system limits.

2.3.2 Data Transfer Options

During execution, two options are available to manage this two-level data storage. The first option accommodates the two-level hardware by moving a channel's data from the storage area to the working area when needed, and returning it to the storage area when the data is no longer needed. It is assumed that an efficient data transfer mechanism exists for these data movements. On computers with a large, single-level, directly addressable memory, the overhead associated with these data movements may become undesirable, so a second data management strategy has been implemented. In the second option, data movements are minimized by directly addressing calculated floating-point arrays in the storage area. This reduces the bulk of moved data by 80%, and therefore also reduces the data movement overhead by 80%. For the second option, the source code has been modified with the addition of an offset to the first index of all calculated floating point arrays. The offset corresponds to the memory offset between blank common and the current channel's location in the storage container. This addressing technique is a violation of the FORTRAN 77 Standard [2-1], which forbids addressing an array beyond its dimension. However, all current FORTRAN compilers will generate correct addresses with this technique.

The two options for data management are controlled with variable IDATMO in the storage allocation record of the standard input file (see Appendix 2.2). (The storage allocation record is the third input card image). The default option (IDATMO=0) results in the first option; all data is moved and overhead CPU times may become significant for some problems. For IDATMO>0, data movement is reduced, but since only the source code in modules TSCL0 and DEFORM-5 have been modified to include the extended addressing option, the option is not available for problems that attempt to execute DEFORM-4, FPIN2, TSBOIL, CLAP, PINACLE, LEVITATE, or PLUTO2. In practice, this has not been found to present an impediment to efficient computing, since these modules all generate CPU-intensive calculations that reduce the overhead fraction to a small portion of the overall computation. The extended addressing option has been found to be most beneficial for executions that employ TSCL0 and DEFORM-5 exclusively, such as the simulator application and other SASSYS-1 analysis applications.

Table 2.3-1: SAS4A/SASSYS Named Common Blocks

/Name/	Module	Description
ADDTNL	FPIN2	SAS-FPIN2 interface data.
ANEUTR	D3IF	Input Block 17 - ANEUTR.
ARRAY	D3IF	Reference memory location for BPOINTR containers.
BOPBUF	BOP	Word addresses for container variables.
BOPROP	BOP	Steam/water properties correlation coefficients.
CAVOLD	FPIN2	Computed molten fuel cavity data.
CAVTY	FPIN2	Computed molten fuel cavity data.
CFTABL	D3IF	Core file accounting data.
CGRID	FPIN2	Cladding grid information.
CMECH	FPIN2	Cladding mechanics calculation results.
CMECHO	FPIN2	Cladding mechanics calculation results.
CMPMR4	PRIMAR-4	Computed floating point data.
CNTLIN	FPIN2	Time step history input.
CONSTA	ROOT	Channel-independent problem constants.
CONTRL	D3IF	DIF3D problem control data.
CPCPCM	PRIMAR-4	Component-to-component heat transfer data.
CTLSYS	CNTLSYS	Word addresses for container variables.
das_common	ROOT	Data for simulator-mode operation.
DATA	FPIN2	Computed floating point data.
DATAO	FPIN2	Computed floating point data.
DEBUGD	FPIN2	Floating point debug input.
DEBUGI	FPIN2	Integer debug input.
DFM5WK	DEFORM-5	Temporary data storage.
DRIVIN	FPIN2	Various floating point input.
EBR2TM	ROOT	Storage for EBR-II reactivity feedback model.
ERRMSG	FPIN2	Error messages.
FCRK	FPIN2	Fuel-clad mechanics results.
FEEQUS	FPIN2	Floating point data storage for pin mechanics.
FGPOR	FPIN2	Fuel porosity information.
FGRID	FPIN2	Fuel grid information.
FLOWT2	LEVITATE	Temporary data storage.
FMECH	FPIN2	Fuel mechanics calculation results.
FMECHO	FPIN2	Fuel mechanics calculation results.

/Name/	Module	Description
FORCES	FPIN2	Floating point data storage for pin mechanics.
FPTVAR	ROOT	Floating-point data storage.
FTPCHA	PRIMAR-4	Save area for channel data.
FUELHC	FPIN2	Fuel material property information.
GEOMIN	FPIN2	Floating point geometric input.
HTDATA	FPIN2	Pin heat-transfer calculation results.
HTEQUS	FPIN2	Floating point data storage for heat transfer.
HTNEW	FPIN2	Pin heat-transfer calculation results.
HTOLD	FPIN2	Pin heat-transfer calculation results.
ICMPM4	PRIMAR-4	Computed integer data.
IDATA	FPIN2	Integer data storage.
INDEX	FPIN2	Integer data storage.
INEUTR	D3IF	Input block 7 - INEUTR.
INPCOM	ROOT	Input block 1 - INPCOM.
INPMR4	PRIMAR-4	Input block 3 - INPMR4.
INPUTI	FPIN2	Various integer input.
INTRFC	FPIN2	SAS-FPIN2 interface data.
INTVAR	ROOT	Integer data storage.
IOPUT	ROOT	Standard input and output files.
ITER	FPIN2	Implicit iteration counters.
KONTRL	ROOT	Integer problem control data.
LINCOM	ROOT	Page line count for output files.
MISCIN	FPIN2	Miscellaneous floating point input.
MPNPNT	ROOT	Word address offsets to channel data in container.
OPCIN	ROOT	Input block 11 - OPCIN.
OV6TEM	D3IF	Temporary data storage.
PAX	ROOT	Data management accounting integers.
PAXX	ROOT	Data management accounting block names.
PDERIV	FPIN2	Floating point data storage.
PKFLT	TSPK	Point kinetics solution data storage.
PLENM	FPIN2	Computed plenum data.
PMATCM	ROOT	Input block 13 - PMATCM.
PMR4IN	PRIMAR-4	Input block 18 - PMR4IN.
PRM4CM	BOP	Steam generator initialization data storage.

/Name/	Module	Description
PNTVOL	D3IF	Temporary integer storage.
POWER	BOP	Heater enthalpy segment data.
POWINA	ROOT	Input block 12 - POWINA.
PRIMCH	PRIMAR-4	Calculated core boundary conditions data.
PRIMIN	PRIMAR-4	Input block 14 - PRIMIN.
PTITL1	ROOT	Floating point and integer page title data.
PTITL2	ROOT	Character page title data.
PTITLE	D3IF	Page title data
RNEUTR	D3IF	Input block 16 - RNEUTR.
SGEN1	BOP	OTSG/Evaporator data storage.
SGEN2	BOP	OTSG/Evaporator data storage.
SGEN3	BOP	OTSG/Evaporator data storage.
SPECS	D3IF	DIF3D integer problem data
SSCPNC	PRIMAR-4	Null transient data storage.
SWLOLD	FPIN2	Floating point data storage.
TBLCFV	PRIMAR-4	Curve-fitting coefficient data storage.
TEMPIN	FPIN2	Input for cladding surface temperature history.
TIMEIT	ROOT	Problem time step data
TKMNEW	FPIN2	Fuel & cladding elastic/plastic property data.
VERNUM	D3IF	External file version number storage.
VERSID	ROOT	Subroutine identification character data storage.
VERSIN	ROOT	Subroutine identification integer data storage.
WKMAMO	LEVITATE	Temporary data storage.
WORKAT	LEVITATE	Temporary data storage.
WORKSP	ROOT	Temporary data storage.
WTR1	BOP	Loop input hydraulic data.
WTR2	BOP	Loop integer data storage.
WTR3	BOP	Loop calculated hydraulic data.
WTR4	BOP	Loop integer data storage.
WTR5	BOP	Component heat fluxes.
WTR6	BOP	Momentum equation coefficients storage.
WTR7	BOP	Pump data storage.
WTR8	BOP	Loop integer data storage.
WTR9	BOP	Loop neighbor element numbers.

/Name/	Module	Description
WTRA	BOP	Component input data.
WTRK1	BOP	Volume/segment integer flags.
WTRK2	BOP	Heater volume/segment data.
WTRK3	BOP	Heater element data.
WTRK4	BOP	Turbine integer input.
WTRK5	BOP	Turbine and nozzle data storage.
WTRK6	BOP	Relief valve data storage.
WTRL1	BOP	Loop integer data storage.
WTRL2	BOP	Boundary condition tables.
WTRL3	BOP	Steam generator data storage.
WTRL4	BOP	Steam generator data storage.
WTRL5	BOP	Check valve and boundary condition data storage.
WTRL6	BOP	Check valve data storage.
WTRL7	BOP	Index sorting data storage.
WTRL8	BOP	Relief valve input.
WTRL9	BOP	Relief valve data storage.
WTRNA1	BOP	Steam generator data storage.
XSINT	D3IF	Cross section processing data storage.

Data Packs

Every individual channel's data block is segmented into a number of pieces, each of which is identified as a data pack. A data pack is the smallest unit of data moved by the data manager in SAS4A/SASSYS-1. Each channel may have up to ten data packs allocated, and will always have at least eight data packs. The first six of these data packs are the six channel-dependent input data blocks, namely INPCHN (block 51), GEOMIN (block 61), POWINC (block 62), PMATCH (block 63), COOLIN (block 64), and FUELIN (block 65). The other two data packs that are always present are COMC and COLC. COMC consists of a large number of data that are used in nearly all modules once they become active, such as arrays for transient geometry, temperatures, and the like. Data pack COLC contains calculated coolant data, with most of its contents used in the TSBOIL module. These eight data packs are always allocated.

There are two additional data packs that need be allocated only if certain channel modules are to become active. By avoiding data pack allocation, computer memory requirements can be reduced considerably, and computational performance enhanced accordingly. Data pack DEFC is necessary only for problems that execute DEFORM-4, DEFORM-5, or FPIN2. Allocation of this data pack is controlled with variable IADEFC in the storage allocation record of the standard input file. The second optional data pack

is named PLUC, and it is used by PINACLE, LEVITATE, and PLUTO2. Allocation of data pack PLUC is controlled with variable IAPLUC on the storage allocation record (third card image) of the standard input file. Problems that initiate either PINACLE, LEVITATE, or PLUTO2 must have either DEFORM-4 or DEFORM-5 also running, but the DEFORM modules may operate without PINACLE, LEVITATE, or PLUTO2. Therefore, in a transient designed to analyze a high-power core disruption sequence, the user should allocate all ten data packs, because it is likely that the fuel relocation modules will be needed. In a sequence analyzing a Design Basis Accident (DBA), fuel relocation would not be expected but the margin to cladding failure is needed as a measure of compliance with technical specifications, so one of the DEFORM or FPIN2 modules would be necessary. If SASSYS-1 is being used as the computational engine for the EBR-II simulator, none of the fuel pin mechanics or fuel relocation modules is necessary, and only the minimum (eight) data packs need be allocated.

2.3.3 Optional Data Storage Containers

Besides the channel-dependent storage area, two additional storage areas are allocated for the control system module (CNTLSYS) and the balance-of-plant module (BOP). These areas need not be allocated if the corresponding module is not to be executed. Allocation of the CNTLSYS storage is controlled with variable IACNTL on the storage allocation record, and the BOP module storage area allocation option is controlled with variable IALBOP in the same record.

If the optional SAS4A/SASSYS-1 interface to the DIF3D code is used, the DIF3D modules allocates two storage areas under the control of the BPOINTR package. These storage areas are used only on the DIF3D side of the interface.

2.4 Installation Features

2.4.1 FORTRAN Source Code

With the single exception noted in Section 2.3.2, the SAS4A/SASSYS-1 FORTRAN source code is written in accordance with ANSI Standard X3.9-1978. At ANL, the source code is stored with common blocks removed and replaced by compiler "INCLUDE" directives, because the common blocks contain a large number of variable names and when included, make up a significant fraction of the source code. The compiler-ready source code has been translated by a number of different compilers, including CRAY, CDC, and IBM mainframes and IBM and Sun workstations. Generally, source code constructions that may be miscompiled by highly-optimizing compilers have been avoided. When such constructs have been found in the past, they have been replaced with source coding that more reliably translates to the desired object code.

2.4.2 Word Length and Precision

On computers with 32 bit (4 byte) word lengths, all floating point scalars, arrays, and constants are set to double precision. Variable lengths are set with "IMPLICIT DOUBLE PRECISION (A-H,O-Z)" statements in each subroutine and function, and all floating point constants are appended with a "D" and an exponent to force 8 byte

accuracy. On hardware with 64 bit (8 byte) word lengths (e.g. CRAY), compiler directives may be set to ignore the double precision specifications. Generic names are used for all library function references (e.g. EXP, SQRT, and LOG), and the compiler is assumed to be capable of substituting the correct function according to the type of the arguments.

2.4.3 Required External Functions

Other than the standard library functions, two additional routines are necessary to fully implement SAS4A/SASSYS-1. The first is a subroutine MEALLO, which is programmed as an entry point in subroutine SYSTEZ. MEALLO provides for allocation of the storage containers, and has three integer arguments. The first argument is returned as the first word memory address of the data container, the second argument is supplied as the container length in words, and the third argument is returned as an allocation error flag. On CRAY computers, MEALLO generates a call to system subroutine HPALLOC, and on Sun workstations, MEALLO references function MALLOC. Equivalent references must be supplied on other computers. (A companion entry named MEFREE is supplied for completeness but is not used).

The second required routine is an integer function named LOCW. This function returns the word memory address for the variable name supplied as the single and only argument. On both CRAY and Sun computers, LOCW references system function LOC, and makes a correction for the word length and the return of a byte address on the Sun machine. An equivalent reference must be supplied on other computers.

2.4.4 Optional External Functions

Subroutine SYSTEZ also contains five additional entry points that return timing information, the date, and job-related information. These subroutines, while optional, are necessary to fill output prints on the standard output file with information of use for performance assessment and archival identification.

On batch systems, entry subroutine TILEFT is useful to return as a single argument the remaining allowable execution time in seconds, if such a limit is relevant. This permits SAS4A/SASSYS-1 to detect the approach of the limit and execute a graceful exit with final prints and a restart file save. In workstation environments or situations where computing time limits are not enforced, TILEFT returns a large number to permit continued computing until other problem limits (maximum number of time steps, maximum problem time) are encountered.

Subroutine entry TIELAP returns as its single argument the elapsed computing time since the start of execution. It is used in SAS4A/SASSYS-1 to fill out a computing time summary that is useful in assessing code performance. By default, TIELAP returns a zero elapsed time. On CRAY computers, TIELAP references subroutine SECOND, and on Sun computers, it refers to function ETIME.

Subroutine entry TODATE returns as its single argument an 8-character variable containing the current date as "MM/DD/YY" where MM denotes the month, DD is the day, and YY is the year. The date is printed at the top of each headed page by

subroutine LINES, and serves an identification function for archival purposes. On CRAY computers, TODATE calls subroutine DATE, and on Sun computers it calls subroutine FDATE. By default, TODATE returns a blank date.

Subroutine entry WCLOCK is called at the beginning of each execution to return as its single argument an 8-character variable containing the current wall clock time as "HH:MM:SS" where HH is the current hour, MM is the number of minutes in the hour, and SS is the number of seconds in the minute. The wall clock time is printed at the top of each headed page in the standard output by subroutine LINES. On CRAY computers WCLOCK calls subroutine CLOCK, and on Sun computers it calls FDATE. By default, WCLOCK return a blank clock time.

Subroutine entry JOBNAM returns four arguments, the first two of which are 8-character variables and the last two of which are integers. These variables are defaulted to blank and zero values, but may be used in specific environments to return job and user names and numbers, which will be printed at the top of each page of the standard output.

2.5 Input and Output Files

2.5.1 Standard Input File

SAS4A/SASSYS-1 reads standard input from logical unit 5 as 80-column formatted card images. A full description of the contents of the standard input file is contained in Appendix 2.2. Listings of example input files can be found in the example problems standard output listings on the microfiche cards in Appendix 2.3.

The first three records of the standard interface file are always required. The first two records each contain 72 columns of problem title data that will appear at the top of each page of the standard output file. Columns 73-80 of the first card image must contain, left adjusted, the version number of the SAS4A/SASSYS-1 code being executed. The current version number is "3.0". The third record is the storage allocation card, which tells SAS4A/SASSYS-1 information needed to allocate the various data containers. If the DIF3D interface option is invoked, an additional storage allocation card (fourth record) is required.

If the current execution is to be restarted from a prior execution, the standard input file must contain a restart record to invoke the reading of a restart file from logical unit 18 (see Section 2.5.3). The reading of the restart file takes place at the point the restart record is encountered on the standard input file. Input blocks loaded before the restart record will be over-written by the restart file data, and input blocks following the restart record will modify or replace data read from the restart file.

The input data blocks for SAS4A/SASSYS-1 are described in Appendix 2.2. Each input data block begins with a block identifier record and ends with a block delimiter record. The block identifier record contains the block name and number, and two integers denoting the relevant current channel and the type of background data fill to be supplied before data reading begins. (The background may be "zeros" or the same

block entered previously for this or another channel). The block delimiter record is a negative integer one ("-1" right adjusted) entered in the first I6 field of the record.

Reading of input blocks is terminated with a block identifier record with the name "ENDJOB" and number "-1". Any records following the "ENDJOB" record are ignored.

2.5.2 Standard Output File

SAS4A/SASSYS-1 prints standard output on logical unit 6 as 133-column, formatted, printed line images. The first column of the standard output file is used for carriage control (line skipping and top-of-form). Listings of example standard output files can be found in the example problems standard output listings in Appendix 2.3.

The standard output file is divided into pages of sixty lines each. Every page is headed with the two title records that begin the input deck. The title lines also contain code version identification, the page number, job and user identification, the execution date, and the clock time. Pages containing channel-dependent information will have the channel number printed in the upper left-hand corner.

The standard output file begins with a print of each record read from the standard input file, followed by a print of the edited input deck. An optional, formatted and annotated print of the input data is available, followed by a tabular print of coolant material properties. This is followed by printer plots of curves formed by the tabular fitting procedure.

The steady-state results are printed next, beginning with prints of channel-dependent data. The prints vary depending on the computational modules invoked, but usually contains node-wise masses, porosities, and temperatures, as well as radial and axial pin geometry. Also printed are nodal powers and reactivity feedback coefficients. Following the channel-dependent prints, steady-state results from the primary loop (PRIMAR-4), control system, and balance-of-plant may appear, if those modules are employed.

A short print of time, power, and reactivity is produced on each main transient time step. The exact form of this print varies depending on whether the default reactivity feedback routines are employed or the EBR-II feedback routines are used. On specified main time steps, long prints of the then current channel conditions (geometry, pressure, temperature, etc.) are produced. In addition, each module may produce intermittent transient prints of calculated results. These prints are controlled by input data. Extensive diagnostic prints may also be triggered through input for most of the computational modules.

2.5.3 Auxiliary Input and Output Files

The input and output files used in SAS4A/SASSYS-1 are listed in Table 2.5-1.

Table 2.5-1: SAS4A/SASSYS Assigned External Files

File	Type	Assigned Use	Subroutine
5	Formatted	Input Data Records	READIN
6	Formatted	Printed Output	READIN
			DATOUT
			SSPRNT
			TSPRNT
			PSHORT
			PKPAGE
7	Formatted	Edited Input Data Records	DATOUT
8	Formatted	Scratch BOP Input Data	READIN
			RENUM
10	Formatted	Printed Output	
11	Binary	Main Time Step Plotting	TSPLOT
12	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
13	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
14	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
15	Binary	PRIMAR-4 Data for Plotting	SSPRPL
			TSPRPL
16	Formatted	PINACLE/LEVITATE Data for Plotting	SSPLOT
			PNPICO
			LEPICO
17	Binary	Output Restart File	RESTAR
18	Binary	Input Restart File	RESTAR
20	Binary	TSBOIL Data for Plotting	TSCMP0
			TSCMP1
21	Binary	DEFORM-5 Plotting	DFORM5
22	Binary	EBR2 Reactivity Plotting	EBR2
23	Binary	FPIN2 Data for Plotting	FPNOUT
24	Binary	EBR-II Mark-V Safety Case Scratch Plotting Data File	TSPLOT
26	Binary	BOP Data for Plotting	LBPLOT
27	Binary	Steam Generator Data for Plotting	INIT, TSBOP
28	Binary	BOP Data for Plotting	INITS, TSBOP
29	Binary	BOP Data for Plotting	PLTBOP

2.6 Example Problems

2.6.1 SASSYS-1 Example Problem

The SASSYS-1 example problem is an analysis of a protected reactivity insertion event in the EBR-II reactor. The basic SASSYS-1 input deck for this example problem was taken from Ref. 2-7. This input deck is the standard EBR-II SASSYS-1 model for the primary and secondary coolant loops. The core model in this deck is for a generic Mark-III reactor, and does not correspond to an actual or planned loading. The standard EBR-II plant protection system model documented in Ref. 2-8 was added to the input deck to provide scram functions, and an external, programmed reactivity insertion of 0.01 $/second to a maximum of 0.15 $ was assumed to drive the transient beginning from the steady-state conditions

The input reactivity insertion raises the reactor power to 115% of nominal. At this power level, the plant protection system begins a reactor scram sequence by inserting a total of -3.7 $ of reactivity over 0.45 seconds, sharply reducing the power. Six seconds following the scram signal, a manual trip of both primary coolant pumps is assumed, followed six seconds later by a manual trip of the secondary pump. (The primary pump trip is not standard EBR-II operating practice, but is assumed here for the purpose of demonstrating SASSYS-1). The auxiliary pump continues to operate throughout the sequence. A printed listing of the standard output file for the SASSYS-1 calculation of this transient can be found in Appendix 2.3.

The reactor power history and the flow history in channel 3, a high-power driver subassembly, are plotted in Fig. 2.6-1. The power reduction begins at ten seconds, and the core flow reduction begins at approximately sixteen seconds. Over the next two minutes, the power drops to the decay heat level, and the flow seeks an equilibrium at the level provided by the auxiliary pump and natural circulation.

The peak fuel, cladding, and coolant temperature histories in channel 3 are plotted in Fig. 2.6-2, along with the coolant saturation temperature. The fuel, cladding, and coolant temperatures rise with the power until the reactor scram. Temperatures then drop with the falling power, until the primary pumps are tripped and the flow reduction causes the temperatures to rise. The coolant saturation temperature falls as the coolant pressure drops during the coastdown of the two primary pumps. As the coolant temperature rises, the increased buoyancy causes the reactor coolant flow to increase slightly, until at about 45 seconds into the transient, a local temperature maximum occurs, at a level near the initial peak cladding temperature. From this time forward, temperatures slowly fall as the coolant flow adjusts to the combination of forced and natural circulation at decreasing decay heat power.

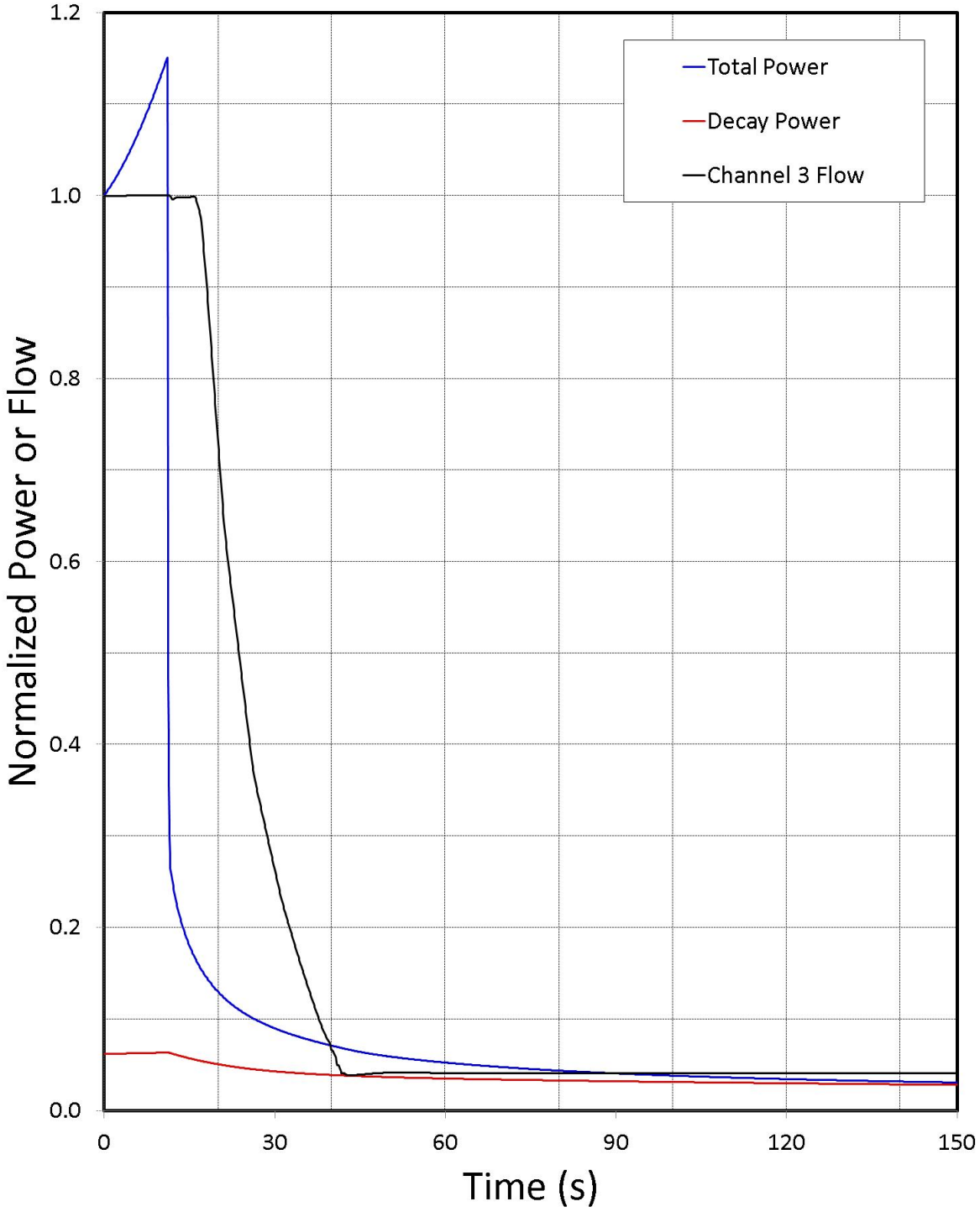


Fig. 2.6-1. SASSYS-1 Example Problem Reactor Power and Flow Histories

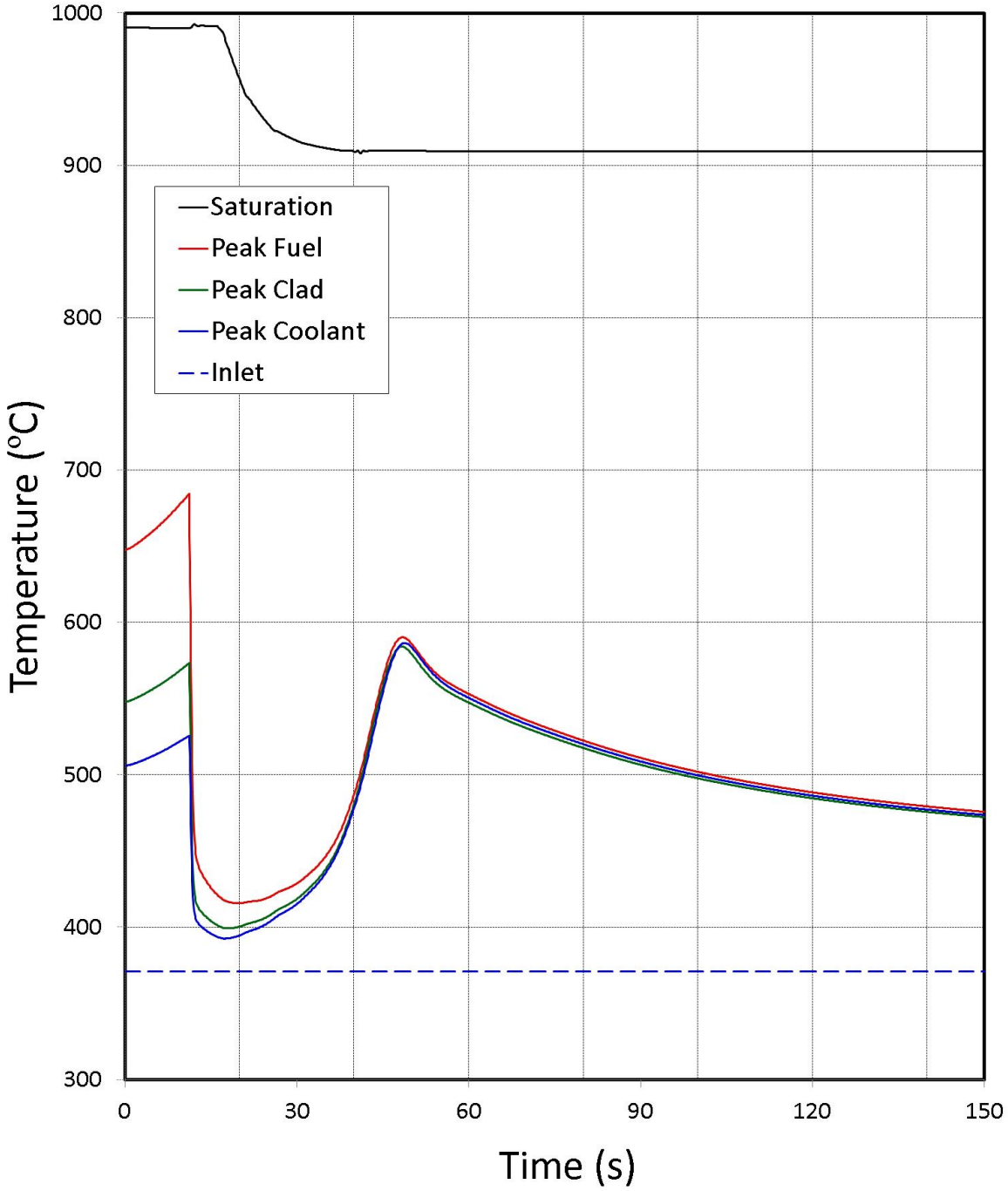


Fig. 2.6-2: SASSYS-1 Example Problem Temperature Histories in the High Temperature Driver Subassembly

2.6.2 SAS4A Example Problem

The SAS4A example problem is an analysis of an unprotected (without scram) transient overpower (TOP) accident in a metal-fueled 3500 MWt pool-type reactor. This reactor has been analyzed previously for accident initiators that included unprotected loss-of-flow (LOF) and loss-of-heat-sink (LOHS) sequences as well as the transient overpower sequence [2-9]. However, the TOP sequence analyzed previously corresponded to removal of one control rod. For this analysis, the ramp reactivity addition rate was set to 0.10 $/s, and no limit was placed on the total reactivity added. This ramp rate results in an initial reactor power rise that approximately corresponds to the 8-second period employed in the TREAT M-Series tests [2-10], and the unlimited insertion assures that fuel melting and cladding failure will occur. Therefore, the whole-core sequence demonstrates 1) molten metal fuel behavior at conditions similar to those of the TREAT M-Series tests, 2) the ability of the SAS4A metal fuel relocation modules, PINACLE and LEVITATE, to reproduce metal fuel performance observed in TREAT, and 3) the reactor safety implications of TREAT fuel relocation observations.

The TOP sequence assumed here is an unlimited 0.1 $/s reactivity ramp addition with failure of the plant protection and safety systems. It is also assumed that since no scram takes place, the reactor coolant pumps continue to operate. The reactor power history calculated by SAS4A for this sequence is shown in Fig. 2.6-3, and the corresponding net and component feedback reactivities are shown in Fig. 2.6-4.

As shown in Fig. 2.6-3, the reactor power rises initially in response to the ramp reactivity insertion, which is labeled as "PROGRAMMED" in Fig. 2.6-4. The initial power ascension approximates the TREAT M-Series 8-second period. At about 7 seconds into the transient, conditions for in-pin fuel relocation are satisfied, and the PINACLE model begins execution to describe the expulsion of fuel within the cladding from the core into the fission gas plenum region, first for a few subassemblies and for more of the core as time goes on. This fuel relocation provides a negative reactivity effect that reduces the power temporarily, countering the input ramp reactivity.

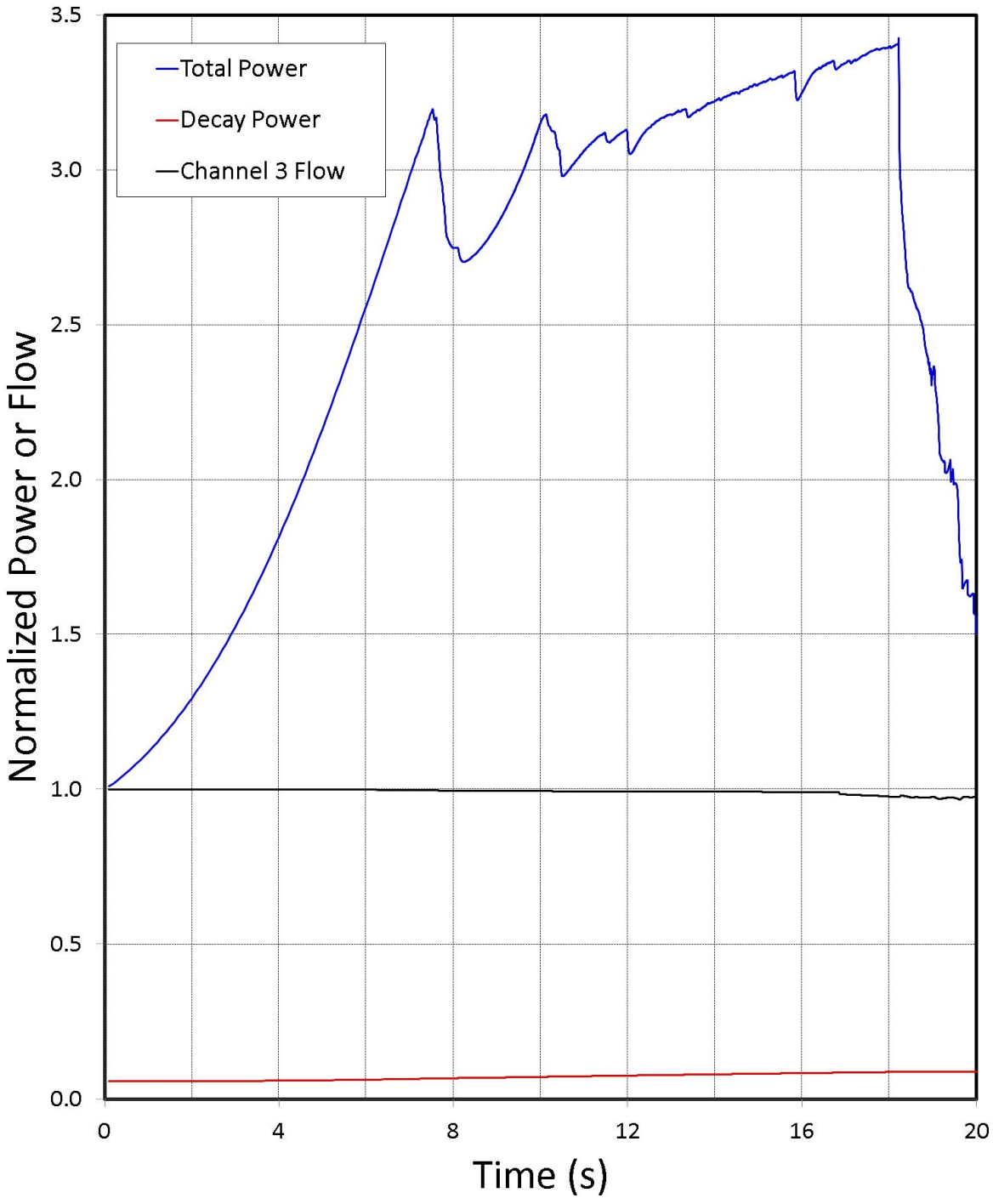


Fig. 2.6-3: SAS4A Example Problem Reactor Power History

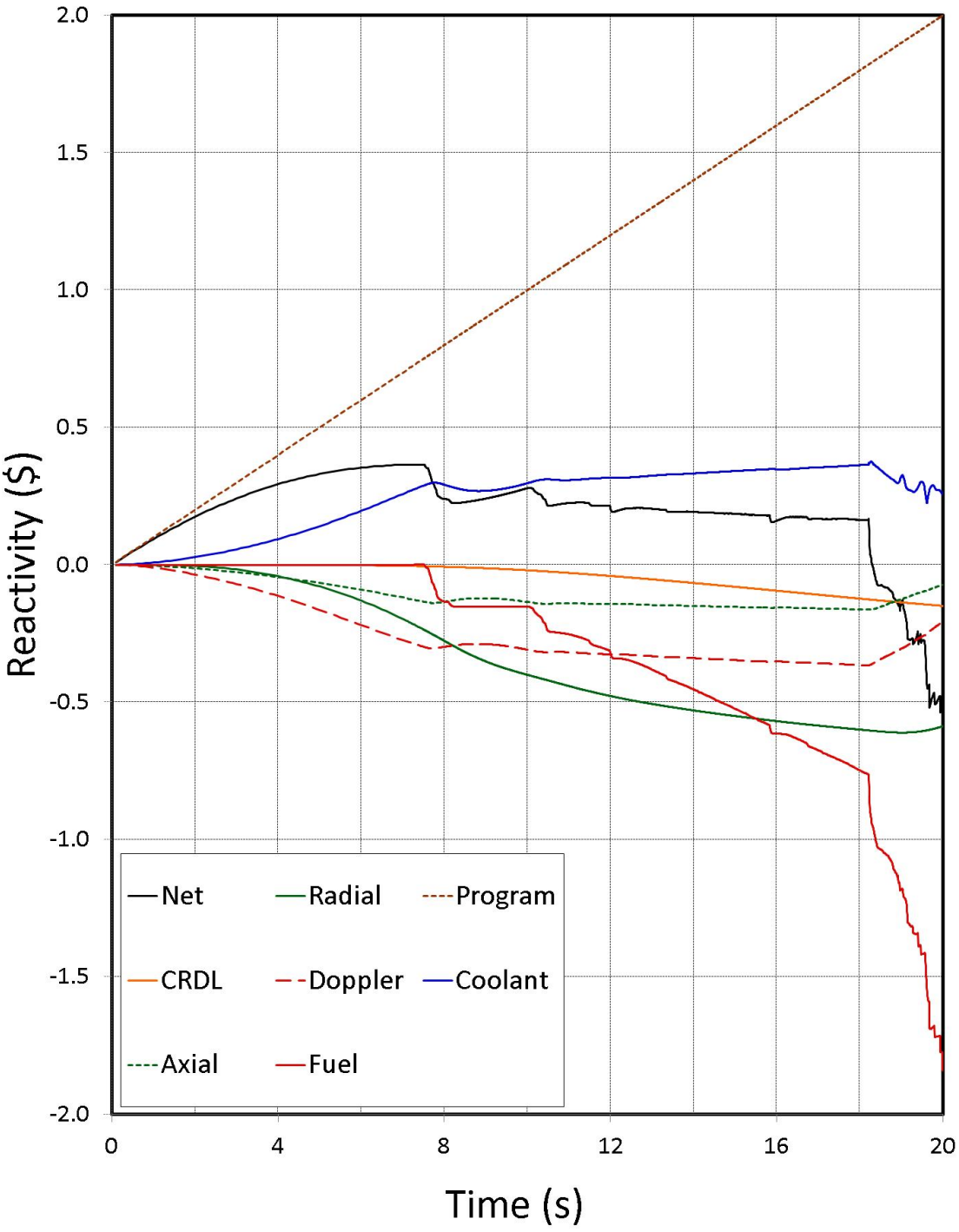


Fig. 2.6-4: SAS4A Example Problem Reactivity History

REFERENCES

NOTICE

Several references in this document refer to unpublished information. For a list of available open-literature citations, please contact the authors.

APPENDIX 2.1: LISTING OF SUBROUTINES

No.	Name	Module	Purpose
1	MAIN	ROOT	Defines main program entry point.
2	ADITIT	D3IF	Prints 8-byte character array.
3	ADUMMY	ROOT	Sets dummy entry points for D3IF.
4	AEQUAT	ROOT	Equates two 8-byte character arrays.
6	ALPHC	DEFORM-4	Calculates instantaneous cladding thermal expansion coefficient given the temperature.
8	ALPHF	DEFORM-4	Calculates instantaneous fuel thermal expansion coefficient given the temperature.
10	ANETMP	PRIMAR-4	Calculates annular element temperatures.
12	AOUT	ROOT	Prints character input blocks.
16	ARF	BOP	Finds water level in cylindrical feedwater heaters with axis oriented horizontally.
17	ASET	ROOT	Sets an 8-byte character array equal to an 8-byte scalar variable.
19	AVGVAL	PRIMAR-4	Calculates average motor torque over a time step for a centrifugal pump.
20	AVRGIT	PRIMAR-4	Calculates average motor torque or pump speed over a time step for a centrifugal pump.
21	AXMESH	D3IF	Calculates neutronics axial mesh from thermal/hydraulics axial mesh.
22	BDIF3D	D3IF	Writes binary interface files DIF3D, TRABIN, and LABELS.
23	BLENDR	D3IF	Manages material volume fraction calculation.
24	BLENDZ	D3IF	Adds external channel input data to volume fraction file.
26	BLKPRN	ROOT	Prints input block name for input edit.
28	BYPSTM	PRIMAR-4	Calculates bypass channel temperatures.
30	BYSASA	PRIMAR-4	Calculates subassembly-to-subassembly heat transfer for a bypass channel.
32	BYTMUD	PRIMAR-4	Sets up arrays used for bypass channel-to-channel heat transfer.
34	CAVITE	DEFORM-4	Calculates uniform molten cavity pressure and axial node density changes in the molten region.
36	CAVMOT	PINACLE	Calculates in-pin motion initiation conditions.

No.	Name	Module	Purpose
38	CCK	BOP	Calculates thermal conductivity for water or steam.
40	CCLAD	ROOT	Calculates cladding specific heat capacity given the temperature.
42	CDUMPS	ROOT	Prints COMMON block contents.
43	CFUEL	ROOT	Calculates fuel specific heat capacity given the temperature.
44	CFUEL1	SSCOMP	Calculates U-Pu-Zr specific heat by region-wise interpolation of IFR Handbook data.
45	CHCHFL	TSCL0	Calculates channel-to-channel heat flux.
46	CHECKN	D3IF	Checks composition-to-region map for consistency.
47	CHECKT	D3IF	Checks composition temperatures for legality.
48	CHENHT	BOP	Calculates water-side heat transfer coefficient for the helical coil steam generator option.
49	CHFSAV	TSBOIL	Stores channel-dependent data for use by PRIMAR-4.
50	CHIN	TSBOIL	Calculates ratio of cladding outer perimeter to coolant area.
52	CHVLW	BOP	Implements the balance-of-plant check valve model.
54	CKVLFL	PRIMAR-4	Sets check valve flow coefficients.
56	CL	ROOT	Calculates coolant specific heat capacity given the temperature.
58	CLADSW	DEFORM-4	Calculates irradiation-induced cladding swelling.
60	CLDFAL	DEFORM-4	Calculates cladding failure conditions.
68	COOLIT	D3IF	Calculates coolant mass for neutronics.
74	COREFL	PRIMAR-4	Estimates core channel flows.
78	CPCPHT	PRIMAR-4	Calculates component-to-component heat transfer.
82	CRAKER	DEFORM-4	Calculates crack volume changes.
83	CRDTMP	PRIMAR-4	Calculates control rod driveline temperatures.
84	CRVFIT	PRIMAR-4	Fits linear or third-order curves to tables; sets up table loop-up coefficients.
85	CRVSUP	PRIMAR-4	Manages curve fitting (CRVFIT) for various input tables.

No.	Name	Module	Purpose
86	CROEF	ROOT	Calculates cladding volumetric heat capacity given the temperature.
88	CSIGMA	DEFORM-4	Calculates cladding displacements and stresses.
92	CTLDSP	CNTLSYS	Prints and checks table input.
93	CTLEQS	CNTLSYS	Forms steady-state equations.
94	CTLIN1	CNTLSYS	Reads input block.
95	CTLIN2	CNTLSYS	Converts signal data to addresses.
96	CTLIN3	CNTLSYS	Checks for data consistency.
97	CTLINT	CNTLSYS	Initializes transient calculation.
98	CTLPRT	CNTLSYS	Prints computed signal values.
99	CTLSOL	CNTLSYS	Manages steady-state equation solution.
100	CTLSO2	CNTLSYS	Solves steady-state equations with null transient.
101	CTLSSI	CNTLSYS	Solves steady-state equations with non-linear equation solver.
102	CTLSSP	CNTLSYS	Prints steady-state solution.
103	CTLSUB	CNTLSYS	Computes transient.
105	CUTBAK	PRIMAR-4	Re-initializes variables for time step cut-back.
107	CVTEMP	PRIMAR-4	Calculates compressible volume temperature.
109	D3IFDR	D3IF	Manages steady-state calculation.
110	D3IFTS	D3IF	Manages transient calculation.
111	D3INXS	D3IF	Manages microscopic cross section calculation.
112	D3MAXS	D3IF	Manages macroscopic cross section calculation.
113	D3OV31	D3IF	Reads microscopic cross section files.
114	D3OV32	D3IF	Homogenizes microscopic cross section data.
115	D3OV33	D3IF	Computes fission yield and Doppler coefficients.
116	D3OV34	D3IF	Manages writing of material cross section file.
117	D3OV41	D3IF	Manages reading of the material cross section file.
118	D3OV42	D3IF	Manages reading of the geometry file.
119	D3OV43	D3IF	Manages reading of the volume fraction file.
120	D3OV44	D3IF	Manages composition cross section computation.
122	D5INIT	DEFORM-5	Initializes DEFORM-5 calculation.
123	DATEDT	D3IF	Manages steady-state neutronics calculations.
124	DATMOV	ROOT	Transfers data between storage and working areas.

No.	Name	Module	Purpose
126	DATOUT	ROOT	Manages listing of input blocks.
127	DECIDE	D3IF	Determines perturbation calculation data strategy.
128	DEFINI	DEFORM-4	Initializes data for an axial segment.
130	DEFORM	DEFORM-4	Manages axially dependent thermal/mechanical calculation.
131	DENSIT	CLAP	Calculates molten cladding temperature and density as a function of internal energy.
132	DFORM3	DEFORM-4	Manages DEFORM-4 calculation.
133	DFORM5	DEFORM-5	Manages DEFORM-5 calculation.
134	DHXCAL	PRIMAR-4	Manages air dump heat exchanger calculation.
136	DIF3DO	D3IF	Initializes DIF3D calculation.
137	DIMXCK	D3IF	Checks isotope cross section temperatures.
138	DKNORM	D3IF	Initializes perturbation theory normalization.
139	DLUPDT	D3IF	Computes material delayed fission yield.
140	DLY23	D3IF	Prints isotope delayed neutron data.
141	DNMAX	D3IF	Computes maximum down-scatter index.
142	DOPCA2	D3IF	Calculates material Doppler coefficients.
143	DOPCAL	D3IF	Manages Doppler coefficient calculation.
145	DRACSF	PRIMAR-4	Calculates shell-side flow coefficients for DRACS heat exchanger.
146	DRACTF	PRIMAR-4	Calculates tube-side flow coefficients for DRACS heat exchanger.
147	DRIVPT	D3IF	Initializes perturbation calculation.
148	DTCFND	ROOT	Calculates coolant time step.
150	DTHFND	ROOT	Calculates heat transfer time step.
152	DTLM	BOP	Performs the log-mean temperature difference calculation for a single-node steam generator.
154	DTMFND	ROOT	Calculates main time step.
158	DTPFND	ROOT	Calculates PRIMAR-4 time step.
166	DVIS	BOP	Calculates viscosity for water or steam.
168	DYNALL	ROOT	Allocates data storage containers.
170	EBR2	TSPK	Calculates reactivity feedbacks using the EBR-II model.
176	ECLADF	DEFORM-4	Calculates cladding elastic modulus.

No.	Name	Module	Purpose
178	EDFP4A	ROOT	Prints first part of input block 18 (PMR4IN).
180	EDFP4B	ROOT	Prints second part of input block 18 (PMR4IN).
181	EDFP4C	ROOT	Prints third part of input block 18 (PMR4IN).
182	EDITIT	D3IF	Prints floating point array.
183	EDLYR4	D3IF	Prints isotope delayed neutron data.
184	EDTCOO	ROOT	Prints input block 64 (COOLIN).
186	EDTFP4	ROOT	Manages printing of input block 18 (PMR4IN).
188	EDTFUE	ROOT	Prints input block 65 (FUELIN).
190	EDTGEO	ROOT	Prints input block 61 (GEOMIN).
192	EDTIP4	ROOT	Prints input block 3 (INPMR4).
194	EDTIPM	ROOT	Prints input block 1 (INPCOM).
196	EDTIPN	ROOT	Prints input block 51 (INPCHN).
198	EDTOPC	ROOT	Prints input block 11 (OPCIN).
200	EDTPMC	ROOT	Prints input block 13 (PMATCM).
202	EDTPMH	ROOT	Prints input block 63 (PMATCH).
204	EDTPRI	ROOT	Prints input block 14 (PRIMIN).
206	EDTPWA	ROOT	Prints input block 12 (POWINA).
208	EDTPWC	ROOT	Prints input block 62 (POWINC).
209	EDXSCO	D3IF	Prints the material cross section file.
210	EFUELF	DEFORM-4	Calculates fuel elastic modulus given the temperature.
212	EGFUTE	LEVITATE	Calculates fuel internal energy from temperature.
214	EGSETE	LEVITATE	Calculates steel internal energy from temperature.
216	EGSETT	LEVITATE	Calculates steel internal energy from temperature.
218	EKT	ROOT	Calculates cladding thermal conductivity given the temperature.
219	EMFLMT	TSCLO	Calculates temperatures in the EM flow meter axial zone/
220	ENEDIT	D3IF	Prints neutronics input data.
222	EUTPEN	DEFORM-5	Calculates cladding penetration by fuel/cladding chemical interaction.
223	EXCHAN	D3IF	Manages input external channel data.
224	EXPAND	DEFORM-4	Calculates thermal/mechanical axial expansion.

No.	Name	Module	Purpose
225	F10FRM	PRIMAR-4	Puts a floating point number into F10.n format for use by LPPLOT.
226	FAILUR	ROOT	Calculates cladding failure conditions.
228	FALMAR	DEFORM-5	Calculates margins to cladding failure and coolant boiling.
229	FARSET	D3IF	Re-orders a single-precision array.
230	FEEDBK	TSPK	Manages reactivity feedback calculation.
232	FEEDSB	TSPK	Calculates Doppler, fuel and cladding relocation, and coolant density (voiding) reactivity feedbacks.
234	FEQUAT	ROOT	Equates two real arrays.
236	FFTF	TSPK	Calculates reactivity feedbacks using the FFTF model.
237	FHEADR	D3IF	Prints isotope-to-material mixing table summary.
238	FINDH	BOP	Computes water or steam enthalpy as a function of temperature and pressure.
240	FK	ROOT	Calculates fuel thermal conductivity given the temperature.
242	FLTSET	ROOT	Equates a real array to a scalar.
243	FLUMV	D3IF	Moves flux data from one buffer to another.
244	FOUT	ROOT	Prints real input blocks.
245	FPDRIV	FPIN2 FPIN2/SAS	Manages transient FPIN2 calculation in the interfaced mode.
246	FPINIT	FPIN2 FPIN2/SAS	Performs initialization of FPIN2 variables in the interfaced mode.
247	FPMAIN	FPIN2	Performs FPIN2 initialization and manages transient calculation in the FPIN2 stand-alone mode.
248	FPNOUT	FPIN2	Prints FPIN2 results.
250	FSIGMA	DEFORM-4	Calculates thermal/mechanical stresses and displacements in the fuel.
251	FSKIP	ROOT	Manages line skipping for input block prints.
252	FSWELL	DEFORM-4	Calculates fission-gas-induced fuel swelling and hot pressing.
253	FUELIT	D3IF	Computes fuel mass for neutronics.
254	FUINIT	LEVITATE	Initiates PLUTO2 or LEVITATE at cladding failure.
255	GEOINP	D3IF	Retrieves neutronics geometry file.

No.	Name	Module	Purpose
259	GRGROW	DEFORM-4	Calculates fuel grain growth.
260	GRVHED	PRIMAR-4	Calculates coolant gravity head.
264	HBFND	TSCL0	Calculates fuel-cladding gap conductance with SAS3D model.
266	HBSMPL	TSCL0	Calculates fuel-cladding gap conductance with the simple thermal expansion model.
267	HBSMPM	TSCL0	Calculates fuel-cladding gap conductance for multiple-pin model.
268	HEXGEO	D3IF	Writes three-dimensional hexagonal geometry file.
269	HF1FUN	BOP	Calculates water saturated liquid enthalpy as a function of pressure.
270	HFUEL1	SSCOMP	Calculates U-Pu-Zr enthalpy by region-wise interpolation of IFR Handbook data.
271	HG1FUN	BOP	Calculates steam saturated vapor enthalpy as a function of pressure.
272	HGAP	DEFORM-4	Calculates fuel-cladding gap conductance with the "Ross-Stoute" type model.
274	HTRVPN	PINACLE	Calculates intact fuel and cladding temperatures.
276	IEQUAT	D3IF	Equates two integer arrays.
278	IFULIJ	ROOT	Computes fuel type for a node.
280	IHXSHF	PRIMAR-4	Calculates IHX shell-side flow coefficients.
281	IHXTBF	PRIMAR-4	Calculates IHX tube-side flow coefficients.
282	IJLIMS	D3IF	Constructs three-dimensional composition map.
283	INCHEK	D3IF	Checks neutronics input for legality.
284	INCPVF	PRIMAR-4	Calculates pressure coefficients for a liquid volume with no cover gas.
285	INGRFN	ROOT	Sets boundary conditions using values input under graphical user interface for EBR-II simulator mode.
286	INIT	BOP	Initializes the evaporator model.
288	INITS	BOP	Initializes the superheater model.
290	INITST	PRIMAR-4	Initializes data arrays for a primary loop sub-interval.
292	INPDRV	ROOT	Manages ASCII file data input.
294	INPEDT	ROOT	Manages input data printing.
296	INPLN	PRIMAR-4	Calculates inlet plenum pressure coefficients.

No.	Name	Module	Purpose
298	INTIRP	ROOT	Interpolates within a real data array; returns a single value.
300	INTRP	ROOT	Interpolates within a real data array; returns a vector of values.
302	INTSET	ROOT	Equates an integer array to a scalar.
304	INVRT3	TSCL0	Inverts a tri-diagonal matrix; solves AX=B.
305	IOUT	ROOT	Prints integer input blocks.
306	IPT3	D3IF	Returns a pointer to an array sub-block.
307	ISGIEL	ROOT	Computes segment number for an element.
308	ISKIP	ROOT	Skips unused locations in print of input blocks.
309	ISOR48	D3IF	Computes material cross sections.
310	ISYSTM	ROOT	Contains entry points for return of word memory addresses.
311	ITGIEL	ROOT	Computes temperature group for an element.
312	JNTIRP	CNTLSYS	Interpolates within a vector array; detects and signal zero gradients.
313	KCLAD	ROOT	Calculates cladding thermal conductivity given the temperature.
314	KFUEL	ROOT	Calculates fuel thermal conductivity given the temperature.
315	KFUEL	SSCOMP	Calculates U-Pu-Zr thermal conductivity by region-wise interpolation of IFR Handbook data.
316	LBPLOT	BOP	Saves BOP parameters for plotting in addition to those saved by PLTBOP.
318	LE1PIN	LEVITATE	Solves molten fuel/fission gas mass and energy conservation equations in the pin cavity.
319	LE2PIN	LEVITATE	Solves molten fuel/fission gas momentum conservation equation in the pin cavity.
320	LEABLA	LEVITATE	Calculates steel cladding/structure ablation and resets channel geometry.
321	LEAK2D	D3IF	Calculates two-dimensional leakage perturbation theory components.
322	LEAK3D	D3IF	Calculates three-dimensional leakage perturbation theory components.
323	LEAKAA	D3IF	Calculates leakage at a plane geometry interface.
324	LEAKBB	D3IF	Calculates leakage for triangular geometry.
325	LECLIN	LEVITATE	Initializes data from TSBOIL and CLAP.

No.	Name	Module	Purpose
326	LEDISR	LEVITATE	Computes intact node disruption.
328	LEFAIL	LEVITATE	Calculates cladding margin to failure.
330	LEFREZ	LEVITATE	Calculates molten fuel and cladding freezing and remelting.
332	LEFRLU	LEVITATE	Calculates molten fuel and cladding freezing and remelting for chunk model.
334	LEFUVA	LEVITATE	Solves energy conservation equation for fuel vapor, with vaporization and condensation.
336	LEGEOM	LEVITATE	Determines component configuration based on flow regime and mass data history.
338	LEIF	LEVITATE	Computes component interface positions.
340	LELUME	LEVITATE	Calculates fuel/steel chunk melting.
342	LEMACO	LEVITATE	Solves component mass conservation equations.
344	LEMOCO	LEVITATE	Solves gas and liquid momentum equations.
346	LENAEN	LEVITATE	Solves gas energy conservation equation.
348	LEPENE	LEVITATE	Calculates cladding penetration by fuel/cladding chemical interaction.
350	LEPICO	LEVITATE	Print core picture in plotting file for LEVITATE.
352	LEPLIN	LEVITATE	Initializes data for transfer to PLUTO2.
354	LEREZO	LEVITATE	Calculates liquid coolant slug positions.
356	LESAIN	LEVITATE	Initializes data for transfer from TSBOIL.
358	LESET2	LEVITATE	Initializes temporaries for each time step.
360	LESEVA	LEVITATE	Solves steel vapor energy equation.
362	LESOEN	LEVITATE	Solves frozen components energy equation.
364	LESRME	LEVITATE	Computes structure conditions.
366	LETRAN	LEVITATE	Computes component heat transfer and friction coefficients.
368	LEVDRV	LEVITATE	Manages LEVITATE calculation.
370	LEVOFR	LEVITATE	Computes component volume fractions and sets flow regimes.
371	LIFEIF	FPIN2	Initializes FPIN2 from LIFE-calculated data.
372	LINES	ROOT	Tracks print line position on a page.
374	LIQCV	PRIMAR-4	Calculates pressure coefficients for a compressible volume with no cover gas.
376	LIQFIN	PRIMAR-4	Calculates compressible volume pressure for no cover gas.

No.	Name	Module	Purpose
378	LMDIF	CNTLSYS	Solves non-linear equation system; taken from MINPAK, ANL-80-74.
379	LOCFND	ROOT	Finds memory address.
380	LOCHEX	D3IF	Returns mesh indices for a hex location.
381	LPPLOT	PRIMAR-4	Puts line printer plots in the printed output file for curve fits to various input tables.
382	LQGSFN	PRIMAR-4	Calculates compressible volume pressure with cover gas.
384	M6	TSBOIL	Solves matrix equation for film motion model.
386	MAPPOW	D3IF	Maps power distribution from neutronics to channel geometry.
390	MKDRIV	DEFORM-4	Manages mechanical/swelling solution for fully cracked fuel, or when melting has reached the cracked region.
392	MOMEN	TSBOIL	Computes coefficients in momentum equation for each segment of each liquid slug.
394	MURAL	SSCOMP	Calculates solidus and liquidus temperatures of (U-Pu-Zr-Fe-Ni) five-metal alloys.
396	MVPPSG	BOP	Transfers data for the evaporator model.
398	MVPPSH	BOP	Transfers data for the superheater model.
402	NABOND	DEFORM-4	Computes height of liquid bond sodium above fuel.
404	NAHT	BOP	Computes the sodium heat transfer coefficient for a node within the evaporator.
406	NAHTS	BOP	Computes the sodium heat transfer coefficient for a node within the superheater.
408	NAKAIR	PRIMAR-4	Solves air dump heat exchanger model.
410	NAPROP	ROOT	Computes sodium properties for printing.
412	NODEPR	TSCLO	Prints diagnostic fuel, cladding, coolant, and structure temperatures.
413	NORMDK	D3IF	Manages normalization of perturbation theory results.
414	NORMPT	D3IF	Normalizes reactivity coefficients.
416	OUTNGF	PRIMAR-4	Calculates pressure coefficients for a compressible outlet plenum with no cover gas.
418	OUTPLF	PRIMAR-4	Calculates pressure coefficients for a compressible outlet plenum with a cover gas.

No.	Name	Module	Purpose
420	OUTPLN	PRIMAR-4	Transfers control to CVTEMP.
422	OUTPT3	DEFORM-4	Prints DEFORM-4 results.
424	OUTPT4	DEFORM-4	Prints DEFORM-4 results.
426	OUTPT5	DEFORM-5	Prints DEFORM-5 results.
428	P4EDT	PRIMAR-4	Prints PRIMAR-4 input data and results.
430	PAR	TSPK	Fits a parabola to three points.
431	PASSPT	D3IF	Manages perturbation calculation.
432	PELTON	SSCOMP	Calculates solidus and liquidus temperatures of U-Pu-Zr fuels.
433	PIFLSG	BOP	Accounts for the momentum equation in a pipe element in the BOP model.
434	PINACL	PINACLE	Manages PINACLE calculation.
438	PINMAP	PINACLE	Prints map of fuel with molten cavity.
440	PIPEFL	PRIMAR-4	Calculates pressure coefficients for pipe flow with friction.
442	PIPTMP	PRIMAR-4	Calculates pipe temperatures using Lagrangian mesh.
444	PKPAGE	ROOT	Prints point kinetics results.
446	PKSTEP	TSPK	Solves point kinetics equations for a time step.
448	PL1PIN	PLUTO2	Solves mass and energy equations in pin cavity.
450	PL2PIN	PLUTO2	Solves momentum equations in pin cavity.
452	PLCOOL	PLUTO2	Calculates temperatures in liquid sodium slugs.
454	PLFREZ	PLUTO2	Calculates fuel freezing and remelting.
460	PLHTR	PLUTO2	Calculates intact fuel and cladding temperatures.
462	PLIF	PLUTO2	Calculates liquid and vapor interface locations.
464	PLINPT	PLUTO2	Initializes PLUTO2 and LEVITATE data.
466	PLMACO	PLUTO2	Solves two-phase channel mass conservation equations.
468	PLMIS	PLUTO2	Calculates channel heat transfer and friction coefficients, sets frozen fuel geometry, and solves the energy equation for mobile fuel.
470	PLMOC	PLUTO2	Solves two-phase channel momentum equations.
472	PLNAEN	PLUTO2	Solves single- and two-phase energy equations for coolant and fission gas.
476	PLOTPN	PINACLE	Prints axial fuel mass distribution picture.
478	PLOUT	PLUTO2	Prints PLUTO2 results.

No.	Name	Module	Purpose
480	PLREZO	PLUTO2	Rezones channel mesh for liquid slugs.
482	PLSAIN	PLUTO2	Initializes interaction zone data.
484	PLSET	PLUTO2	Initializes pin cavity data.
486	PLSET1	PLUTO2	Initializes data for temperature solutions.
488	PLSET2	PLUTO	Initializes time step temporary data.
490	PLSTR	PLUTO2	Calculates channel temperatures outside the interaction zone.
492	PLTBOP	BOP	Saves balance-of-plant data for plotting.
494	PLTECS	PLUTO2	Calculates cladding and structure temperatures.
500	PLUDRV	PLUTO2	Manages PLUTO2 calculation.
502	PLVOFR	PLUTO2	Calculates fuel, liquid sodium, and gas void fractions.
504	PMCHEK	ROOT	Checks input density tables for consistency.
506	PMPBLF	PRIMAR-4	Calculates pressure coefficients for a pump bowl with cover gas.
508	PMPFLW	BOP	Accounts for the momentum equation in a pump element in the BOP model.
510	PMPFNW	BOP	Updates water pump heads and speeds from updated segment flows.
512	PMSTRT	PRIMAR-4	Initializes data arrays for a sub-interval.
514	PN1PIN	PINACLE	Solves mass and energy conservation equations.
516	PN2PIN	PINACLE	Solves momentum conservation equations.
518	PNINIT	PINACLE	Initializes data.
522	PNINPT	PINACLE	Initializes data.
524	PNORM	ROOT	Normalizes input power distribution.
526	PNPICO	PINACLE	Print core picture in plotting file for PINACLE.
528	PNSET	PINACLE	Initializes data.
529	PNSET2	PINACLE	Initializes temporary data for a time step.
530	POINEX	ROOT	Extrapolates reactivity for a time step.
531	POINS1	ROOT	Sets PRIMAR-4 COMMON length.
532	POINS2	ROOT	Sets BOP COMMON lengths.
536	POINST	ROOT	Sets COMMON, input block, and data pack lengths for data storage allocation and management.
537	POOLFL	PRIMAR-4	Calculates pressure coefficients for a pool.

No.	Name	Module	Purpose
538	PORMIG	DEFORM-4	Calculates as-fabricated porosity migration.
539	POWCHN	D3IF	Maps axial power distribution from neutronics to channel geometry.
540	POWINT	ROOT	Extrapolates power for a time step.
541	POWMAP	D3IF	Manages power distribution mapping.
542	PREA	ROOT	Provides user-supplied power or reactivity history.
543	PRECAL	SSCOMP	Pre-calculates composition-dependent coefficients in simplified equations for U-Pu-Zr thermal properties.
544	PREP01	D3IF	Manages initialization for perturbation theory calculation.
545	PREP02	D3IF	Manages re-ordering of flux files for perturbation calculation.
546	PRESDR	PRIMAR-4	Calculates pressure drop in a flow element.
547	PRESPL	DEFORM-4	Calculates fission gas plenum pressure based on initial fill gas and released fission gas.
548	PRIMAR	PRIMAR-4	Manages PRIMAR-4 calculation.
550	PRIMR1	PRIMAR-4	Calculates PRIMAR-1 option.
552	PRIMUP	PRIMAR-4	Updates data needed in PRIMAR-4.
553	PRMADJ	PRIMAR-4	Adjusts inlet and outlet plenum variables to account for differences between estimated and computed channel flows.
554	PRMEND	PRIMAR-4	Stores final sub-interval results in permanent arrays.
555	PRMPRT	PRIMAR-4	Prints PRIMAR-4 results.
556	PRNT1A	D3IF	Prints one-dimensional character array.
557	PRNT1D	D3IF	Prints one-dimensional floating point array.
558	PRNT1E	D3IF	Prints one-dimensional floating point array.
559	PRNT1I	D3IF	Prints one-dimensional integer array.
560	PRNT2D	D3IF	Prints two-dimensional floating point array.
561	PRNT2E	D3IF	Prints two-dimensional floating point array.
562	PRNTEL	D3IF	Prints headings.
563	PRNTST	BOP	Sets print flags for selected printing of BOP parameters.
564	PRSH2O	BOP	Calculates the orifice coefficient and steady-state pressure drop for each BOP element.

No.	Name	Module	Purpose
565	PRSRZF	PRIMAR-4	Computes pressure coefficients for a pressurizer (expansion tank).
566	PRSTEP	PRIMAR-4	Calculates next PRIMAR time step or cuts back current step size.
568	PSAT	ROOT	Calculates saturation vapor pressure of sodium.
570	PSHORT	ROOT	Prints reactor power and reactivity on main time step.
571	PTINP	D3IF	Calculates non-leakage perturbation theory components.
572	PUMPFL	PRIMAR-4	Calculates pump head and flow coefficients.
573	PUMPFN	PRIMAR-4	Performs pump impeller speed and head calculation at the end of a sub-interval.
575	QUITS	ROOT	Terminates execution.
576	RDLYR4	D3IF	Reads isotope delayed neutron data file.
577	REACOF	D3IF	Manages perturbation theory calculation.
578	REACUO	D3IF	Normalizes reactivity coefficients in channel geometry.
579	REACUP	D3IF	Updates reactivity coefficients in channel geometry.
580	READEC	ROOT	Transfers data packs from storage area to blank common.
581	READIN	ROOT	Reads ASCII input data file.
583	REFLX1	D3IF	Re-orders flux data for perturbation calculation.
584	REGMAT	D3IF	Sorts material-to-region assignment.
585	REGNCK	D3IF	Checks Subassembly region assignment.
586	REINIT	ROOT	Performs initialization on restart.
588	RELGAS	DEFORM-4	Calculates volatile fission gas release from fuel.
590	RENUM	BOP	Processes BOP input data.
592	RESTAR	ROOT	Reads and writes a binary restart file.
594	REVLW	BOP	Computes the fractional valve opening area for a relief valve in the BOP model.
596	REXDET	TSPK	Solves detailed radial expansion model.
598	REXSMP	TSPK	Solves simple radial expansion model.
602	RHOEND	TSPK	Stores point kinetics solution data.
604	RHOF	ROOT	Calculates theoretical fuel density given the temperature.

No.	Name	Module	Purpose
606	RHOFM	ROOT	Calculates theoretical metal fuel density given the temperature and composition.
610	RHOLNA	ROOT	Calculates liquid sodium density given the temperature.
614	RHOV	ROOT	Calculates sodium vapor density given the temperature.
616	RNGPOS	D3IF	Computes subassembly position indices.
618	RUPSKF	PRIMAR-4	Calculates pressure coefficients for a pipe rupture sink, guard vessel with cover gas.
619	RUPSRF	PRIMAR-4	Calculates pipe rupture source pressure coefficients.
620	RVACTM	PRIMAR-4	Calculates temperatures in the RVACS/RACS.
621	RXSCO6	D3IF	Reads records from the material cross section file.
622	RXSH23	D3IF	Reads isotope cross section mixing file.
623	SASTMP	FPIN2	Interfaces pin temperatures for FPIN2 mechanics calculation.
625	SDEQT	D3IF	Stores a single-precision array into a double-precision array.
626	SDRCST	D3IF	Stores a single-precision array into a double-precision array.
627	SDSEQT	D3IF	Stores the transpose of a single-precision array into a double-precision array.
628	SELECT	PRIMAR-4	Sets average and final inlet/outlet temperature into/from a compressible volume, according to segment flow direction.
629	SELSRT	BOP	Performs a selection sort on BOP component user-assigned numbers as part of generating the internal numbering used by the coding.
630	SETBCS	D3IF	Calculates coefficients used in leakage computation.
631	SETHEX	D3IF	Returns mesh indices for a hex location.
632	SETINS	D3IF	Initializes and integer array.
633	SFFUNW	BOP	Computes saturated liquid water entropy.
634	SGFUNW	BOP	Computes saturated steam entropy.
636	SGMOM	BOP	Accounts for the momentum equation in the subcooled region of the evaporator and in the superheater.

No.	Name	Module	Purpose
638	SGUNIT	BOP	Computes temperatures and flows in evaporators.
640	SHAPE	ROOT	Calculates the total power in each axial node.
642	SHIFT	BOP	Updates beginning-of-timestep parameters in evaporators.
644	SHIFTS	BOP	Updates beginning-of-timestep parameters in superheaters.
646	SHUNIT	BOP	Computes temperatures in superheaters.
648	SIAXEX	TSPK	Solves simple model for axial expansion.
650	SIGFRA	DEFORM-4	Calculates fuel fracture strength.
651	SINEQT	D3IF	Stores a single-precision array.
652	SINSET	D3IF	Stores a single-precision scalar into an array.
653	SODFRC	CLAP	Calculates coolant vapor/molten cladding friction factor.
654	SOLID	DEFORM-4	Controls iterations in fuel/cladding mechanical calculation.
658	SSADHX	PRIMAR-4	Solves steady-state air dump heat exchanger model.
660	SSBOP	BOP	Performs steady-state initialization of the BOP model.
662	SSBYPS	PRIMAR-4	Calculates bypass channel steady-state coolant and wall temperatures.
664	SSCFUN	BOP	Computes subcooled water entropy as a function of pressure.
666	SSCKVL	PRIMAR-4	Calculates steady-state check valve pressure coefficients.
667	SSCLM1	TSCL0	Calculates steady-state coolant pressures and saturation temperatures for the multiple-pin model.
668	SSCOMP	SSCOMP	Calculates pre-transient radial composition variation in U-Pu-Zr fuel.
670	SSCOOL	TSCL0	Calculates steady-state coolant temperatures for a single channel.
672	SSCPCP	PRIMAR-4	Initializes component-to-component heat transfer.
674	SSCPNL	PRIMAR-4	Manages null transient for component-to-component heat transfer.

No.	Name	Module	Purpose
676	SSDRAC	PRIMAR-4	Calculates steady-state DRACS temperatures.
678	SSDRIV	ROOT	Manages steady-state calculation.
680	SSFUEL	DEFORM-4	Manages steady-state calculation.
682	SSHFUN	BOP	Computes superheated steam entropy as a function of pressure and enthalpy.
684	SSHTR	TSCL0	Calculates steady-state fuel and cladding temperatures.
686	SSHTRW	BOP	Performs initialization of BOP heater models.
688	SSIHX	PRIMAR-4	Calculates steady-state IHX temperatures.
690	SSIHXC	PRIMAR-4	Calculates steady-state IHX temperatures using a simple model.
692	SSIN01	ROOT	Performs initialization of channel-independent data.
693	SSINC1	ROOT	Performs initialization of channel-dependent data.
694	SSINCH	ROOT	Performs initialization of channel-dependent data.
696	SSLQSG	PRIMAR-4	Initializes liquid segment elements at steady-state.
698	SSNULL	TSCL0	Manages null transient for multiple-pin subassembly heat transfer model.
700	SSNZZL	BOP	Performs initialization of BOP model nozzle model.
702	SSP4CV	PRIMAR-4	Initializes compressible volume gas pressure, mass, and volume, and liquid mass and interface height.
704	SSP4PR	PRIMAR-4	Prints PRIMAR-4 steady-state results.
706	SSP4TH	PRIMAR-4	Initialization of node volumes, and coolant and wall temperatures for pipe-type temperature groups.
707	SSPINT	PRIMAR-4	Initializes data for multiple-plenum option.
708	SSPK	TSPK	Initializes point kinetics model data.
709	SSPLFL	PRIMAR-4	Calculates steady-state primary loop flows.
710	SSPLOT	ROOT	Writes steady-state binary plot file records (future).

No.	Name	Module	Purpose
712	SSPMLP	PRIMAR-4	Initializes steady-state primary-loop flows, pressures, and temperatures.
714	SSPMPW	BOP	Performs steady-state initialization of the BOP pumps.
716	SSPRIM	PRIMAR-4	Performs steady-state initialization.
718	SSPRM4	PRIMAR-4	Manages PRIMAR-4 steady-state initialization.
720	SSPRNT	ROOT	Prints steady-state channel results.
722	SSPRPL	PRIMAR-4	Writes steady-state PRIMAR-4 plot file record.
724	SSPRSR	PRIMAR-4	Calculates steady-state pressure and pump head for a segment in the intermediate loop.
726	SSPUMP	PRIMAR-4	Initializes steady-state pump parameters.
730	SSRVW	BOP	Performs steady-state initialization of BOP relief valves.
732	SSSASA	PRIMAR-4	Initializes subassembly-to-subassembly heat transfer.
734	SSSCLP	PRIMAR-4	Initializes intermediate loops and steam generators.
736	SSSTDR	PRIMAR-4	Manages steady-state steam generator calculation.
740	SSSTGN	BOP	Driver subroutine for the steady-state initialization of steam generator elements (e.g. evaporators and superheaters).
742	SSTHRM	ROOT	Manages steady-state thermal/hydraulics calculation.
743	SSTOUT	PRIMAR-4	Initializes data for multiple-plenum option.
744	SSTRBN	BOP	Performs steady-state initialization of the turbine.
746	SSVALV	PRIMAR-4	Calculates steady-state valve pressures.
748	START0	ROOT	Zeros common storage and initializes allocation.
749	START1	D3IF	Initializes DIF3D data management.
750	STEPFN	PRIMAR-4	Completes liquid flow and temperature calculations for a subinterval.
752	STEPGS	PRIMAR-4	Calculates gas flow between compressible volumes and storage tanks for a subinterval.
754	STEPLQ	PRIMAR-4	Manages liquid flow and pressure calculations.
756	STEPTM	PRIMAR-4	Manages liquid temperature calculations.
758	STGNFL	PRIMAR-4	Calculates sodium-side steam generator flow coefficients.

No.	Name	Module	Purpose
763	STRANC	DEFORM-5	Calculates cladding plastic strain.
764	STRATV	PRIMAR-4	Stratified volume calculations.
765	STRGVH	PRIMAR-4	Calculates gravity heads in a stratified volume.
766	SUBSIZ	PRIMAR-4	Sets the PRIMAR sub-interval time step size.
769	SYSTEZ	ROOT	Contains entry points for computer-system-dependent functions for timing, addressing, job identification, machine identification, user identification, and date.
770	T41A3D	TSBOIL	Sets matrix coefficients for pressure-drop bubble calculation.
772	T42A3D	TSBOIL	Solves matrix equations for pressures and mass flow rates in pressure-drop bubble calculation.
774	T4A3D	TSBOIL	Manages pressure-drop and uniform-pressure bubble calculations and initializes variables for calculation of vapor pressures and mass flow rates.
778	TAVSET	PRIMAR-4	Computes mass-average outlet temperature from a pipe over at time step.
779	TBLKUP	PRIMAR-4	Provides linear or third-order interpolation from tables.
780	TEFUEG	LEVITATE	Calculates fuel temperature as function of energy.
782	TESEEG	LEVITATE	Calculates steel temperature as a function of energy.
784	TESEGG	LEVITATE	Calculates steel temperature as a function of energy.
785	THEXP1	SSCOMP	Calculates U-Pu-Zr thermal expansion by region-wise interpolation of IFR Handbook data.
786	THRMEX	TSPK	Calculates mean thermal expansion coefficient of core structural material for detailed radial expansion model.
787	TIMCTC	ROOT	Converts time step number and case time to CHARACTER type.
788	TIMER	ROOT	Provides current and elapsed computer time.
790	TLFUN	BOP	Computes the temperature of water as a function of enthalpy and pressure (subcooled liquid through superheated steam).
793	TRIGEO	D3IF	Write three-dimensional triangular geometry file.

No.	Name	Module	Purpose
796	TRNSPT	BOP	Tracks the transport of enthalpy through each BOP flow segment.
797	TRTEMO	SSCOMP	Calculates first and last solid-state transition temperatures of U-Pu-Zr alloys.
799	TSAT	ROOT	Calculates saturation temperature of liquid sodium as a function of pressure.
800	TSBOIL	TSBOIL	Manages the two-phase coolant dynamics calculation.
802	TSBOP	BOP	Driver subroutine for the BOP transient calculation.
804	TSC2	TSBOIL	Extrapolates coolant, cladding, and structure temperatures; computes density, thermal conductivity, heat capacity, and viscosity; estimates change in coolant flow rate.
806	TSC21	TSBOIL	Computes terms in momentum equation for each fully liquid segment of each coolant slug.
808	TSC3	TSBOIL	Computes coolant heat transfer coefficients and film thicknesses; also calculates heat flow to uniform pressure bubbles.
812	TSC43A	TSBOIL	Calculates vapor temperatures and pressures in uniform pressure bubbles.
814	TSC5	TSBOIL	Calculates liquid slug flow rates and liquid/vapor interface positions after the first bubble is formed.
816	TSC6	TSBOIL	Calculates temperatures in liquid slugs.
818	TSC7	TSBOIL	Computes pressure and saturation temperatures in liquid slugs and performs the iteration to specify the time at which boiling starts.
820	TSC8	TSBOIL	Performs accounting for bubble collapse, bubble formation, liquid slug expansion and reentry, and merging of bubbles upon disappearance of a liquid slug.
822	TSC82	TSBOIL	Checks for formation of a new bubble (other than the first bubble formed in a channel)
824	TSC83	TSBOIL	Calculates liquid slug expulsion and reentry.
826	TSC84	TSBOIL	Calculates bubble collapse.
828	TSC85	TSBOIL	Performs bubble accounting.
830	TSC86	TSBOIL	Performs liquid slug accounting.

No.	Name	Module	Purpose
832	TSC87	TSBOIL	Performs gas bubble accounting for the gas release voiding model.
834	TSC9	TSBOIL	Computes next coolant time step size; evaluates and resets current time step if the step size is too large.
836	TSCA	TSBOIL	Calls TSCA1 and TSCA2 in first section; or, in second section, computes film heat transfer coefficients and heat fluxes and sets cladding temperatures in the fuel pin for the next time step.
838	TSCA1	TSBOIL	Calculates increments to the integrated heat fluxes from the cladding to coolant and from the structure to the coolant. Also calculates increments to the film heat transfer coefficients and the average sodium density.
840	TSCA2	TSBOIL	Calculates temperatures of structure, reflectors, cladding in the plenum and gas in the plenum.
842	TSCBUB	TSBOIL	Creates a new vapor bubble.
844	TSCC	TSBOIL	Calculates film motion (not currently used).
846	TSCC2	TSBOIL	Sets film dry-out boundaries for the film motion model.
848	TSCINT	TSBOIL	Initializes channel data for coolant dynamics calculation.
850	TSCL0	TSCL0	Manages single-phase coolant dynamics calculation.
852	TSCLD1	CLAP	Initializes data for cladding relocation model and solves mass and energy transfer equations.
854	TSCLD2	CLAP	Solves moving cladding momentum equation for film velocity.
855	TSCLM1	TSCL0	Calculates transient coolant flow rates for the multiple-pin option.
856	TSCMP0	TSBOIL	Provides binary output of channel temperatures, flows, and pressures.
858	TSCMP1	TSBOIL	Provides binary output of channel temperatures, flows, pressures, and bubble interface positions.
860	TSCNV1	TSCL0	Extrapolates coolant temperatures, computes coolant flow and pressures, tests for start of boiling.
862	TSCNV2	TSCL0	Computes coolant flow rate coefficients.

No.	Name	Module	Purpose
864	TSCNV3	TSCL0	Computes coolant-to-cladding and coolant-to-structure heat transfer coefficients at the end of a heat transfer time step.
866	TSCNV7	TSCL0	Computes sodium density and viscosity.
868	TSCNV8	TSCL0	Computes liquid film heat transfer coefficient.
870	TSCSET	TSBOIL	Initializes coolant variables each coolant time step.
872	TSDRCS	PRIMAR-4	Calculates DRACS temperatures.
874	TSDRIV	ROOT	Manages transient calculation.
875	TSGRFN	ROOT	Extracts results to be displayed under graphical user interface for EBR-II simulator mode.
877	TSHTM2	TSCL0	Computes cladding, coolant, structure, and plenum gas temperatures for a single-phase coolant gas plenum region for the multiple-pin model.
878	TSHTM3	TSCL0	Computes fuel, cladding, coolant, and structure temperatures for single-phase coolant core and blanket regions for the multiple-pin model.
879	TSHTN1	TSCL0	Computes reflector, coolant, and structure temperatures for single-phase coolant reflector zone.
880	TSHTN2	TSCL0	Computes cladding, coolant, structure, and plenum gas temperatures for a single-phase coolant gas plenum region for the single-pin model.
882	TSHTN3	TSCL0	Computes fuel, cladding, coolant, and structure temperatures for the core and blanket regions of a single-phase coolant channel for the single-pin model.
884	TSHTN4	TSCL0	Computes coolant density and heat capacity, and initializes coolant flow geometry for a single-phase coolant channel.
886	TSHTN5	TSCL0	Corrects cladding temperatures for the heat of fusion in melting and freezing.
888	TSHTN6	TSCL0	Corrects fuel temperatures for the heat of fusion in melting and freezing.
890	TSHTRN	TSCL0	Manages channel heat transfer calculation for a single-phase coolant channel.

No.	Name	Module	Purpose
892	TSHTRV	TSBOIL	Computes fuel and cladding temperatures in the core and blanket regions for a two-phase coolant channel.
894	TSHTRW	BOP	Performs transient calculation for BOP heater temperatures and heat sources.
896	TSIHX	PRIMAR-4	Calculates IHX shell and tube-side temperatures and gravity head.
898	TSIHXC	PRIMAR-4	Calculates IHX temperatures and gravity head using a simple model.
900	TSILLB	TSBOIL	Initializes cladding temperatures, interface velocities, and interface positions.
902	TSINIT	ROOT	Initializes beginning-of-transient data.
906	TSNZZL	BOP	Calculates nozzle parameters during a transient.
908	TSOV45	TSBOIL	Manages calculation of pressure, temperature, and flow rates in liquid slugs, and bubble accounting in two-phase coolant dynamics computation.
910	TSPK	TSPK	Manages the solution of the point kinetics equations over a main time step given the extrapolated or calculated reactivity.
912	TSPLOT	ROOT	Writes transient binary plotting file records.
914	TSPRNT	ROOT	Prints channel data during the transient calculation.
916	TSPRPL	PRIMAR-4	Writes transient binary plotting file records.
918	TSRVW	BOP	Accounts for the momentum equation in a relief valve.
922	TSSTGN	BOP	Transient driver subroutine for steam generator elements.
924	TSTHRM	ROOT	Manages the transient thermal/hydraulics calculation.
925	TSTRBN	BOP	Performs transient turbine model calculation.
926	TWODMC	D3IF	Constructs two-dimensional composition map.
927	TWOGEO	D3IF	Writes two-dimensional geometry file.
928	UNISOT	D3IF	Sorts the isotope mixing table.
929	UTS	ROOT	Computes the cladding ultimate tensile strength given the temperature.

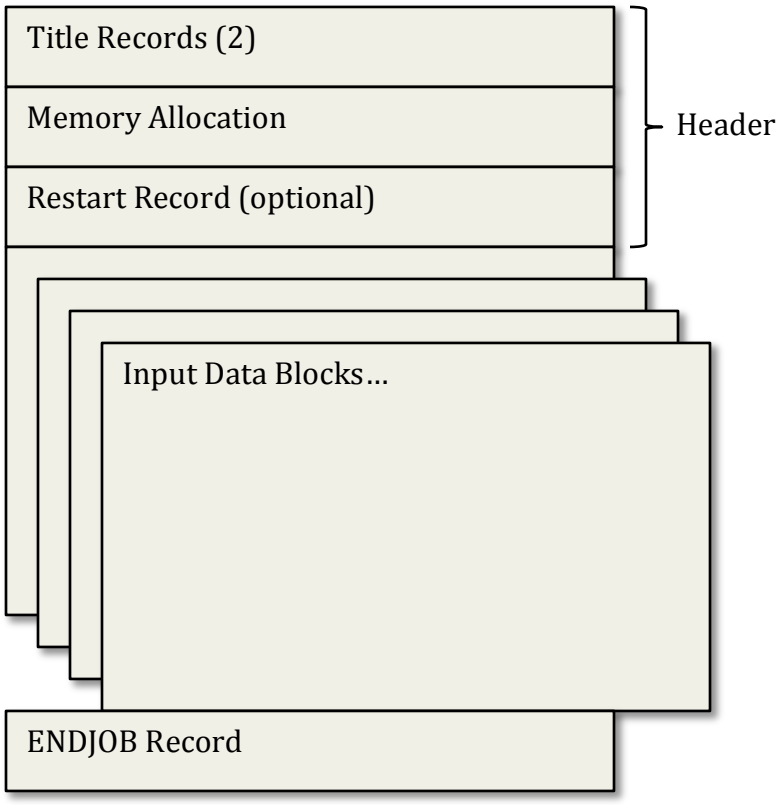
No.	Name	Module	Purpose
930	VALVAJ	PRIMAR-4	Computes steady-state valve pressure drop adjustment, if needed, between compressible volumes connected by several liquid segments.
931	VALVEW	BOP	Computes BOP standard valve orifice coefficients.
932	VALVFL	PRIMAR-4	Computes valve pressure coefficients.
933	VFCHAN	D3IF	Manages material mass calculation.
934	VFEDIT	D3IF	Prints volume fraction file.
935	VFRITE	D3IF	Initializes volume fraction file.
936	VISC	ROOT	Calculates liquid sodium viscosity given the temperature.
937	VOIDIT	D3IF	Computes void-coolant volume fraction.
938	VSLTMP	PRIMAR-4	Computes average vessel temperature for the control rod driveline expansion feedback calculation.
939	WCMPXS	D3IF	Writes record of the composition cross section file.
940	WGEODS	D3IF	Manages writing of geometry file.
941	WRAPIT	D3IF	Finalizes volume fraction file data.
942	WRITEC	ROOT	Transfers data packs from blank common to the storage area.
944	WTRDRV	BOP	Driver subroutine for the BOP loop calculation (excluding evaporators and superheaters).
946	WTRPRT	BOP	Prints BOP parameters.
952	WXSCO6	D3IF	Writes material cross section file records.
954	XDENCK	D3IF	Checks cross section group energies.
955	XDRDR2	D3IF	Reads microscopic cross section file.
956	XDRDR3	D3IF	Reads microscopic cross section file.
960	XKL	ROOT	Calculates liquid sodium thermal conductivity given the temperature.
966	XSCAL1	D3IF	Manages data for composition cross section computation.
967	XSCAL2	D3IF	Computes composition cross sections.
968	XSCAL3	D3IF	Stores Perturbation cross sections.
969	XSCAL4	D3IF	Transposes emission spectra order.
970	XSCINP	D3IF	Retrieves perturbation cross section data.
972	XSCTL	D3IF	Computes down-scatter indices.

No.	Name	Module	Purpose
974	XSCTSV	D3IF	Computes material scattering cross sections.
978	XSFIP2	D3IF	Computes material fission yields.
979	XSFIPR	D3IF	Manages material fission yield computation.
984	XSRITE	D3IF	Initializes cross section homogenization file.
988	XSUP02	D3IF	Updates macroscopic cross sections.
989	XSUPDT	D3IF	Updates macroscopic cross sections.
992	YLDCF	DEFORM-4	Calculates the cladding yield strength.
995	ZBLEND	D3IF	Maps masses from thermal/hydraulic axial mesh to neutronics axial mesh.

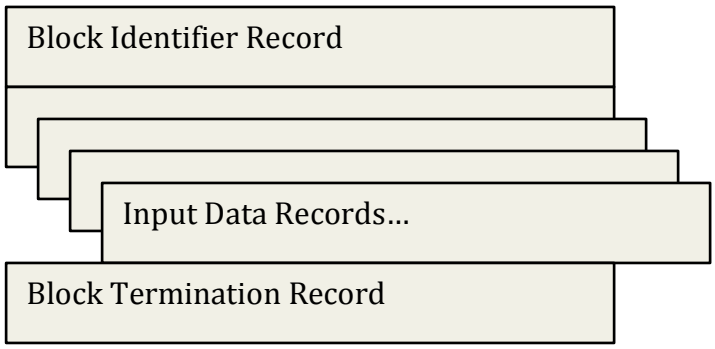
APPENDIX 2.2:
SAS4A/SASSYS-1 STANDARD INPUT DESCRIPTION

2.2-1 Input Format

SASSYS/SAS4A input data are read from logical unit 5 as an 80 column per record ASCII character file with the following structure



where the Input Data Blocks have the following structure:



In addition to the above, any record whose first character is the "#" symbol will be treated as a comment record. Comment records can be located at any point in the input, even among Input Data records.

2.2-2 Input Data Records Descriptions

Each input file for SAS4A/SASSYS-1 begins with a file header that includes two title records (primary and secondary) along with memory allocation information and an optional restart record.

Primary Title Record: (TITLE(I), I=1,9), VERNAM)

Format: (10A8)

TITLE(I): Primary Title (72 characters)

VERNAM: The code version label for this input deck. For Version 3.1.x, the version label is the eight character string:

"3.1bbbbb"

left adjusted in columns 73 through 80, where "b" is a blank character (space). The appropriate version label is required in order for execution to proceed beyond the reading of the primary title record.

Secondary Title Record: (TITLE(I), I=10,18)

Format: (9A8)

TITLE(I): Secondary title

The first 72 columns of the primary and secondary title records will appear as a heading at the top of each page (60 lines) of printed output. Both title records are always required.

Storage Allocation Record: NCH, NEUTSP, IDBUGP, IPDECK, NBYSSH, IDATMO, IADEFC, IAPLUC, IACNTL, IALBOP

Format: (I6,9I3)

The storage allocation record is always required.

NCH Number of channels for this case (see NCHAN). Maximum value is 22000.

NEUTSP Neutronics storage allocation flag. Set > 0 when DIF3D, DIF3D-K, or VARIANT-K modules are used.

IDBUGP Data management print flag. Set > 0 when data storage allocation and data movement diagnostic prints are desired.

IPDECK Input data editing flag. Set > 0 for a compressed copy (i.e. redefinitions eliminated, last defined values retained) of the input deck output as an ASCII file on logical unit 7.

NBYSSH Number of bypass channels involved in subassembly-to-subassembly heat transfer.

IDATMO Data management option flag. Set = 0 for default data management strategy for all modules. Set > 0 for extended address data management option for modules TSCL0 and DEFORM-5 (data packs COMC, COLC, and DEFC). Extended address data management is not currently available in modules TSBOIL, PINACLE, LEVITITE, PLUTO-2, or DEFORM-4.

IADEFC Data pack DEFC storage allocation flag. Set > 0 to eliminate storage allocation for data pack DEFC (DEFC is necessary for DEFORM-4 and DEFORM-5).

IAPLUC Data pack PLUC storage allocation flag. Set > 0 to eliminate storage allocation for data pack PLUC (PLUC is necessary for PINACLE, LEVITATE, and/or PLUTO-2).

IACNTL Control system module data storage allocation flag. Set > 0 to eliminate storage allocation for control system module data and input data block INCONT.

IALBOP Balance-of-plant module data storage allocation flag. Set > 0 to eliminate storage allocation for balance-of plant module data and input data blocks IINBOP and FINBOP.

Neutronics Storage Allocation Record: MAXFCM, MAXECM

Format: (2I12)

The neutronics storage allocation record is required only for NEUTSP > 0.

MAXFCM Number of single precision words in data buffer array.

MAXECM Number of single precision words in data storage array.

Restart Record: NAMBLK, NUMBLK, IRN

Format: (A8, I4, I6)

The restart record is required only for cases that initiate with the reading of a restart file from logical unit 18.

NAMBLK "RESTART" (left justified)

NUMBLK 100

IRN Restart number on the restart file that this case will use. If IRN = 999, the restart used will be the last restart written on the restart file. If IRN = 0 , the first restart written on the restart file will be

used. (IRN > 0 used for the multiple restart option only, see MULSTR).

Comment Records:

Format: (A80)

#… A comment record is any input record whose first character (column 1) is a "#" symbol. Arbitrary text may follow the comment character. While comment records may contain more than 80 characters, only the first 80 characters are printed to the output file during input processing. Comment records have an advantage over XNOTES input blocks in that they may occur anywhere within an input description, including between the input records of other input blocks.

Block Identifier Record: NAMBLK, NUMBLK, ICH, IZERO

Format: (A8, I4, 2I6)

The block identifier record is required as the first record of each input block.

NAMBLK Block name (left justified, see Table I).

NUMBLK Block number (see Table I).

ICH Channel number (use 1 if NUMBLK < 51).

IZERO 0, Zero block background input before reading data. Do not use 0 for data input following the reading of a restart file.

>0, Channel number of that block of the same name whose input data is to be used as background input before reading data. Background input blocks must be previously defined. Use IZERO = ICH for data input during a restart.

Block Input Data Records:

Within each block, input data is read on a format consistent with the data type for that block: integer, floating point, or character. See Table I for the data type associated with each input data block.

For Version 3.1 and later versions, input data may be specified either on fixed formats for integer, floating point, and character types, or on a specialized free format for all input blocks except INCONT, IINBOP, and FINBOP.

Fixed Format Integer Input: LOC, NUM, ISTORE(10)

Format: (12I6)

LOC Initial block location for data input.

NUM Number of input data to be read in this record in the ISTORE fields (1 ≤ NUM ≤ 10).

ISTORE Input data definitions to be placed in locations (LOC) to (LOC+NUM-1) in the input

Fixed Format Floating Point Input: LOC, NUM, STORE(5)

Format: (2I6,5E12.5)

LOC Initial block location for data input.

NUM Number of input data to be read in this record in the STORE fields (1 ≤ NUM ≤ 5).

STORE Input data definitions to be placed in locations (LOC) to (LOC+NUM-1) in the input block.

Fixed Format Character Input: LOC, NUM, STORE(10)

Format (2I6,10A6)

LOC Initial block location for data input.

NUM Number of input data to be read in the record in the STORE fields (1 ≤ NUM ≤ 10).

STORE Input data definitions to be placed in locations (LOC) to (LOC+NUM-1) in the input block.

Specialized Free Format: VNAME VALUE

where VNAME is the upper case alphanumeric input variable name, and VALUE is the number (either integer or real, depending on the type of the input block) or character string to be assigned to VNAME. If VNAME is defined as an array and no array location is specified, the initial array location is assumed. At least one blank column must separate VNAME and VALUE. The array location is specified in the conventional FORTRAN form as (I), (I,J), or (I,J,K) depending on the dimensions appropriate for the named variable. The first 72 columns of each input record are available for free format input.

Specialized Free Format: VNAME1 VALUE1 VNAME2 VALUE2 …

as above with repeated couples of names and values appearing on the same input record.

Specialized Free Format: VNAME VALUE1 VNAME2 VALUE2 …

as above where VNAME is an array variable name with the optional specification of an initial position for assignment of VALUE1; subsequent data values will be assigned to following input positions in the order of their appearance.

Specialized Free Format: VNAME n*VALUE

as above where VNAME is an array variable name with the optional specification of an initial assignment position, VALUE is the data value entered for assignment, "n" is an integer, and n* specifies that VALUE will be assigned to n consecutive input locations starting with the initial position.

Note: Block input data need not be input in numerical order. In the case of multiple entries of a particular variable, the last value input will be used. Columns 73-80 on the input record may be used as a comment field. On restart cases, only new or overriding data need be input.

Block Delimiter Record: LOC

Format: (I6)

The block delimiter record is required as the final record of each input block.

LOC -1

ENDJOB Record: NAMBLK, NUMBLK

Format: (A8, I4)

NAMBLK = "ENDJOB" (left justified)

NUMBLK = -1

XNOTES Record:

Format: (18A4)

Comments can be added in the input file as a pseudo input block called XNOTES. The block begins with a block identifier record having the block name 'XNOTES', followed by 80 column records containing the comments. The block ends with -1 in columns 5-6. The comment records are not stored and not transferred to the edited input data file on logical unit 7 or the restart file on logical unit 17.

Example:

```
XNOTES      1      0      0       (block identifier)
.
.
.
(COMMENTS)
.
.
.
    -1                            (block delimiter)
```

Table 2.2-1: Input Blocks

NUMBLK	NAMBLK	Input Format	Maximum Length
1	INPCOM	Integer	250
3	INPMR4	Integer	1600
5	INCONT	Special Mixed	-
6	IINBOP	Special Integer	-
7	INEUTR	Integer	17096
11	OPCIN	Flt. Pt.	250
12	POWINA	Flt. Pt.	1000
13	PMATCM	Flt. Pt.	1725
14	PRIMIN	Flt. Pt.	150
15	FINBOP	Special Flt. Pt.	-
16	RNEUTR	Flt. Pt.	3900
17	ANEUTR	Character	5020
18	PMR4IN	Flt. Pt.	5500
51	INPCHN	Integer	600
61	GEOMIN	Flt. Pt.	350
62	POWINC	Flt. Pt.	400
63	PMATCH	Flt. Pt.	200
64	COOLIN	Flt. Pt.	300
65	FUELIN	Flt. Pt.	300

Table 2.2-2:Assigned Logical Unit Numbers

File	Type	Assigned Use	Routine
1-4		Reserved	
5	Formatted	Input Data Records	READIN
6	Formatted	Printed Output	
7	Formatted	Edited Input Data Records	DATOUT
8	Formatted	Scratch BOP Input Data	READIN RENUM
9	Binary	Scratch EBR-II Mk V Plotting Data	TSPLOT
10	Formatted	Auxiliary Printed Output	
11	Binary	Main Time Step Data for Plotting	TSPLOT
12	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
13	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
14	Binary	PLUTO2/LEVITATE Data for Plotting	PLOUT
15	Binary	PRIMAR-4 Data for Plotting	SSPRPL TSPRPL
16	Binary	PRIMAR-4 Stratified CV Data	STRATV
17	Binary	Output Restart File	RESTAR
18	Binary	Input Restart File	RESTAR
19	Formatted	PINACLE/LEVITATE Data for Plotting	PNPICO LEPICO
20	Binary	Coolant T/H Model Data for Plotting	TSCMP0 TSCMP1
21	Binary	DEFORM-5 Data for Plotting	DFORM5
22	Binary	EBR-II Reactivity Data for Plotting	EBR2
23	Binary	FPIN2 Data for Plotting	FPNOUT
24	Binary	Subchannel T/H Model Data	SBFT24
25	Binary	BOP Model Data for Plotting	PLTBOP
26	Binary	BOP Model Data for Plotting	LBPLOT
27	Binary	Steam Generator Model Data for Plotting	TSBOP
28	Binary	Superheater Model Data for Plotting	TSBOP
29	Binary	BOP Model Data for Plotting	PLTBOP
30		Reserved	
31-99		Reserved for Spatial Kinetics Model	

Table 2.2-3:Abbreviations for the Computational Modules of SASSYS-1/SAS4A

Computational Module	Abbreviation
Boiling	BL
CLAP	CL
DEFORM	DF
FPIN2	FP
LEVITATE	LE
Neutron Kinetics	NK
PLUTO2	PL
PINACLE	PN
PRIMAR-4	P4
SSCOMP	SC

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
1	NCHAN	Number of core channels. Maximum = 22000. (not to be confused with the bypass channels of PRIMAR-4). Must match NCH in the data allocation record.		
2	IDBUG0	Channel independent debug flag. = 0, No debugging prints. > 0, Steady-state debug prints and transient time step prints. = 2, Steady state coolant debug prints. = 3, More steady state coolant debug prints.		
3	IFUEL1	Number of fuel types (Max. = 8).		
4	ICLAD1	Number of cladding types (Max. = 3).		
5	IPLUP	Fission gas plenum location: = 0, Fuel-pin gas plenum above the core. = 1, Fuel-pin gas plenum below the core.		
6	IPROPT	DEFORM-4 printed output selection option. = 0, Use time steps to control printing. = 1, Use absolute times based on PRSTRT and PRTDEL (PMATCM #1264, 1265) as well as time steps to control printing.		
7	ITKEL	Temperature scale for SSPRNT and TSPRNT print routines and TSPLOT plotting routine. = 0, Temperatures in Kelvins. > 0, Temperatures in degrees centigrade.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
8	IPOWER	Power driver option. = 0, External reactivity vs. time from PREA subroutine or table. Total reactivity is the sum of the external reactivity and the internally-calculated feedback reactivity. = 1, Power vs. time from PREA subroutine or table.		NK
9	IPOWOP	Power option. = 0, Steady-state power in the peak axial segment is calculated from total reactor power (See POWTOT). > 0, Steady-state total reactor power is calculated from the peak axial segment . (See POW).		NK
10	NPK	Reactor neutronics option. = 0, Point kinetics with input perturbation theory reactivity worth tables. = 1, Point kinetics with DIF3D (finite difference) calculated perturbation theory reactivity worth tables. = 2, DIF3D-K or VARIANT-K nodal space-time neutronics using direct solution. = 3, DIF3D-K nodal point kinetics with first order perturbation theory reactivity feedbacks. = 4, DIF3D-K nodal point kinetics with adiabatic reactivity feedbacks. = 5, DIF3D-K or VARIANT-K nodal space-time neutronics using improved quasi-static method.		
11	MAXSTP	Maximum number of main (power and reactivity) time steps in transient calculation.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
12	IPO	Number of main (power and reactivity) time steps between full printouts before IBLPRT or coolant boiling (See IBLPRN).		
13	IPOBOI	Number of main (power and reactivity) time steps between full printouts after IBLPRT or coolant boiling.		
14	IBLPRT	Main time step number for switch of full printout interval from IPO to IPOBOI. If IBLPRT = 0, switch occurs at coolant boiling inception.		
15	NSTEP	Restart file save option. = 0, No restart file saved. > 0, Restart file saved every NSTEP main time steps. Restart file is also saved when maximum problem time TIMAX (Block 11, loc 7) is reached, or when maximum computer time is about to be reached. See TCOSTP (Block 11, loc 9).		
16	NDELAY	Number of delayed neutron precursor families, $0 \le NDELAY \le 6$.		NK
17	NDKGRP	Number of decay heat groups. $0 \le NDKGRP \le 24$ The number of decay heat groups defined for any given curve may not exceed NDKGRP (except as noted below for NDKGRP = 0) but may be less than NDKGRP. This allows standard curves to be combined with user-supplied curves with a lower expansion order. Decay heat calculations can be disabled by setting NDKGRP = 0 even if other decay heat input is present.		NK

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
18	NPREAT	Number of entries in PREA vs. time table, -1 < NPREAT < 21. (See IPOWER, PREATB, and PREATM).		NK
19	NPRES	Coolant driving pressure option. = 0, The exponential decay of pump head (See PDECD, PDEC1, PDEC2) is used. > 0, Number of entries in table of coolant driving pressure or normalized coolant flow rate vs. time. -1 < NPRES < 20. (See IFLOW, PRETAB, PRETME).		
20	IFLOW	Used only if IPRION < 4, NPRES > 0. If IFLOW = 0 and IPRION < 4, then the coolant driving head is specified as a function of time. If IFLOW > 0, IFLOW is the channel number in which coolant flow is specified as a function of time.		
21	NONEU0	Reserved for space-time options.		
22	NT0TAB	Number of entries in T0TAB vs. T0TME table, i.e., coolant inlet temperature vs. transient time table.		
23	MULSTR	Multiple restart option. = 0, Normal restart option: Restarts written at multiples of NSTEP. Only the latest restart file is saved. = 1, Multiple restart option: Restarts written at multiples of NSTEP. All restart files are saved.		
24	ICLCMP	Core channel plotting option. = 0, Data for plots of transient not saved. > 0, Data output on logical unit 11 for transient information plots.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
25	INEDIT	Input edit option. = 0, No input edit. > 0, Input edit.		
26	IYLD	Cladding flow stress formulation. = 0, Based on TID-26666 = 1, DiMelfi - Kramer strain, strain-rate, temperature, and fluence dependent model. = 2, Same as 1, but with high strain rate approximation. = 3, Input table YLDTAB.		DF
27	IPRION	PRIMAR-4 option. = 4, For PRIMAR-4 option. < 4, For PRIMAR-1 option.		
28	IMELTV	Axial extent assumptions for the molten cavity pressure calculation. = 0, Extends only over axial extent of melting. = 1, Cavity includes all central cavity. = 2, Each axial node treated as separate cavity.		DF
29	INAS3D	Alkali metals coolant properties. (Overridden by ID2O, IPBDEN, KPROPI, and ICLPRP). = 0, For SAS4A sodium properties. > 0, For SAS3D sodium properties. < 0, For NaK properties.		
30	NCLADM	Not currently used.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
31	ICREXP	Control rod drive expansion option = 0, No control rod drive expansion feedback. = 1-3, Calculate feedback from single-node model. (Option 2 switches on CRD output in older decks, but use of ICRDDB flag to control output is recommended). = 4, Calculate feedback from multinode model.		
32	IXSTPC	Controls when the DEFORM computed axial expansion calculation is stopped based on cladding conditions. = 0, Continues. = 1, Inner cladding node temperature > TESOL(ICLADV). = 2, Inner two cladding nodes temperature > TESOL(ICLADV). = 3, All cladding nodes temperature > TESOL(ICLADV).		DF
33	IXSTPF	Controls when the DEFORM computed axial expansion calculation is stopped based on fuel melt percentage molten. = 0, Continues. > 0, Percent molten (0 < IXSTPF <= 100).		DF
34	IMCVTY	Controls how much crack volume is included in the volume of the molten cavity. See IROR in Block 51, location 45.		DF
35	IDBPWI	= 0, No debug print for POWINT subroutine. = 1, Debug print for POWINT subroutine.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
36	IRADEX	Radial expansion feedback option. = 0, No radial expansion feedback. > 0, Radial expansion feedback using the inlet coolant temperature. < 0, Radial expansion feedback using the inlet plenum wall temperature. Simple radial expansion model =1,-1 Calculate radial expansion reactivity feedback only. =2,-2 Print the radial expansion reactivity feedback, inlet temperature and average structure temperature every time step. =3,-3 Print debug. Detailed radial expansion model =4,-4 Print the radial expansion reactivity feedback, inlet temperature and average structure temperature every time step. =5,-5 Print axial core shape, net deflection, and radial expansion with curve, plus debug, every time step. =6,-6 FFTF core restraint design. See ANL/RAS 88-6 for consistent set of data. See program listing for additional cautions. =7,-7 FFTF core restraint design, print axial core shape, net deflection, and radial expansion with curve, plus debug, every time step.		
37	KFAILP	= 0, Mechanistic axial pin failure propagation in PLUTO2 and LEVITATE. (See FNARME Block 13, loc 1176). = 1, Axial pin failure propagation determined by input. (See TEFAIL, FNARME, PRFAIL in Block 13, loc 1175-1177).		PL

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
38	NCPLEV	Switch from PLUTO2 to LEVITATE when NCPLEV axial cladding nodes have exceeded the cladding liquidus temperature. Suggested value: 3. NCPLEV = 0: Do not switch from PLUTO2 to LEVITATE due to cladding melting. A switch from PLUTO2 to LEVITATE occurs automatically if all fuel and cladding in the pin are molten in any axial node.		PL
39	NFUELD	Number of dollars of fuel reactivity to terminate the calculation. Recommended value: -5.		PL,LE
40	IAREXT	Controls radial extent of integration when calculating the plain strain axial expansion. = 0, Over the solid fuel annulus. = 1, Over all the fuel, both solid and molten.		DF
41	NOREAC	Reactivity print option. = 0, Full output from PSHORT. > 0, Full output from PSHORT every NOREAC main time steps.		
42	NSLEEX	Number of fully molten hexcan cells in a subassembly to terminate the calculation.		LE
43	NSRMTB	Not currently used.		
44	INRAEJ	= 0, Parametric fuel injection calculation. (See CIPINJ, Block 13, location 1276) = 1, Ejection of in-pin fuel is calculated using a mechanistic model.		LE

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
45	NPOWDK	Number of power curves or sets of user-defined decay heat curves used. 0 ≤ NPOWDK ≤ 5 For IPOWER = 0, NPOWDK defines the number of user-defined decay heat curves to expect in the input. (Do not count any built-in ANS standard curves that are used in the problem.) NPOWDK should be zero when using the original (Version 1.0) decay heat input. For IPOWER = 1, NPOWDK defines the number of user-supplied power vs. time tables. This usage is unrelated to the decay heat model.		
46	NPDKST	Number of entries in the POWLVL vs. POWTIM and PWLVL2 vs. PWTIM2 tables for performing steady-state initialization of the decay heat precursors. 0 ≤ NPDKST ≤ 8 If NPDKST = 0, infinite steady-state irradiation is assumed for all decay heat regions regardless of the input in POWLVL/POWTIM and PWLVL2/PWTIM2.		
47	ICHUNK	= 0, The chunk model in LEVITATE is not used. = 1, The chunk model in LEVITATE is used.		LE
48	ILUBLK	= 0, Inhibit chunk formation due to bulk freezing of the fuel. = 1, Allow chunk formation via bulk freezing if no solid support for chunk formation is present.		LE
49	INAPN	Sodium vapor pressure treatment. = 0, No sodium vapor pressure in the fuel pin cavity. = 1, Sodium vapor pressure is considered in the fuel pin cavity.		PN

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
50	NOEQPN	Controls the pressure in the molten cavity at the time of PINACLE initiation. = 0, The pressure in the cavity is equal to the DEFORM calculated pressure. If the input PCFAIL > 1.0, the pressure is set equal to PCFAIL. = 1, The pressure in the cavity is calculated using the available fission gas.		
		LOCATIONS 51-54 USED ONLY IF |IRADEX| > 3		
51	NSUBTC	Total number of subassemblies in the active core region, including control and internal blanket subassemblies. Used for calculating the core radius in the radial expansion reactivity feedback calculation.		
52	MTGRD	Support grid material, used for calculating the thermal expansion of the grid during a transient. = 1, 316 SS. = 2, HT-9.		
53	MTACLP	Above-core load pad material. Used for calculating the thermal expansion of the above-core load pad during a transient. = 1, 316 SS. = 2, HT-9.		
54	MTTLP	Top load pad material, used for calculating the thermal expansion of the top load pad during a transient. = 1, 316 SS. = 2, HT-9.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
55	MODEEX	Axial expansion option. = 0, Force balance or free expansion, depending on radial gap. = 1, Cladding controlled fuel expansion. = 2, Independent free expansion. = 3, Force balance all the time.		
56	JREEXT	= 0, No correction term. = 1, Add correction term to reactivity extrapolation.		
57	IFT19	Not currently Used.		
58	IREACT	Reactivity feedback model option. = 0, Use detailed reactivity models. = 1, Use FFTF empirical reactivity model. = 2, Use EBR-II empirical reactivity model. = -1 Compute, write out but do not use FFTF model. = -2 Compute, write out but do not use EBR-II model.		
		LOCATIONS 59-65 USED ONLY IF |IRADEX| > 3		
59	NSUBTR	Total number of subassemblies in the reactor, including drivers, radial and internal blankets, control assemblies, radial reflectors and shields.		
60	NRRNGS	Number of restraint rings in core restraint design. = 0, No restraint rings. = 1, Restraint ring at top load pad only. = 2, Restraint rings at top and above-core load pads.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
61	MTRRAC	Material of the restraint ring at the above-core load pad elevation. = 1, 316 SS. = 2, HT-9.		
62	MTRRT	Material of the restraint ring at the top load pad elevation. = 1, 316 SS. = 2, HT-9.		
63	MTRFAC	Radial reflector and/or blanket above-core load pad material. = 1, 316 SS. = 2, HT-9.		
64	MTRFT	Radial reflector and/or blanket top load pad material. = 1, 316 SS. = 2, HT-9.		
65	IROPT	Assumption for low power-to-flow ratios. = 0, Subassemblies vertical at the grid plate. = 1, Above-core load pads remain compacted (most pessimistic).		
66	JCRIND	For use with EBR-II reactivity model only. This is the lowest node in which the control rod is present in the special EBR-II control rod feedback model. Sums then run from JCRIND to the top of S/A.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
67	ID2O	Heavy water coolant properties. (Overridden by IPBDEN, KPROPI, and ICLPRP). = 0, Na or NaK properties (See INAS3D). = 1, D2O properties.		
68	IDNFLW	= 0, For initial upflow through the core. = 1, For initial downflow through the core.		
69	IPLTSG	Number of main timesteps between saving plot data for the steam generator model.		
70	IBOP	Balance of plant modeling option. = 0, If balance-of-plant model is not used. = 1, If balance-of-plant model is used.		
71	ICRDDB	Control rod drive expansion print option. = 0, No output from control rod drive expansion model. = 1, Regular CRD output every main time step. = 2, Additional debug output every PRIMAR time step.		
72-74	ICRTMP (K)	Specifies the environment temperature for section K of the control rod drive for ICREXP = 2. If = 0, the UIS temperature is used. If > 0, the temperature of compressible volume ICRTMP is used.		
75-77	ICRNOD (K)	Number of axial nodes per section of CRD.		
78	NSEGCR	Number of PRIMAR4 segment representing control rod assemblies.		
79	ICHCHT	Not currently Used.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
80	NOEQLE	Controls the pressure in the molten cavity at the time of LETITATE or PLUTO2 initiation. = 0, The pressure in the cavity is equal to the DEFORM calculated pressure. If the input PCFAIL > 1.0, the pressure is set equal to PCFAIL. = 1, The pressure in the cavity is calculated using the available fission gas. If LEVITATE or PLUTO2 are initiated after PINACLE, the pressure is always equal to the PINACLE pressure and NOEQLE is not relevant.		
81	MTCB	Core barrel material. = 1, 316 SS. = 2, HT-9.		
82	KDEBUG	= 0, No EBR-II routine debug. = 1, Turns on EBR-II routine debug.		
83	KEBRS1	Main timestep number to turn EBR-II routine debugging on.		
84	KEBRS2	Main timestep number to turn EBR-II routine debugging off.		
85	IDBDKH	Reserved for future decay heat modeling.		
86	NULLD3	Number of flux shape calculations in addition to the initial cold solution in the steady state power distribution/thermal hydraulics iteration for NPK > 0.		
87	ISSNUL	Number of time steps in the steady-state null transient for core channel thermal hydraulics. If ISSNUL=0, no null transient. Note: ISSNUL>0 is required if the multiple pin option is used (JJMLTP>0).		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
88	IPRSNL	If ISSNUL>0, then print out temperatures every IPRSNL time steps of the null transient.		
89	NOFDBK	Transient reactivity feedback option for NPK=0. = 0, Use subroutine FEEDBK for transient reactivity feedbacks. > 0, Do not calculate transient reactivity feedback with subroutine FEEDBK.		
90	IBOPLT	Balance-of-plant plotting file option. = 0, Do not call subroutine LBPLOT. > 0, Main time step frequency for writing BOP plotting file from subroutine LBPLOT.		
91	ISIMPG	Graphical interface for simulator application. = 0, No graphical interface. = 1, Graphical interface for EBR-II. Some card-image input will be overridden interactively by values from graphical interface. SASSYS is invoked by the graphical interface, not directly by the user. Usage instructions are in ANL-FRA-171: requires IDATMO>0.		
92	KHDBK	Print flag for messages if any extrapolation of the IFR handbook data is used. Only for IMETAL=2, IRHOK=1 and IFUELM=0. = 0, Print messages. = 1, Do not print messages.		
93	KFIRR	Correction option for irradiation effect on metal fuel thermal conductivity. = 0, Empirical correction based on average fuel burnup (See BURNFU). = 1, Theoretical correction based on porosity and sodium logging of fuel radial node. (See PRSTY and XLOGNA).		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
94	KDENBU	Option for correction of U-Pu-Zr alloy fuel theoretical density for the presence of fission products, based on average fuel burnup and fabricated composition (See BURNFU, WUREF, WPUREF, WZRREF). Only for IMETAL = 2, IRHOK = 1, and IFUELM = 0. = 0, No correction for fission products. = 1, Make correction for fission products.		
95-100	IFIT (K)	Input table look-up options. IFIT: = 0, Linear fit. = 1, Third order fit. = 2, Third order fit with slope discontinuities if: X(J+1) - X(J) < 0.001. = 3, Linear fit to log(Y). = 4, Third order fit to log(Y). = 5, Third order fit to log(Y) with slope discontinuities. K: = 1, Power vs. time or user specified reactivity vs. time curves (PREATB, PRETB2). = 2, PRIMAR-1 pump head vs. time or channel flow vs. time. = 3, PRIMAR-1 inlet temperature vs. time. = 4, PRIMAR-4 pump head, motor torque, or pump speed vs. time. = 5, Reserved for future use. = 6, Reserved for future use.		
101	IPIC	PINACLE/LEVITATE pin picture plot flag. = 0, No plot data on unit 19. = 1, Plot data written on unit 19.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
102	IBOWTP	Temperature flag in EBR-II bowing reactivity. = 0, Normalized core temperature rise based on upper plenum temperature. = 1, Normalized core temperature rise based on average coolant temperature in fueled channels.		
103	ITARGE	Not currently used.		
104	IEMGEM	FFTF Gas Expansion Module (GEM) model. = 0, Not used. > 0, Invoke FFTF GEM model.		
105	NEXSO	Number of entries in EXSOTB/EXSOTM point kinetics external source table (Max. 20).		
106	IPBDEN	Heavy liquid metal coolant thermophysical properties. (Overridden by KPROPI and ICLPRP). = 0, Coolant properties determined by INAS3D and ID2O. = 1, Use Pb coolant thermophysical properties. = 2, Use Pb (44.5%)-Bi (55.5%) eutectic thermophysical properties.		
107	MSTPLA	Transient time step for change of plotting data output frequency from MSTPL1 to MSTPL2.		
108	MSTPLB	Transient time step for change of plotting data output frequency from MSTPL2 to MSTPL3.		
109	MSTPL1	Transient time step plotting data output frequency before time step MSTPLA.		
110	MSTPL2	Transient time step plotting data output frequency after time step MSTPLA and before time step MSTPLB.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
111	MSTPL3	Transient time step plotting data output frequency after time step MSTPLB.		
112	KTREAT	TREAT modeling flag. = 0, Use standard modeling. > 0, Use special TREAT modeling.(Air properties for coolant, constant coolant flow rates).		
113	KQSCRA	Modeling option for external source with scram. = 0, Trip external source at time TSCRAM+ DELSCR. = 1, Hold external source at constant value after TSCRAM+DELSCR. = 2, Continue external source according to NEXSO, EXSOTB, EXSOTM specifications after TSCRAM+DELSCR. If NEXSO = 0, the external source is held at the initial steady-state value set by RHOZRO.		
114	KPROPI	Coolant thermophysical properties correlation coefficients. (Overridden by ICLPRP). = 0, Use default coefficients defined by INAS3D, ID2O, IPBDEN, or ICLPRP. > 0, Input correlation coefficients in APROPI (Block 13, locs 1335-1394).		
115	ISCH	Coolant channel thermal-hydraulics model option. = 0, Use single-pin model. > 0, Use detailed coolant sub-channel model.		
116	ISKDOT	Input data printing option. = 0, Print data as input, and also print the full input data file as stored in memory (DATOUT). > 0, Skip the DATOUT print, do not recapitulate the input data.		

Block 1 — INPCOM — Channel-Independent Options and Integer Input

Location	Symbol	Description	Units	Used By
117	NLINMX	Printed output line limit, in thousands of lines, for the printed output file (Unit 6). Default (0) is no limit.		
118	ICLPRP	Coolant material properties used in the core and all of PRIMAR except for the DRACS loops. = 0, Correlation coefficients set by INAS3D, ID2O, IPBDEN, or KPROPI = 1, For Na, SAS4A version. = 2, For Na, SAS3D version. = 3, For NaK. = 4, For D2O. = 5, For Pb. = 6, For Pb-Bi. = 7, For user-supplied property correlation coefficients. Note: If ICLPRP > 0, then ICLPRP overrides INAS3D (Block 1, loc 29), ID2O (Block 1, loc 67), IPBDEN (Block 1, loc 106), and KPROPI (Block 1, loc 114). See INAKDR (Block 3, loc 509) for the DRACS loop properties.		
119	IFT1TM			
120-250	INPDU2	Not currently used.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
1	NCVP	Number of compressible volumes, primary loops.		
2	NCVS	Number of compressible volumes, secondary loops.		
3	NCVD	Number of compressible volumes, DRACS loops. Not yet operational.		
4	NSEGLP	Number of liquid segments, primary loops. All SAS4A channels (except the bypass channels) form one liquid segment.		
5	NSEGLS	Number of liquid segments, secondary loops.		
6	NSEGLD	Number of liquid segments, DRACS loops. Not yet operational.		
7	NSEGGP	Number of gas segments, primary loops.		
8	NSEGGS	Number of gas segments, secondary loops.		
9	NSEGGD	Number of gas segments, DRACS loops. Not yet operational.		
10	NELEMT	Total number of liquid flow elements, max = 140. A bypass channel must not be split into more than one flow element. Note maximum total numbers: Compressible volumes 38 Liquid segments 40 Gas segments 28 Liquid elements 140 Pumps, sodium 12 IHXs 4 Steam generators Table look-up model 12 Detailed model 8 Check valves 14		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		DRACS heat exchangers (not yet operational) 4 Temperature groups 100 Bypass channels 8 Axial nodes in IHX 61 Note subscripts used in this block: ICV Compressible volume ISGL Liquid segment ISGG Gas segment IELL Liquid flow element M 1 Inlet 2 Outlet IPMP Pump IIHX IHX ITGP Temperature group IBYP Bypass channel ISGN Steam generator IVLV Valve ICKV Check valve IDHX Air dump heat exchanger IRVC RVACS		
11–48	ITYPCV (ICV)	Compressible volume type. = 1, Inlet plenum. = 2, Compressible liquid volume, no gas. = 3, Compressible outlet plenum, no cover gas. = 4, Almost incompressible liquid, no gas. (pipe tees, extra inlet plenum, etc.) = 5, Pipe rupture source. = 6, Pipe rupture sink, guard vessel. = 7, Outlet plenum with cover gas. = 8, Pool with cover gas. = 9, Pump bowl and cover gas. (not yet operational) =10, Pressurizer with cover gas. (not yet operational) =11, Compressible gas volume, no liquid.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
49–188	ITYPEL (IELL)	Liquid flow element type. =1, Core subassemblies. = 2, Bypass channel. = 3, Pipe. = 4, Check valve. = 5, Pump impeller. = 6, IHX, shell side. = 7, IHX, tube side. = 8, Steam generator, sodium side. = 9, DRACS heat exchanger, tube side. =10, DRACS heat exchanger, shell side. =11, Valve. =12, Air dump heat exchanger, sodium side. =13, Annular element.		
189–268	JCVL (M,ISGL)	Compressible volumes at the ends of the liquid segment.		
269–324	JCVG (M,ISGG)	Compressible volumes at the ends of the gas segment.		
325–364	NELML (ISGL)	Number of elements in the liquid segment.		
365–404	JFSELL (ISGL)	First element number in segment ISGL. Segment ISGL contains elements JFSELL(ISGL) through JFSELL(ISGL)+NELML(ISGL)-1.		
		PUMPS		
405	NPUMP	Number of sodium pumps: Max 12.		
406–417	IELPMP (IPMP)	Element number of pump IPMP.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
418–429	IEMPMP (IPMP)	Type of pump. =-2, EM pump. =-1, Electromagnetic pump. = 0, Use table of pump head vs time. = 1, Centrifugal pump. = 2, Homologous pump model. = 3, EBR-II pump model.		
430–469	ILRPMP (IPMP)	= 0, Pump operation according to model selected, see Block 3, locations 418-429. Uses locked rotor model for IEMPMP = 2 according to pump WB and SB, see Block 18, locations 1983-2222. = 1, Pump speed set to zero, locks rotor immediately as in a pump seizure. =-1, For table of pump speed vs. time (IEMPMP = 1 or 2). =-2, For table of pump head vs. flow.		
		IHX, DRACS, CHECK VALVES		
470	NIHX	Number of IHXs: Max. 4.		
471	NDRACS	Number of DRACS heat exchangers. Not yet operational.		
472	NCKV	Number of check valves: Max. 6.		
473–476	IELIHX (IIHX)	Element number of IHX # IIHX, primary loop.		
477–480	IELDRP (IDRX)	Element number of DRACS # IDRX, primary loop. Not yet operational.		
481–484	ILIHXS (IIHX)	Element number of the IHX, intermediate loop.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
485–488	IELDRS (IDRX)	Element number of DRACS # IDRX, intermediate loop. Not yet operational.		
489–492	IHXCLC (IIHX)	= 0, Use detailed IHX. > 0, Table no. ITAB for table look-up IHX. See DTMPTB, ZCENTR, TMPMTB in Block 18. DTMPTB contains the normalized reactor coolant temperature drop through the IHX. NTNODE must equal 2. < 0, Table no. -ITAB for table look-up IHX. See DTMPTB, ZCENTR, TMPMTB in Block 18. For DTMPTB(1) > 1.0, DTMPTB contains the temperature of the reactor coolant leaving the IHX. NTNODE must equal 2. For DTMPTB(1) = 1.0, DTMPTB contains the normalized heat rejection from the IHX; DTSIHX, XSIHX1, and VSIHX2 must be specified in Block 18. NTNODE must equal 2.		
493–496	IDRCLC (IDRX)	= 0, Use detailed DRACS. > 0, Table no. ITAB for table look-up DRACS. (See DTMPTB, ZCENTR, TMPMTB in Block 18). Not yet operational.		
497	IPRADJ	= 0, No PRMADJ pressure adjustments for channel flow estimation errors. = 1, Adjustments for the outlet plenum only. Recommended value. = 2, Adjustments for both inlet and outlet plenums.		
		DEBUG PRINTS		
498	ICPDBG	> 0, For centrifugal pump debugs.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
498–506	IBL3D2 (I)	Inlet and outlet pressure debugs if IBL3D2(1) > 0. IBL3D2(2) > 0 for steady- state core outlet temperature debugs.		
507	IDBPR4	PRIMAR4 debug parameter, initial value. = 0, No debug print-out. = 1, Final results for each PRIMAR step.		
508	IDBP4N	Value of IDBPR4 after time = TMDBP44. (See Block 18, location 1).		
509	INAKDR	Coolant properties. = 0, Use the same coolant properties in all loops, as determined by INAS3D (block 1, loc. 29), ID20 (block 1, loc. 67), IPBDEN (block 1, loc. 106), KPROPI (block 1, loc. 114) or ICLPRP (block 1, loc. 118). = 1, Use SAS4A correlations for Na in the DRACS loop, ISGL ≥ ISGLNK (block 3, loc. 1377) or ICV ≥ ICVNAK (block 3, loc. 1378) (ISGL = liquid segment number, ICV = compressible volume number). = 2, Use SAS3D correlations for Na in the DRACS loop. = 3, Use NaK properties in the DRACS loop. = 4, Use D2O properties in the DRACS loop. = 5, Use Pb properties in the DRACS loop. = 6, Use Pb-Bi properties in the DRACS loop. = 7, User supplied property correlation coefficients.		
		PIPE RUPTURE		
510	ISRCRP	Compressible volume number of pipe rupture source.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
511	ISNKRP	Compressible volume number of pipe rupture sink.		
		TEMPERATURE GROUPS		
512	NTGPT	Number of temperature groups. ≤ 100. The liquid flow element representing a bypass channel must be a separate temperature group. The same is true of IHX.		
513–612	NTNODE (ITGP)	Number of nodes in the temperature group. Each temperature group must have at least 2 nodes. (For a tabular IHX, it must equal 2).		
613–712	IFSTEL (ITGP)	First element in the temperature group.		
713–812	ILSTEL (ITGP)	Last element in the temperature group.		
		BYPASS CHANNELS		
813	NBYP	Number of bypass channels.		
814–821	NTLWBY (IBYP)	Number of nodes in lower part of walls A and B of bypass channel - Region 1.		
822–829	IDKTYP (IBYP)	Decay heat curves for bypass channels.		
830–837	IELBYP (IBYP)	Element numbers for bypass channels. (Usually opposite active core).		
838	ISSTP	Not currently used.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		STEAM GENERATORS		
839	NSGS	Number of steam generators.		
840–851	IELSGN (ISGN)	Element number for steam generator.		
852–863	ISGCLC (ISGN)	= 0, Use detailed steam generator. > 0, Table look-up ITAB for steam generator, temperature drop vs time. < 0, –table number for table of outlet temperatures vs time. (See Block 18, locations 2937-3440).		
864–875	IEVAP (ISGN)	For all steam generator models, = 1, Evaporator. = 2, Superheater. = 3, Once-through.		
		CHECK VALVES		
876–881	IELLCK (ICKV)	Element number for check valve ICKV.		
882–889	IUM883	Not currently used.		
		PRINTS AND BINARY OUTPUT		
890	IP4PRT	Print PRIMAR-4 results every IP4PRT PRIMAR steps.		
891	NBINOT	Number of IBINOT entries for PRIMAR-4 binary output on unit 15. If NBINOT = 0, no output.		
892	IBINST	PRIMAR-4 binary output every IBINST steps.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
893–971	IBINOT	Identification of binary output on unit 15. First two digits give IBNTYP = type of variable. Last 4 digits give INUM, the variable subscript. If INUM > 5000, then INUM-5000 is the starting value for a range of subscripts, and the next INUM is the last value in the range.		
972	INULLT	Steady-state null transient plotting flag. Used with NBINOT and IBINOT. = 0, No steady-state plot information on unit 15. > 0, Write steady state plot information on unit 15. For ISSCPC > 0, plot information is written on unit 15 every INULLT steps during the null transient.		
		VALVES		
973	NVALVE	Number of valves, ≤ 8,		
974–981	IELVLV (IVLV)	Element number for valve IVLV.		
982–989	ITABVV (IVLV)	Table number in DTMPTB tables for valve pressure drop coefficient vs. time. Note: Enter the initial pressure drop coefficient for the value G2PRDR (IELVLV(IVLV)).		
		PUMP DEFAULTS		
990	IPMDFT	≤ 0, Default values are used for PMPHD and PMPTQ. Not used unless IEMPMP(IPMP) = 2. (Block 18, location 3657, 3720).		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		DRACS		
991	NDHX	Number of air dump heat exchangers. Max. = 4.		
992–995	IELDHX (IDHX)	Element number for air dump heat exchanger IDHX.		
996–999	IFCDHX (IDHX)	= 0, Natural convection. = 1, Forced convection on the air side.		
		DETAILED STEAM GENERATOR		
1000–1003	IFWC (ISGN)	Feedwater control options. = 1, Constant feedwater flow at steady state value. = 2, Table look-up of feedwater flow. = 3, Drum level controller.		
1004–1007	IGHC (ISGN)	Specification of multiple evaporator and superheater sections. = Number of superheater parallel sections X 100 + number of evaporator parallel sections.		
		CONTROL ROD DRIVE EXPANSION REACTIVITY FEEDBACK		
1008	NEXPFB	= 0, No contribution to control rod expansion feedback from vessel wall heating. > 0, Number of liquid elements and/or compressible volumes contributing to control rod expansion feedback.		
1009–1018	IEXPFB (K)	> 0, Element number. < 0, –Compressible volume number.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		PLENUM MODEL		
1019	IPL2A	Not currently used.		
		COMPONENT-COMPONENT HEAT TRANSFER		
1020–1051	IBYBY (K,IBYP)	The K-th bypass channel number for subassembly to subassembly heat transfer from bypass channel IBYP. If -NCH ≤ IBYBY < 0, then -IBYBY is a core channel number. If IBYBY < -NCH, then -IBYBY is the temperature of a constant temperature heat sink. Dimension (4,8).		
1052–1081	IELHT (K)	Element number of the K-th element involved in component-to-component heat transfer from IELHT(K) to IELHT2(K). For the second wall of annular element IELL, IELHT = 1000 + IELL.		
1082–1111	IELHT2 (K)	Element number. ICV, or Temperature of heat sink (if –IELTH2 > max number of CVs.).		
1112–1141	NELHTN (K)	+ N, Use first N nodes. – N, Use last N nodes. = 0, Use all nodes.		
1142	IDBHTN	= 0, No debug prints. = 1, Short comp-comp prints. ≥ 2, Debug prints.		
1143	ISTHTH	PRIMAR step when IDVHTH is turned on.		
1144–1152	IB3DM2	Not currently used.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		COMMON COVER GAS PRESSURES		
1153	NCCV	Number of connected compressible volume cover gasses with common gas pressure.		
1154	ICCVFS	First compressible volume with common gas pressure.		
		STEADY-STATE INITIALIZATION		
1155–1158	ISSIHX (IIHX)	Steady state temperature drop. = 1, If user specifies.		
1159–1170	ISSPMP (IPMP)	Steady state pump head. = 1, If user specifies.		
1171	NIHXBY	Number of liquid segments that bypass the IHX.		
1172–1181	IHXBYP (K)	Liquid segment numbers for the segments that bypass the IHX.		
1182	NPMPBY	Number of liquid segments that bypass the pump.		
1183–1192	IPMPBY (K)	Liquid segment numbers for the segments that bypass the pump.		
		BYPASS CHANNEL HEAT TRANSFER		
1193–1200	IHTBYB (IBYP)	Coolant heat transfer parameter set for wall B in bypass channel IBYP.		
1201–1208	IHTBYD (IBYP)	Coolant heat transfer parameter set for wall D in bypass channel IBYP. See Block 18, locations 2694-2696, and 4300-4308.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		FORMER CONTROL ROD DRIVE FEEDBACK		
1209–1242	KCHUIS	Reserved. (was ICHUIS in Version 2.1).		
		ANNULAR ELEMENTS		
1243	NANEL	Number of annular elements.		
1244–1273	IELANE (IANL)	Element number for annular element.		
		RVACS INPUT		
1274	NSCRVC	Number of sections in the RVACS < 7.		
1275	IRVOPT	Number of entries in table of h vs T for simple RVACS model. = 0, Use detailed RVACS model.		
1276–1281	IELRVC (IRVC)	Element number or -ICV, starting at the bottom and going up. If IELRVC(IRVC) > 1000, use second wall of element IELVRC(IRVC)-1000.		
1282–1287	NANRVC (IRVC)	Number of nodes in this section, only applicable if CV.		
		NULL TRANSIENT		
1288	ISSCPC	Number of time steps in the null transient to initialize component-component heat transfer.		
1289	ISST15	Print PRIMAR-4 results every ISST15 steps during the null transient.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		RVACS INPUT		
1290	IDBRV	Debug parameter for RVACS. = 0, No debug. = 1, Regular print every time step. = 2, Detailed debug prints.		
1291	IDBRVS	PRIMAR-4 step when RVACS debugs start.		
		RADIAL REFLECTOR REACTIVITY FEEDBACK		
1292	NRREAC	Number of radial reflectors involved in reactivity calculations. (for use with empirical feedback models).		
1293–1300	ISLREA (K)	Segment numbers of radial reflectors for reactivity calculations.		
1301	LBYP	Number of radial reflector bypass channels.		
1302–1309	LELBYP	Element number of the radial reflector bypass channels.		
		PIPE TEMPERATURE OPTION		
1310	IPIPTM	PRIMAR-4 pipe temperature convective term differencing approximation. = 0, Always use a Lagrangian calculation for coolant temperatures in pipes and annular elements. = 1, Use an Eulerian calculation for large time steps (the coolant moves two or more nodes in a time step).		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		= 2, Use an Eulerian calculation for large time steps only during the PRIMAR-4 null transient (ISSCPC>0). Notes: 1) The Eulerian calculation is faster for large time steps. 2) The Lagrangian calculation does not result in numerical axial diffusion, whereas the Eulerian calculation does. 3) Recommended value: IPIPTM=2.		
		MULTIPLE INLET/OUTLET PLENA		
1311	IFMIOP	Multiple inlet/outlet plenum option. = 0, Single inlet and outlet plena. = 1, Multiple inlet and outlet plena. Must specify NSEGMP (INPCHN, 362), TPLCV, PPLCV, and ZPLENC (PMR4IN, 4685, 4723, and 4761).		
		ELEMENT/WALL THERMAL ADJUSTMENT		
1312	ITHPEN	Optional adjustments to element and wall thermal treatment, based on thermal penetration depth. = 0, No adjustments. = 1, WALLH and HWALL = thermal conductivity, k. = 2, WALLH and HWALL = k/total thickness. = 3, WALLH and HWALL = 3*k/total thickness. Recalculates WALLH, WALLH2, HWALL, WALLMC, CMWALL, WALLMC, WALMC2, and HAELHT for specified elements and compressible volumes. No adjustments are made if WALTHK(IELL) = 0,		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
		WALTH2(IAEL) = 0, or THKWAL(ICV) = 0. (See Block 18, Loc. 4799-5007).		
		STRATIFIED VOLUME MODEL		
1313	NSTRCV	Number of stratified compressible volumes.		
1314–1316	ICVSTR (ICVST)	Compressible volume number for stratified treatment.		
1317–1319	ISTRVT (ICVST)	= 1, For vertical coolant inlet, as in an outlet plenum, = 2, For horizontal coolant inlet.		
1320–1322	NUMWAL (ICVST)	Number of wall sections.		
1323–1325	IFSTWL (ICVST)	Wall number (IW) of the first wall section.		
1326–1334	IWLHRZ (IW)	= 0, For a vertical wall. = 1, For a horizontal wall at the top of a compressible volume. = 2, For a horizontal wall at the bottom of a compressible volume.		
1335–1343	NVNDWL (IW)	Number of vertical nodes in a vertical wall. NVNDWL = 1 for a horizontal wall.		
1344–1352	NLNDWL (IW)	Number of lateral nodes in a wall section. Max. = 8. Note: Sum (NVNDWL*NLNDWL) ≤ 300.		
1353–1361	ICV2WL (IW)	Number of the compressible volume in contact with the outer side of the wall section. Equal to 0 for an adiabatic outer boundary. If ICV2WL > 38, ICV2WL = the temperature of a constant temperature heat sink.		

Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
1362	IDBSTR	Debug flag for the stratified temperature model. = 0, No debug prints. = 1, Final results only. = 5, Everything.		
1363	ISTDBS	PRIMAR time step when stratified debug starts.		
1364	ISTSTP	Stop the run at PRIMAR step ISTSTP. Not used if ISTSTP = 0 or NSTRCV = 0.		
1365	IFT16	Write out stratified CV output on file 16 every IFT16 PRIMAR steps. No output if IFT16 = 0.		
		THICK WALL PIPES		
1366	NTHKPW	Number of pipes to be treated with a thick wall treatment.		
1367–1376	IELTPW (ITWP)	Element number for thick wall treatment.		
		NaK in the DRACS Loop (See INAKDR, loc 509)		
1377	ISGLNK	Use INAKDR to determine the coolant properties for ISGL ≥ ISGLNK (ISGL = liquid segment number).		
1378	ICVNAK	Use INAKDR to determine the coolant properties for ICV ≥ ICVNAK (ICV = compressible volume number).		
		STEADY STATE INITIIALIZATION OPTION		
1379	NCVSSI	Number of compressible volumes for which the steady-state coolant pressure and temperature are specified (Max. = 10).		

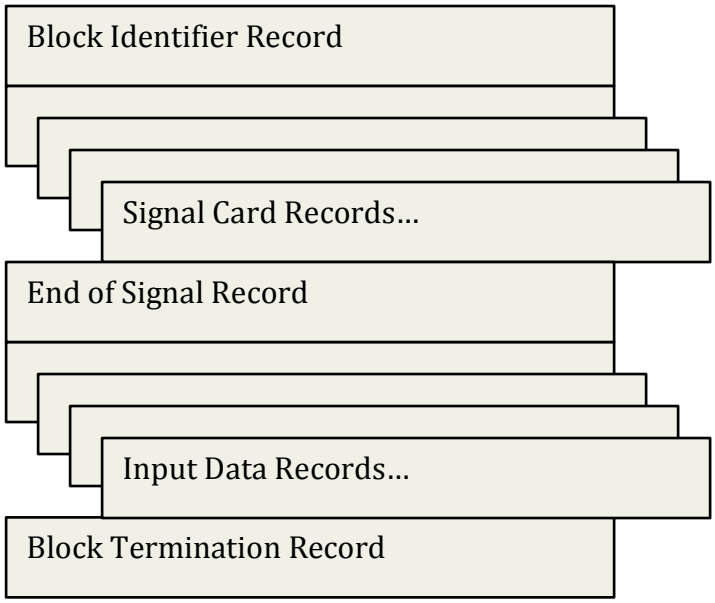
Block 3 — INPMR4 — PRIMAR-4 Integer Input

Location	Symbol	Description	Units	Used By
1380–1389	ICVSSI (II)	Compressible volume number for which steady-state pressure and temperature are specified.		
		AIR DUMP HEAT EXCHANGER OPTION		
1390–1393	IADHX (IDHX)	= 0, Simple air dump heat exchanger model. = 1, Code calculates HOTB, HITB, XKHXLS, XKRLS as a function of geometry and flow rate. See Block 18, loc. 3813-3836. Not currently used.		
1394–1397	ISTGTB (IDHX)	= 0, Staggered spacing between tube rows. = 1, Inline tube bundle. Used only if IADHX(IDHX) = 1. Not currently used.		
1398–1401	NROW (IDHX)	Number of tube rows. Used only if IADHX(IDHX) = 1. Not currently used.		
1402–1600	IBL3DM	Not currently used.		

Block 5 — INCONT — Control System Input

INPUT BLOCK STRUCTURE

The control system input block structure is identical to the standard SAS4A/SASSYS input block structure in all but one respect. A new card format known as a signal card has been introduced. These cards immediately follow the block identifier card and precede the standard format data cards. The ordering of the different card types is depicted as follows:



The format for the block identifier card is described above. For the control system input block the block name is "INCONT" and the block number is 5.

SIGNAL CARDS

A signal card contains data fields for the FORTRAN variables ISIG, JTYPE, J1SIG, J2SIG, F1SIG, F2SIG, F3SIG, F4SIG, and F5SIG, with record format 4I5,5F10.3. These variables are described in Table 5.1.

A signal card is used to define a signal in the user's block diagram. There are four signal types: measured, demand, block, and control. Each signal must be assigned a unique signal identification number using the "ISIG" field. The value of ISIG must be greater than zero and less than 999.

MEASURED SIGNAL

A measured signal makes available to the block diagram the present value of a referenced SAS4A/SASSYS variable. The correspondence between the variable that is referenced and the signal card data field values is given in Table 5.2. Note that all measured signals have a JTYPE value in the range of -50 to -89, inclusive

Block 5 — INCONT — Control System Input

Table 5.1: Signal Card Format

Column	FORTRAN Symbol	Definition	Variable Type
1–5	ISIG	Serial Number	Integer
6–10	JTYPE	Signal Type	Integer
11–15	J1SIG	Signal Descriptor 1	Integer
16–20	J2SIG	Signal Descriptor 2	Integer
21–30	F1SIG	Constant1	Real
31–40	F2SIG	Constant2	Real
41–50	F3SIG	Constant3	Real
51–60	F4SIG	Constant4	Real
61–70	F5SIG	Constant5	Real

Table 5.2. Signal Card Contents

Signal Type	**Signal Variable**	**Card Contents**
Measured	Compressible Volume Pressure, PRESL3	JTYPE = -50 J1SIG = Volume Number, ICV
Measured	Liquid Segment Flowrate, FLOWSL3	JTYPE = -51 J1SIG = Liquid Segment Number, ISGL
Measured	Liquid Cover Gas Interface Elevation, ZINTR3	JTYPE = -52 J1SIG = Volume Number, ICV
Measured	Liquid Mass, XLQMS3	JTYPE = -53 J1SIG = Volume Number, ICV
Measured	Cover Gas Volume, VOLGC3	JTYPE = -54 J1SIG = Volume Number, ICV
Measured	Time	JTYPE = -55
Measured	Pump Head, HEADP3	JTYPE = -56 J1SIG = Pump Number, IPMP
Measured	Liquid Temperature, TLQCV3	JTYPE = -57 J1SIG = Volume Number, ICV
Measured	Liquid Density, DNSCV3	JTYPE = -58 J1SIG = Volume Number, ICV

Block 5 — INCONT — Control System Input

Measured	Wall Temperature, TWLCV3	JTYPE = -59 J1SIG = Volume Number, ICV
Measured	Cover Gas Pressure, PRESG3	JTYPE = -60 J1SIG = Volume Number, ICV
Measured	Cover Gas Mass, GASMS3	JTYPE = -61 J1SIG = Volume Number, ICV
Measured	Cover Gas Temperature, TGASC3	JTYPE = -62 J1SIG = Volume Number, ICV
Measured	Not Used.	JTYPE = -63
Measured	Liquid Segment Temperature, TSLIN3	JTYPE = -64 J1SIG = Segment Number, ISGL J2SIG = 1 (Inlet) J2SIG = 2 (Outlet)
Measured	Pump Speed, PSPED3	JTYPE = -65 J1SIG = Pump Number, IPMP
Measured	Core Channel Coolant Flowrate, CHFLO3	JTYPE = -66 J1SIG = Channel Number, ICH J2SIG = 1 (Inlet) J2SIG = 2 (Outlet)
Measured	Liquid Node Temperature, TLNOD3	JTYPE = -67 J1SIG = Node Number, INOD
Measured	Wall Node Temperature, TWNOD3	JTYPE = -68 J1SIG = Node Number, INOD
Measured	Liquid Element Temperature, TELEM	JTYPE = -69 J1SIG = Element Number, IEL J2SIG = 1 (Inlet) J2SIG = 2 (Outlet)
Measured	Not Used.	JTYPE = -70
Measured	Core Channel Outlet Temperature, CHFCOF	JTYPE = -71 J1SIG = Channel Number, ICH J2SIG = 1 (Inlet) J2SIG = 2 (Outlet)
Measured	Normalized Reactor Power, EXP(POWVA(3,1))	JTYPE = -72
Measured	Normalized Fission Power, POWFS0*AMPO	JTYPE = -73

Block 5 — INCONT — Control System Input

Measured	Normalized Decay Power, Sum(POWWT(I)*POWDKH(I))	JTYPE = -74
Measured	Not Used.	JTYPE = -75,...,-82
Measured	Steam Generator Feedwater Mass Inlet Flowrate	JTYPE = -83 J2SIG = SG Number
Measured	Steam Generator Feedwater Inlet Enthalpy	JTYPE = -84 J2SIG = SG Number
Measured	Steam Generator Steam Mass Flowrate	JTYPE = -85 J2SIG = SG Number
Measured	Steam Generator Outlet Temperature	JTYPE = -86 J2SIG = SG Number
Measured	Steam Generator Steam Pressure	JTYPE = -87 J2SIG = SG Number
Measured	Steam Generator Water Level	JTYPE = -88 J2SIG = SG Number
Measured	Steam Generator Steam Outlet Enthalpy	JTYPE = -89 J2SIG = SG Number F3SIG = Initial Condition Flag F4SIG = Yo
Demand	Demand Table	JTYPE = -90 J1SIG = Demand Table Number J2SIG = Number of Entries in Table F4SIG = Yo
Block	Summer	JTYPE = 1 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG F1SIG = g1 F2SIG = g2 F3SIG = g
Block	Multiplier	JTYPE = 2 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG F1SIG = g
Block	Divider	JTYPE = 3 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG F1SIG = g

Block 5 — INCONT — Control System Input

Block	Differentiator	JTYPE = 4 J1SIG = Input Signal 1, ISIG F1SIG = g
Block	Integrator	JTYPE = 5 J1SIG = Input Signal 1, ISIG F1SIG = g F3SIG = Initial Condition Flag F4SIG = Yo F5SIG = Ez (Zero Crossing Parameter)
Block	Lag Compensator	JTYPE = 6 J1SIG = Input Signal 1, ISIG F1SIG = g F2SIG = Tau F4SIG = Yo (Not used for J1SIG(999) = 1) F5SIG = Ez (Zero Crossing Parameter)
Block	Lead - Lag Compensator	JTYPE = 7 J1SIG = Input Signal 1, ISIG F1SIG = g F2SIG = Tau1 F3SIG = Tau2 F4SIG = Yo (Not used for J1SIG(999) = 1) F5SIG = Ez (Zero Crossing Parameter)
Block	Function Generator	JTYPE = 8 J1SIG = Input Signal 1, ISIG J2SIG = Function Generator Table Number F1SIG = g
Block	Maximum	JTYPE = 9 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	Minimum	JTYPE = 10 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	Time Delay	JTYPE = 11 J1SIG = Input Signal 1, ISIG F1SIG = Tau F4SIG = Yo (Not used for J1SIG(999) = 1)

Block 5 — INCONT — Control System Input

Block	Natural Logarithm	JTYPE = 12 J1SIG = Input Signal 1, ISIG F1SIG = g
Block	Exponentation	JTYPE = 13 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG F1SIG = g
Block	Velocity Limiter	JTYPE = 14 J1SIG = Input Signal 1, ISIG F1SIG = Vdown F2SIG = Vup F3SIG = g
Block	AND	JTYPE = 15 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	OR	JTYPE = 16 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	NOT	JTYPE = 17 J1SIG = Input Signal 1, ISIG
Block	Comparator	JTYPE = 18 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	Sample and Hold	JTYPE = 19 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG
Block	JK Flip-Flop	JTYPE = 20 J1SIG = Input Signal 1, ISIG J2SIG = Input Signal 2, ISIG F4SIG = Qo
Block	Constant	JTYPE = 21 F1SIG = g
Control	Reactivity, $	JTYPE = -1 J1SIG = Signal Number Used F5SIG = Ez (Zero Crossing Parameter)
Control	Normalized Pump Motor Torque	JTYPE = -2 J1SIG = Signal Number Used J2SIG = Pump Number F5SIG = Ez (Zero Crossing Parameter)

Block 5 — INCONT — Control System Input

Control	Steam Generator Feedwater Mass Flowrate	JTYPE = -3 J1SIG = Signal Number Used J2SIG = Steam Generator Number F5SIG = Ez (Zero Crossing Parameter)
Control	Steam Generator Feedwater Enthalpy	JTYPE = -4 J1SIG = Signal Number Used J2SIG = Steam Generator Number F5SIG = Ez (Zero Crossing Parameter)
Control	Steam Generator Steam Mass Flowrate	JTYPE = -5 J1SIG = Signal Number Used J2SIG = Steam Generator Number F5SIG = Ez (Zero Crossing Parameter)
Control	Sodium Valve Loss Coefficient	JTYPE = -6 J1SIG = Signal Number Used J2SIG = Valve Number F5SIG = Ez (Zero Crossing Parameter)
Control	Steam Generator Steam Pressure	JTYPE = -7 J1SIG = Signal Number Used J2SIG = Steam Generator Number F5SIG = Ez (Zero Crossing Parameter)

DEMAND SIGNAL

A demand signal makes available to the block diagram the product of the current value of a time dependent function defined by the user through a demand table and an initial condition value. A demand table is a set of ordered pair values supplied by the user in the format of Tables 5.3 and 5.4. The code obtains the demand signal by linearly interpolating among the table entries using the current time. The initial value is obtained as described in Section 6.4.3. The correspondence between the demand table and the signal card data fields is given in Table 5.2. Note that a demand signal has a JTYPE value of -90.

BLOCK SIGNAL

A block signal makes available to the block diagram the value at the output of a block. The correspondence between the block characteristics and the signal card data fields is given in Table 5.2. Note that all block signals have a JTYPE value in the range from 1 through 21. A measured, demand, or block signal can be used as an input to a block by specifying on the block's signal definition card the signal identification number assigned to the input signal. The signals input to each block type are combined according to the mathematical expressions given in Fig. 5.1.

Block 5 — INCONT — Control System Input

Table 5.3: Table Card Format

Column	FORTRAN Symbol	Definition	Variable Type
1	LOC	Storage Location of VAR1	Integer
7	N	Number of Consecutive Locations	Integer
13	VAR1	Constant 1	Real
25	VAR2	Constant 2	Real
37	VAR3	Constant 3	Real
49	VAR4	Constant 4	Real
61	VAR5	Constant 5	Real

Table 5.4: Table Card Data

Location	FORTRAN Symbol	Definition/Comments
1	CTLTAB(J,J1SIG)	Table of normalized demand values. Dimension (20,100). Index J1SIG designates table number and J is element number in table.
2001	CTLIM(J,J1SIG)	Times for CTLTAB table. Dimension (20,100).
4001	CTLFNC(J,J1SIG)	Table of function generator dependent variables. Dimension (20,100).
6001	CTLSIG(J,J1SIG)	Table of independent variables for CTLFNC table. Dimension (20,100).
8001	EPSCS	Convergence parameter for dynamic blocks over a subinterval.
8002	EPSCPL	Maximum relative change in a control signal over a subinterval.

CONTROL SIGNALS

A control signal is used to set the value of a SAS4A/SASSYS variable equal to the value of a block signal. The correspondence between the block signal and the SAS4A/SASSYS variable and the signal card data fields is given in Table 5.2. Note that all control signals have a JTYPE value that ranges from -1 through -7.

END OF SIGNALS

A sequence of signal definition cards is delimited by a signal card with the ISIG field entry equal to “999”.

Block 5 — INCONT — Control System Input

This card also contains flags for control of the steady-state solution finder. First, the J1SIG field is used to determine whether the steady-state solution finder is to be used. An entry of "1" activates the steady-state solution finder, while any other entry in this field causes the solution finder to be bypassed. (A discussion of the initial condition option is given in Section 6.4.3.) Secondly, the J2SIG field allows the user to control the amount of steady-state output generated. An entry of "1" produces an extended output for trouble shooting purposes, while any other entry produces a standard output.

A flag also exists for generating an extended print-out during the transient for debugging purposes. The debug print is generated by setting the JTYPE field to "1". The print-out begins at the time specified on the F1SIG field.

DATA CARDS

A data card contains the data fields for the FORTRAN variables LOC, N, VAR1, VAR2, VAR3, VAR4, and VAR5, with the record format (2I6,5E12.5). The variables are defined in Table 5.4.

A data card appearing in the control system block has a format identical to the standard SAS4A/SASSYS data card used in other input blocks and is processed in the same way. The format information given above is the same as in the SAS manuals and is given here for completeness.

Data cards are used to construct demand tables and function generator tables, and to supply solution control parameters. These quantities and their storage locations are defined in Table 5.4.

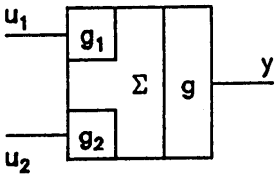
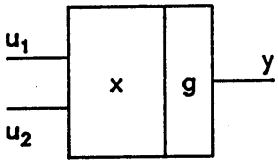
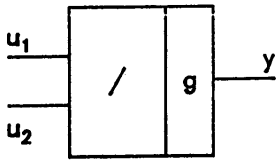
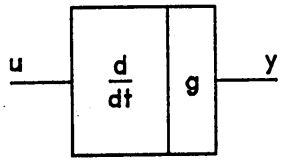
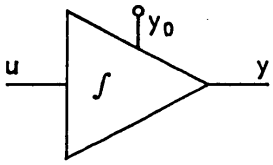
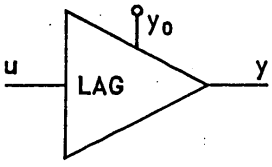
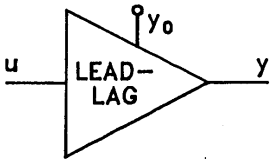
Block	Type	Representation	Mathematical Expression
1. summer	function		$y = g(g_1u_1 + g_2u_2)$
2. multiplier	function		$y = gu_1u_2$
3. divider	function		$y = g\frac{u_1}{u_2}$
4. differentiator	function		$y = g\frac{d}{dt}u$
5. integrator	dynamic		$y = y_0 + g\int_0^t u\,dt$
6. lag compensator	dynamic		$y + \tau\frac{d}{dt}y = gu$ $y(0) = y_0$
7. lead–lag compensator	dynamic		$y + \tau_1\frac{d}{dt}y = g(u + \tau_2\frac{d}{dt}u)$ $y(0) = y_0$

Fig. 5.1 Basic Mathematical Blocks.

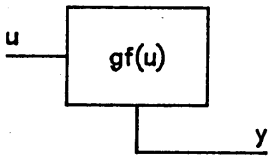
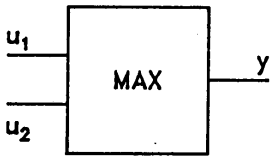
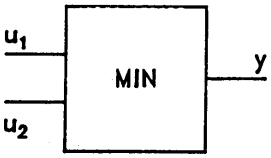
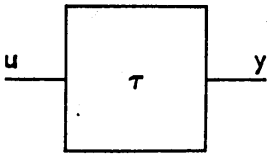
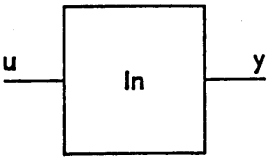
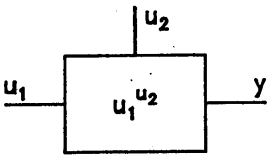
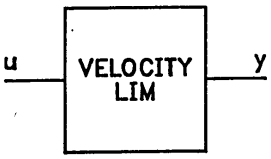
	Block	Type	Representation	Mathematical Expression
8.	function generator	table		$y = gf(u)$
9.	maximum value	function		$y = \max(u_1, u_2)$
10.	minimum value	function		$y = \min(u_1, u_2)$
11.	time delay	function		$y = y_0$ $0 \le t \le T$ $y = u(t - \tau)$ $t > T$
12.	natural logarithm	function		$y = \ln u$
13.	exponentiation	function		$y = u_1^{u_2}$
14.	velocity limiter	function		$y = y_{down}$ $gu < y_{down}$ $y = y_{up}$ $gu > y_{up}$ $y = gu$ otherwise $y_{down} = y(t - h) - hv_{down}$ $y_{up} = y(t - h) + hv_{up}$

Fig. 5.1 Basic Mathematical Blocks (cont.).

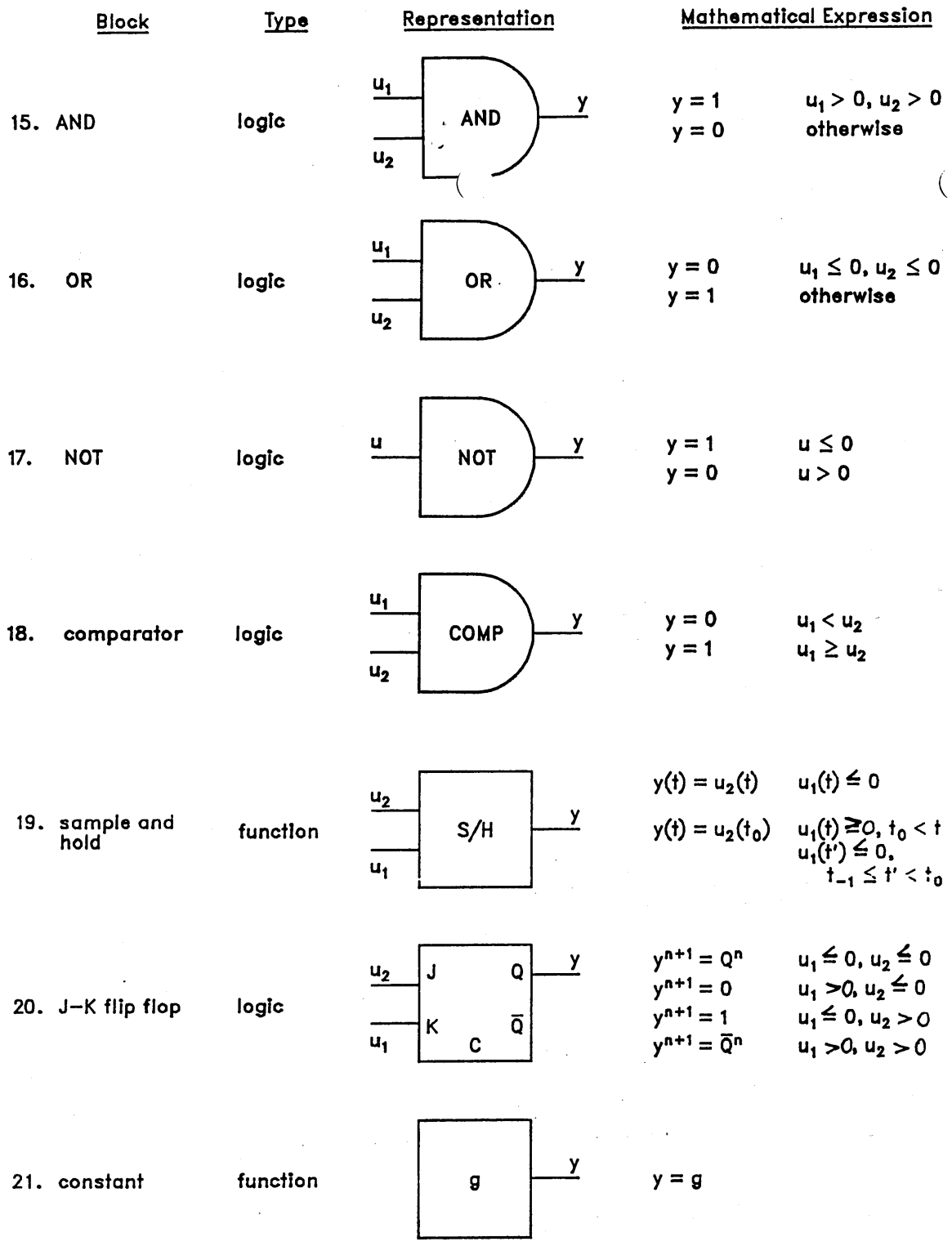


Fig. 5.1 Basic Mathematical Blocks (cont.).

Block 6 — IINBOP — Balance-of-Plant Integer Input

See ANL/RAS 89/6, Appendix B.

Note: The first-encountered IINBOP is saved and may not be redefined by subsequent data. Within the block, the data must be presented as defined in ANL/RAS 89/6. This block must precede Block 15, FINBOP.

The input format for the lines in the Block 6 is:

(2I3,11I6)

The first entry on a line identifies the type of geometric components for which data are being entered. The categories of components are numbered as follows:

1	compressible volume
2	segment
3	element
4	steam generator
5	waterside pump
6	volume boundary condition
7	not currently used
8	supersegment
9	flags to invoke options
10	standard valve
11	balance-of-plant legs
12	check valve
13	selection of parameters for printing
14	relief valve.

One point about these categories needs clarification. There is a category for general elements (category 3), and there are also categories for specific types of elements (pumps (5), standard valves (10), and check valves(12)). The data which fall under the general elements category must be entered for all elements. In addition, some element types require data unique to that type of element; these are entered under the appropriate element category. For example, the length of an element must be entered for all elements and so appears in the general elements category, whereas pump motor torque must be entered only for pumps and so appears in the pump elements category. Therefore, some information about a pump is entered in the general elements category and the rest in the pump elements category.

Block 6 — IINBOP — Balance-of-Plant Integer Input

The second entry is the continuation card number. This accommodates components which have more fixed point input entries than can fit on one card. The continuation card number is 1 for the first fixed-point data card for a component, 2 for the second card, etc. The third entry gives the component number in the user's nodalization. The numbering of steam generators must be the same on the sodium side and on the water side. Pumps and valves on the water side are numbered independently from pumps and valves on the sodium side. The remaining data entries vary with the geometric component and are as follows:

Compressible Volume

(2I3,11I6): 1, 1, user's no., NTPCVW, NCVBCW, NSUPSG, NQFLG. NLGCVW, NENTRF

NTPCVW: A volume can be filled with single-phase liquid, single-phase vapor, or two-phase fluid. In addition, the pseudo-volume which marks the subcooled/two-phase interface in the evaporator is treated as a special case. NTPCVW is used to distinguish these four categories of volumes, with

= 1 for a single-phase liquid volume,
= 2 for a single-phase vapor volume,
= 3 for a two-phase volume;
= 4 for the pseudo-volume at the liquid/two-phase interface in the evaporator.

NCVBCW: Volumes which perform certain functions (i.e., heater volumes, steam generator outlet plena) must be flagged, and NCVBCW is used to flag them as follows:

= 0 for a standard volume,
= 1 for a volume boundary condition volume,
= 2 for an inlet flow boundary condition volume,
= 3 for an outlet flow boundary condition volume,
= 4 for a steam generator inlet plenum,
= 5 for a steam generator outlet plenum,
= 6 for a heater volume,
= 7 for a turbine.

The designation "standard volume" simply means any volume which does not fall into one of the categories for NCVBCW = 1 through 7.

NSUPSG: If the volume is contained within a supersegment, NSUPSG must be entered and given the number of the supersegment. NSUPSG is not entered for volumes which begin or end a supersegment.

Block 6 — IINBOP — Balance-of-Plant Integer Input

NQFLG flags whether or not a compressible volume is a heater, with NQFLG:

= 0 if the volume is not a heater and
= the user's number for the heater if the volume is a heater.

NLGCVW is the number of the leg of the nodalization to which the volume belongs (See ANL/RAS 89/6, Sec. 8.3 for an explanation of how a nodalization is divided into legs).

NENTRF: The thermodynamic state of a compressible volume can be specified through floating point input data in several ways. The user sets NENTRF for each volume to tell the code which thermodynamic quantities are being entered for that volume, with

= 1, single-phase volumes; pressure and temperature entered,
= 2, single-phase volumes; pressure and enthalpy entered,
= 3, two-phase volumes; pressure and quality entered,
= 4, two-phase volumes; temperature and quality entered,
= 5, two-phase heater volumes; pressure, two-phase level, and ambient temperature entered,
= 6, two-phase heater volumes; temperature, two-phase level, and ambient temperature entered.

If the volume is attached to a flow boundary condition, the following additional quantities are entered:

NBCINF, NFLSEG, IFBWCL

NBCINF: the number of the table in which boundary condition data are stored if the boundary condition is controlled through a user-input table, rather than by the control system.

NFLSEG: If the boundary condition is controlled by data from a table input by the user, the user must choose which thermodynamic data to enter and must signal this choice to the code through the flag NFLSEG, with

= 0, if enthalpy is entered,
= 1, if temperature and pressure are entered for a subcooled liquid boundary condition,
= 2, if temperature and pressure are entered for a superheated steam boundary condition,
= 3, if quality and pressure are entered for a two-phase boundary condition,
= 4, if quality and temperature are entered for a two-phase boundary condition.

Block 6 — IINBOP — Balance-of-Plant Integer Input

For an outflow boundary condition, NFLSEG = -1.

IFBWCL: flags whether the boundary condition is controlled by a table or by the control system, with

= 0, if the boundary condition is controlled by a table,
= 1, if the boundary condition is controlled by the control system.

If the volume is a volume boundary condition, the following additional quantities are entered:

NBCINP, IVBWCL

NBCINP is the number of the table in which boundary condition data are stored if the boundary condition is controlled through a user-input table, rather than by the control system,

IVBWCL flags whether the boundary condition is controlled by a table or by the control system, with

= 0, if the boundary condition is controlled by a table,
= 1, if the boundary condition is controlled by the control system.

Segment

(2I3,11I6): 2, 1, user's no., JCVW(1), JCVW(2), NODMAX

JCVW(1) is the compressible volume number in the user's nodalization for the volume at the segment inlet,

JCVW(2) is the user's volume number at the segment outlet,

NODMAX is the maximum number of enthalpy transport nodes into which may be tracked along a segment. See ANL/RAS 89/6, Section 4.4.2, a discussion of the enthalpy transport model.

(2I3,11I6): 2, 2, user's no., JCV1FG, IHTSEG, IHTLW, IHTUP

This input line is used only for heaters using a heater model other than the simple heater model.

JCV1FG indicates where a segment attached to a heater volume is attached to the volume, with

= -1, if the segment is attached to the bottom of the volume,
= 0, if the segment is attached in between the top and the bottom of the volume,
= 1, if the segment is attached to the top of the volume.

IHTSEG is the user's number of the heater volume through which the segment passes,

Block 6 — IINBOP — Balance-of-Plant Integer Input

IHTLW is entered if the segment is attached to a drain and is the user's number of the volume containing the drain,

IHTUP is entered if the segment is attached to a desuperheating section and is the user's number of the volume containing the desuperheating section.

Element

(2I3,11I6): 3, 1, user's no., NBOREL(1), NBOREL(2), NELSGW, ITYPW

NBOREL(1) is the element number of the upstream neighboring element in the user's nodalization. The code uses the convention that the first element in a segment is the one furthest upstream, and for this element, NBOREL(1) is set to 0.

NBOREL(2) is the element number of the downstream neighboring element in the user's nodalization. The code uses the convention that the last element in a segment is the one furthest downstream, and for this element, NBOREL(2) is set to -1.

NELSGW is the user's number of the segment in which the element is located.

ITYPW identifies the element type, with

= 3, for a pipe,
= 4, for a check valve,
= 5, for a pump,
= 6, for a heated element,
= 7, for a nozzle,
= 8, for a superheater,
= 11, for a valve.

(These element types use the same numbering as those on the sodium side wherever possible).

Steam Generator

a) IEVAP(ISGN) = 1 (evaporator) or 3 (once-through)

(2I3,11I6): 4, 1, steam gen. number, ICVSGN(1), ICVSGN(2), NOSGW, NODSC, NODTP, NODSH, IDUM1, IDUM2, LMPDOT

ICVSGN(1) is the user's number for the compressible volume which serves as the steam generator inlet plenum,

ICVSGN(2) is the user's number for the volume which is the outlet plenum,

NOSGW is the user's number for the segment which is at the outlet of the vapor leg which is fed by the steam generator (used for saving plot data only),

Block 6 — IINBOP — Balance-of-Plant Integer Input

NODSC	is the number of nodes in the subcooled zone,
NODTP	is the number of nodes in the two-phase zone,
NODSH	is the number of nodes in the superheated zone,
IDUM1	is a dummy integer,
IDUM2	is a dummy integer,
LMPDOT	is the number of timesteps used to compute an average value for PDOT, the derivative of pressure with respect to time.
(2I3,11I6):	4, 2, steam gen. number, ISGBUG, IHELE, IOPT1, IOPT2
ISGBUG	is the number of PRIMAR timesteps between debug prints for the steam generator calculation. If 0 is entered, no debug prints will be generated.
IHELE	is an indicator for the geometry in the evaporator/steam generator: = 0 for straight tube, = 1 for helical coil.
IOPT1	is an indicator for the search option in the subcooled zone: = 1 on calibration factor, = 2 on length.
IOPT2	is an indicator for the search option in the superheated zone: = 1 on calibration factor, = 2 on length.

b) IEVAP(ISGN) = 2 (superheater)

(2I3,11I6):	4, 1, steam gen. number, NELSUH, NODSHT
NELSUH	is the user's element number for the superheater associated with the evaporator (if any),
NODSHT	is the number of nodes in the superheater.
(2I3,11I6):	4, 2, steam gen. number, ISHBUG, IHELES
ISHBUG	is reserved.
IHELES	is an indicator for the geometry in the superheater: = 0 for straight tube, = 1 for helical coil.

See ANL/RAS 90/1 for a detailed explanation of these steam generator parameters. Variable IEVAP (Block 3, #864-875) should be set to 2 if a superheater is used, and to 3 if only an evaporator is used.

Block 6 — IINBOP — Balance-of-Plant Integer Input

Pump

(2I3,11I6): 5, 1, pump number, IEMPW, IELPW, ILRPW, IPMWCL

IEMPW is the number designating the type of pump model chosen, i.e.,

= 0, if a table of pump head vs. time is entered,
= 1, if centrifugal pump model 1 is used,
= 2, if centrifugal pump model 2 is used.

Identical pump models are used for both waterside and sodium pumps, and so the discussion in ANL/RAS 84-14 of sodium pump models is the best source of more detailed information about the waterside pump models.

IELPW is the user's element number of the pump,

ILRPW is the flag which activates the locked rotor modeling, i.e.

= 1, for a locked rotor, with pump speed set to 0, and
= -2, if a table of pump head vs. flow is entered.

Unless a table of pump head vs. flow is entered, ILRPW is initially set to 0; if the code computes that the flow or pump speed becomes so low as to lock the rotor, ILRPW will automatically be reset to 1 by the code.

IPMWCL is the flag which routes control of the pump to the control system, with

= 0, for table lookup of the pump motor torque,
= 1, for control of the pump motor torque by the control system

Volume boundary condition

(2I3,11I6): 6, 1, table number, NTABVL

The thermodynamic state of a volume boundary condition volume can be specified by any of six choices of input data to be entered in the floating point volume boundary condition table. The code determines which choice the user has made from the variable NTABVL, with

= 1, for pressure and enthalpy entered for a liquid volume,
= 2, for pressure and temperature entered for a liquid volume,
= 3, for pressure and enthalpy entered for a vapor volume,
= 4, for pressure and temperature entered for a vapor volume,
= 5, for pressure and quality entered for a two-phase volume,
= 6, for temperature and quality entered for a two-phase volume.

Block 6 — IINBOP — Balance-of-Plant Integer Input

Supersegment

(2I3,11I6): 8, 1, superseg. number, NSSIN, NSSOUT

NSSIN is the compressible volume number at the supersegment inlet,

NSSOUT is the volume number at the supersegment outlet.

See ANL/RAS 89/6, Section 8.2 for an explanation of how a supersegment is set up.

Option flags

(2I3,11I6): 9, 1, NTRNPT, IBOPRT

NTRNPT flags whether or not enthalpy transport is used in vapor-filled segments, with

= 0, if enthalpy transport is used,
= 1, if enthalpy transport is not used.

See ANL/RAS 89/6, Section 4.4.2 for a detailed explanation of when the enthalpy transport model should or should not be used in segments composed of superheated vapor.

IBOPRT is the number of PRIMAR timesteps between full prints of the balance-of-plant parameters. If IBOPRT is not entered, the code sets IBOPRT to 1.

Standard valve

(2I3,11I6): 10 1 user's number IVLELW IVLWCL

IVLELW is the user's number for the element which contains the valve,

IVLWCL flags whether the valve is controlled by a table or by the control system. If the valve is controlled by the control system, there are two options: 1) have the control system specify the valve driving function as a function of time, or 2) have the control system specify the valve stem position as a function of time. The code uses IVLWCL to determine which of these three choices the user has made, with IVLWCL

= 0 if the valve is controlled by a table,

= 1 if the driving function VFRACL is specified by the control system,

= 2 if the stem position VSTEMW is specified by the control system.

See Sec. 4.2 for a detailed description of the valve model.

Block 6 — IINBOP — Balance-of-Plant Integer Input

Balance-of-plant legs

(2I3,11I6): 11, 1, LEGORD

LEGORD orders the legs of the balance of plant for the purpose of printing output (See ANL/RAS 89/6, Section Sec. 8.3 for a discussion of how the balance of plant can be divided into legs).

Check valve

(2I3,11I6): ,12, 1, user's number, ICVLEW, ICHVLK(1), ICHVLK(2), NCHVST

ICVLEW is the user's number for the element containing the valve,

ICHVLK(1) specifies the type of valve closure criterion entered. The user must choose between having the valve begin to close when the pressure drop across the valve falls below a user-input number or having it begin to close when the flow through the valve becomes less than a user-input number. This choice is communicated to the code by ICHVLK(1), with

= 1, if the valve begins to close when a pressure drop criterion is satisfied,
= 2, if the valve begins to close when a flow criterion is satisfied.

ICHVLK(2) specifies the type of valve opening criterion entered. The user must make the same choice as for valve closure,and this choice is designated through ICHVLK(2), with

= 1, if the valve begins to open when a pressure drop criterion is satisfied,
= 2 if the valve begins to open when a flow criterion is satisfied.

NCHVST specifies the current state of the valve, with

= 1, if the valve is fully open and will begin to close if the pressure drop across the valve is less than the user-input value CHEPS1,
= 2, if the valve is fully open and will begin to close if the flow through the valve is less than CHEPS1,
= 3, if the valve is in the process of closing,
= 4, if the valve is closed and will begin to open if the pressure drop across the valve exceeds the user-input value CHEPS2,
= 5, if the valve is closed and will begin to open if the flow through the valve exceeds CHEPS2,

Block 6 — IINBOP — Balance-of-Plant Integer Input

= 6 if the valve is in the process of opening.

The initial value of NCHVST should always be entered as either 1, 2, 4, or 5; as the transient progresses and the valve opens and/or closes, the code will update NCHVST to reflect the current state of the valve.

Selection of parameters for printing

(2I3,11I6): 13, 1, JPRINT(17)

The user may select some or all of 17 parameters to be printed by setting the appropriate JPRINT array element to 1. The JPRINT array is ordered as follows:

JPRINT(1) all compressible volume pressures

JPRINT(2) steam generator subcooled/two-phase interface pressures

JPRINT(3) flows in all segments except flow boundary conditions and evaporator subcooled regions

JPRINT(4) flows in all standard valves only

JPRINT(5) flows in all pumps only

JPRINT(6) flows in all evaporator subcooled regions only

JPRINT(7) all evaporator outlet flows only

JPRINT(8) flows at all flow boundary conditions

JPRINT(9) mixture enthalpies in all compressible volumes

JPRINT(10) temperatures in all compressible volumes

JPRINT(11) densities in all compressible volumes

JPRINT(12) outlet enthalpies for all elements

JPRINT(13) outlet pressures for all elements

JPRINT(14) orifice coefficients for all elements

JPRINT(15) orifice coefficients for all standard valves only

JPRINT(16) pump head for all pumps

JPRINT(17) pump speed for all pumps.

If JPRINT(1) is set to 2, all 17 prints will be made.

Relief valve

(2I3,11I6): 14, 1, user's number, IRVLVW

IRVLVW is the user's number for the element assigned to the check valve.

Block 11 — OPCIN — Channel-Independent Floating-Point Input

Location	Symbol	Description	Units	Used By
1	EPSTEM	Steady-state temperature convergence delta. The steady-state temperatures in the fuel-pin must converge such that |T' - T| <= EPSTEM, where T' is the temperature on the last iteration and T is the temperature on the previous iteration. Suggested value: 0.1.	K	
2	EPSREA	Not currently used.		
3	EPSPOW	Neutron flux amplitude convergence criterion.		NK
4	EPSGAM	Not currently used.		
5	DT0	Initial and maximum main time step length.	s	
6	DTMXB	Maximum heat-transfer time-step length after coolant boiling inception. Suggested value: 0.01 s. Maximum value: 0.02 s.	s	BL
7	TIMAX	Maximum problem time. Restart file is saved when time TIMAX is reached if NSTEP (Block 1, loc 15) > 0.	s	
8	REAITR	Not currently used.		
9	TCOSTP	Number of CPU seconds reserved at end of run for writing of restart file when NSTEP > 0.	s	
10	DTFUEL	Maximum fuel temperature change per heat-transfer time step. Suggested value: 50.0 for IMETAL = 0, 5.0 for IMETAL > 0.	K	
11	DTCLAD	Maximum cladding temperature change per heat-transfer time step. Suggested value: 30.0.	K	
12	TCLMAX	Not currently used.		

Block 11 — OPCIN — Channel-Independent Floating-Point Input

Location	Symbol	Description	Units	Used By
13	DTP0	Initial PRIMAR time step size.	s	
14	DTPMAX	Maximum PRIMAR time step size before boiling starts.	s	
15	DTPBOI	Maximum PRIMAR step size after start of boiling.	s	
16	DTPLEV	Maximum PRIMAR step size after LEVITATE starts.	s	
17	DTPFCI	Maximum PRIMAR step size after PLUTO-2 starts.	s	
18	TPRFCI	Time after PLUTO-2 initiation when PRIMAR step can be increased to DTPBOI.	s	
19	DPINMX	Maximum change in inlet pressure per PRIMAR step.	Pa	
20	DTINMX	Maximum change in inlet temperature per PRIMAR step.	K	
21	DTMMXB	Maximum main time step after the onset of boiling.	s	BL
22	DPWMAX	Maximum fractional change in power per main time step, only used if IPOWER = 1.		
23	ASCRAM	Not currently used.		
24	PSCRAM	Normalized total power for scram initiation. Relevant for IPOWER=0, NPK=0.		
25	GSCRAM	Not currently used.		
26	DTSSCP	Time step size for the null transient to initialize component-component heat transfer in PRIMAR-4.	s	
27	EPSSCP	Component-component heat transfer convergence criterion for the null transient.		

Block 11 — OPCIN — Channel-Independent Floating-Point Input

Location	Symbol	Description	Units	Used By
28-87	DXMAPR	Not currently used.		
88	DTNULL	Time step size for the null transient for steady-state core channel thermal hydraulics. Not used if ISSNUL=0.	s	
89	TPCOST	Time to start writing PINACLE data for core image (PNPICO subroutine).	s	
90	TPCOLE	Time to start writing LEVITATE data for core image (LEPICO subroutine).	s	
91	TPCOEN	Time to stop writing data for core images.	s	
92	DTPICP	Time interval for writing data for core images while PINACLE is active.	s	
93	DTPICL	Time interval for writing data for core images while LEVITATE is active.	s	
94	DTMMAX	Maximum main time step length. Default = DT0.	s	
95-104	DTMIN (I)	Main time step table. DTMIN(I) is the length of the main time step to be used in the problem time interval from TDTMIN(I) to TDTMIN(I+1). For times before TDTMIN(1), DT0 is used as the main time step. If J is the index of the last entry in the DTMIN table, then the main time step for times after TDTMIN(J) is DTMIN(J). If there are no entries in the DTMIN table, the automatic main time step selection algorithm will be used.	s	
105-114	TDTMIN (I)	See DTMIN above.	s	
115-149	TMAINS	Problem times for forced main time step termination.	s	
150	DELSCR	Time delay after scram initiation (ASCRAM, PSCRAM, GSCRAM) for scram reactivity table (SCRTAB, SCRTME) application and for external source (KQSCRA) changes.	s	

Block 11 — OPCIN — Channel-Independent Floating-Point Input

Location	Symbol	Description	Units	Used By
151	DELPUM	Time delay after scram initiation (ASCRAM, PSCRAM, GSCRAM) for beginning of PUHALF pump coastdown.	s	
152	PUHALF	Flow halving time after TSCRAM+DELPUM. F(t)=F(0)/(1+t/PUHALF), where t is the time after TSCRAM+DELPUM. Only for IFLOW > 0. **DEFAULT VALUES** DTP0 1.0 DTPBOI 0.01 DTPLEV 0.004 DTPFCI 0.001 TPRFCI 0.05 DPINMX 25000. DTINMX 5.0 DTPMAX 1.0 DTMMXB 0.02	s	
153-250	OPCDUM	Not currently used.		

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
1	POW	Steady-state power in the peak axial fuel pin segment. (sum of fuel + cladding + coolant + structure power; See IPOWOP). Note: POW=POWTOT*FRPR/POWSUM where POWSUM=sum over NCHAN channels of (NPIN*NSUBAS*(sum over MZ of PSHAPE)). (See MZ, NCHAN, PSHAPE, NPIN, FRPR, and NSUBAS).	W	NK
2	GENTIM	Prompt neutron lifetime.	s	NK
3	POWTOT	Total reactor power.	W	NK
4-9	BETADN (L)	Effective delayed neutron fraction for delayed neutron precursor family L. L =1,...,NDELAY.		NK
10-15	DECCON (L)	Decay constant for delayed neutron precursor family L. L =1, ..., NDELAY.	1/s	NK
16-21	OLDBDK (L)	Not currently used.		
22-27	OLDDKL (L)	Not currently used.		
28	OLDBDT	Not currently used.		
29-48	PREATB (L)	Transient external reactivity or power table utilized by function PREA for NPREAT > 0. If reactivity is input, entries are in dollars. If power is input, entries are normalized to nominal power (so that for PREATM = 0.0, PREATB = 1.0). L = 1, …, NPREAT.		NK
49-68	PREATM (L)	Transient problem times at which values in PREATB table are to be applied. L = 1, …, NPREAT.	s	NK
69	FRPR	Fraction of total reactor power represented by sum of all SAS4A channels.		NK

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
70	FRFLOW	Fraction of total reactor coolant flow represented by sum of all SAS4A channels.		
71	CRDLEN	Length of control rod drives washed by outlet sodium, for ICREXP = 1 (single node model). Typical value: 6 m.	m	
72	CRDEXP	Thermal expansion coefficient of control rod drives. Typical value: 2×10^{-5}.	1/K	
73	ACRDEX	Control rod expansion feedback = ACRDEX * DZ + BCRDEX * DZ^2.	\$/m	
74	BCRDEX	See ACRDEX.	$\$/m^2$	
75	CRDMC	Control rod drive mass times specific heat, for ICREXP = 1. Typical value: 5.6×10^4 J/K.	J/K	
76	CRDHA	Control rod drive surface area times heat- transfer coefficient, for ICREXP = 1. Typical value: 2300.	W/K	
77	UIVOL	Coolant volume in the upper internal structure region. Typical value: 25. Note: Locations 71 - 77 are only used if ICREXP > 0 (Block 1, loc 31).	m^3	
78	RDEXPC	Coefficient in simple radial expansion feedback model.	\$/K	
79	XMCXAC	XMC/XAC in simple radial expansion feedback model. XMC: Distance from nozzle support point to core midplane. XAC: Distance from nozzle support point to above core load pad.		
80-89	SCRTAB	Scram reactivity table (See ASCRAM, PSCRAM, GSCRAM).	\$	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
90-99	SCRTME	Times for SCRTAB. Zero time corresponds to TSCRAM+DELSCR, where TSCRAM is the time for scram initiation determined by ASCRAM, PSCRAM, or GSCRAM.	s	
100-179	PRETB2 (K,IPW)	Normalized power table for power type IPW (K = 1-20, IPW = 2-5). Note: Table for type 1 is in PREATB.		
180-259	PRETM2 (K,IPW)	Times for PRETB2 table.	s	
260-289	BETADK (L,IPW)	Decay heat precursor yield for group L in decay heat curve IPW. $1 \le L \le \text{Min}(NDKGRP, 6)$, $1 \le IPW \le NPOWDK$ Only decay heat curves with six or fewer groups may be defined by BETADK. For curves consisting of more terms, see DKBET2 below.		
290-319	DKLAM (L,IPW)	Decay heat decay constant for BETADK(L,IPW).	1/s	
320-324	BETAHT (IPW)	Sum of decay heat precursor yields for user-supplied decay heat curve IPW. If BETAHT(IPW) > 0.0, precursor yields for curve IPW are renormalized to BETAHT(IPW). BETAHT applies to precursor yields defined by BETADK (above) or DKBET2 (below).		
325-364	POWLVL (K,IPW)	Table of normalized total power for initializing decay power in decay heat region IPR. $1 \le K \le NPDKST$ $1 \le IPR \le \text{Min}(NDKREG, 5)$ NDKREG is the number of decay heat regions as determined internally by the code based on user-supplied decay heat input (see DKFRAC below). Only the first five regions are included in this table (see PWLVL2/PWTIM2 below to specify the remaining regions).		

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
		Zero values in this table will initialize decay heat based on zero total power. To calculate infinite, steady-state initialization for all regions, set NPDKST to zero.		
365-404	POWTIM (K,IPW)	Duration (in seconds) of initializing power level POWLVL(K,IPR).	s	
405	PUBYU	Not currently used.		
406	HAUIS	Heat transfer coefficient * area for upper internal structure to hot pool heat transfer. Used for ICREXP > 0.	W/K	
407	XMCUI	Mass * specific heat of steel in the upper internal structure region. Used for ICREXP > 0.	J/K	
		LOCATIONS 408-415 USED ONLY IF |IRADEX| > 3		
408	SLLMAX	Maximum allowable slope of subassembly at grid plate with respect to vertical based on subassembly nozzle/grid plate clearances; default: 2.0×10^{-4}.	m/m	
409	PITCHG	Subassembly pitch at the grid at the reference temperature TR.	m	
410	PITCHA	Flat-to-flat dimension across the above core load pad at the reference temperature TR.	m	
411	PITCHT	Flat-to-flat dimension across the top load pad at the reference temperature TR.	m	
412	RDEXCF	Radial expansion coefficient for uniform core dilation.	$/m	
413	TLPRRC	Clearance between the top load pad and the restraint ring. Default: 2.54×10^{-3} m.	m	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
414	BNDMM1	Applied bending moment at the top of the core region, representing the flat-to-flat temperature difference at the outer edge of the active core. Default: 1.4×10^{-3}.		
415	BNDMM2	Applied bending moment in the region above the core, representing the flat-to-flat temperature difference in this region for subassemblies at the outer edge of the active core. Default: 1.4×10^{-3}.		
416	TINSRT	Time interval over which REAINS (Block 12, location 417) dollars of reactivity is inserted. Default: 1.0.	s	
417	REAINS	Amount of reactivity to be inserted linearly during time interval TINSRT. (Block 12, location 416).	$	
418	TLIMIT	Control rod drive line temperature at which insertion of reactivity REAINS (Block 12, location 417) is to begin.	K	
419	DFLTCS	Subassembly displacement at the above-core load pad at zero power resulting from creep and irradiation swelling history, positive outward, for subassemblies at the outer edge of active core.	m	
420	DFLTSS	Subassembly displacement at the top load pad at zero power resulting from creep and irradiation swelling history, positive outward, for the subassemblies at the outer edge of active core.	m	
		LOCATIONS 421-428 USED ONLY IF |IRADEX| > 3		
421	ACLPRC	Clearance between the compacted above-core load pads and the restraint ring at the above-core load pad elevation, if any. If no above-core restraint ring, enter 0.	m	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
422	FCDTR1	Nominal steady-state above-core restraint ring temperature, expressed as a fraction of the average coolant temperature rise through the core.		
423	FCDTR2	Nominal steady-state top restraint ring temperature, expressed as a fraction of the coolant temperature rise through the core.		
424	FCDTRF	Nominal steady-state reflector load pad temperature, expressed as a fraction of the coolant temperature rise through the core.		
425	DRCOLL	Additional clearance between the subassembly and its load pad, known as a "floating collar".	m	
426	CRSAC	Additional clearance in the interior of the core, or the difference between the actual core radius and the ideal core radius. Default: 6.35×10^{-4}.	m	
427	RR1TC	Thermal response time constant for the above-core restraint ring.	s	
428	RR2TC	Thermal response time constant for the top restraint ring.	s	
		ADDITIONAL INPUT FOR THE DETAILED CONTROL ROD EXPANSION MODEL REQUIRED FOR ICREXP = 4.		
429	RODID	Outside diameter of control rod driveline.	m	
430	RODOD	Outside diameter of control rod driveline.	m	
431-433	SHRDLN (K)	Length of section K of the control rod, section is deleted if zero.	m	
434-436	SHRDID (K)	Inside diameter of section of control rod shroud, no shroud assumed if zero.	m	
437-439	SHRDOD (K)	Outside diameter of section of control rod shroud, no shroud is assumed if zero.	m	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
440	RHOCRD	Density of control rod structure.	kg/m^3	
441	HTCPCR	Heat capacity of control rod structure.	J/kg-K	
442	CONDCR	Thermal conductivity of control rod structure.	W/m-K	
443	VFCRD	Structure volume fraction in driveline core, remainder is sodium.		
444	HFILM	Film coefficient on outer control rod shroud surface.	W/m^2-K	
445	FLSHRD	Flowrate in shroud annulus.	kg/s	
446	AREACR	Discharge area for segment representing control rod assembly(s).	m^2	
447	FLOEXP	Exponent on flow in the CRD shroud friction pressure drop equation.		
		ADDITIONAL INPUT FOR THE DETAILED RADIAL CORE EXPANSION MODEL		
		REQUIRED FOR |IRADEX| > 3.		
448	ACLPEL	Elevation of the center of the above-core load pad with respect to the bottom of the SAS4A model of the fueled region, zone 'KZPIN', at the reference temperature TR.	m	
449	TLPEL	Elevation of the center of the top load pad with respect to the bottom of the SAS4A model of the fueled region, zone 'KZPIN', at the reference temperature TR.	m	
450	PTCHRA	Flat-to-flat dimension across the above-core load pad for subassemblies exterior to the last row of driver subassemblies at the reference temperature TR.	m	
451	PTCHRT	Flat-to-flat dimension across the top load pad for subassemblies exterior to the last row of driver	m	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
		subassemblies at the reference temperature TR.		
452	RCBARR	Core barrel radius at the reference temperature TR.	m	
453	FCDTCB	Nominal steady-state core barrel temperature, expressed as a fraction of the coolant temperature rise through the core.		
454	CB2TC	Thermal response time constant for the core barrel.	s	
		ADDITIONAL INPUT FOR THE EBR-II REACTIVITY FEEDBACK MODEL, |IREACT| = 2		
455	YKNF	Fuel number-density coefficient of reactivity.	Δk/(Δn/n)	
456	YKHF	Fuel change in reactivity per fractional change in core fuel height.	Δk/(Δh/h)	
457	YKNNA	Sodium number-density coefficient of reactivity.	Δk/(Δn/n)	
458	YKNSS	Steel number-density coefficient of reactivity.	Δk/(Δn/n)	
459	YRCUR	Upper-reflector coefficient of reactivity.	Δk/K	
460	YLCLR	Lower-reflector coefficient of reactivity.	Δk/K	
461	YRCRR	Radial-reflector coefficient of reactivity.	Δk/K	
462	YRCCR	Control-rod-flow coefficient of reactivity.	Δk/K	
463	YRCGP	Grid-plate coefficient of reactivity.	Δk/K	
464	YRCDOP	Non-linear Doppler-effect of reactivity.	Δk	
465	YDELT0	Nominal core delta T at full reactor power.	K	
466	YABOW	Coefficient of non-linear core bowing effect. P = B Delta T/Delta T Deg. + A. (See Block 12, location 467).		

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
467	YBBOW	Coefficient of non-linear core bowing effect. P = B Delta T/Delta T Deg. + A. (See Block 12, location 466).		
468	FCR	Control-rod feedback parameter: $0 \le FCR \le 1$.		
469	YTCUT	The normalized core temperature rise below which the bowing feedback is 0. For instance, if YTCUT=0.5, then for core temperature increases that are less than 1/2 of the nominal core temperature rise (103.5 K) reactor feedback due to bowing is 0$.		
		EXTERNAL SOURCE SPECIFICATION FOR POINT AND SPATIAL KINETICS APPLICATIONS		
470	RHOZRO	Initial subcritical reactivity for point kinetics external source. =0, No external source. <0, Initial external source will be set to give a steady initial steady state with the reactivity equal to RHOZRO.	$	
471-490	EXSOTB (L)	Relative point and spatial kinetics external source values at times given in EXSOTM.		
491-510	EXSOTM (L)	Times for point and spatial kinetics external source values given in EXSOTB. See also NEXSO and RHOZRO. The time dependence for the point kinetics external source specified by RHOZRO will be given by the pairs of values entered in EXSOTB and EXSOTM. For RHOZRO < 0 and NEXSO = 0, a constant external source will be used. The EXSOTB values will be normalized to unity at t = 0. The time dependence for the spatial kinetics external source specified on the FIXSRC FILE will be given by the pairs of values entered in EXSOTB	s	

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
		and EXSOTM. For NEXSO = 0, a constant external source will be used. The EXSOTB values will be normalized to unity at t = 0.		
511-630	DKBET2 (L,IPW)	Decay heat precursor yield for group L in decay heat curve IPW. $1 \le L \le NDKGRP$ $1 \le IPW \le NPOWDK$ Decay heat data for curve IPW may be present in either BETADK/DKLAM or DKBET2/DKLAM2. If data is present in both locations, values in DKBET2/DKLAM2 will be used.		
631-750	DKLAM2 (L,IPW)	Decay heat decay constant for DKBET2(L,IPW).	1/s	
751-800	DKFRAC (IPR,IPW)	Fraction of user-supplied decay heat curve IPW to be used in decay heat region IPR. $1 \le IPR \le NDKREG \le 10$ $1 \le IPW \le NPOWDK$. NDKREG is determined internally by the code based on the input of DKFRAC and DKANSI (below). A maximum of 10 regions can be defined. By default, DKFRAC is a NPOWDK by NPOWDK identity matrix, providing compatibility with old input files. (Regions and curves have the same meaning in this case).		
801-880	DKANSI (IPR,N)	Fraction of built-in ANS standard decay curve N to be used in decay heat region IPR. N = 1: U-235 thermal fission N = 2: Pu-239 thermal fission N = 3: U-238 fast fission N = 4: Pu-241 thermal fission $5 \le N \le 8$ is reserved for future standard curves.		

Block 12 — POWINA — Power, Decay-Heat, and Reactivity Input

Location	Symbol	Description	Units	Used By
881-920	PWLVL2 (K,IPR-5)	Table of normalized total power for initializing decay power in decay heat region IPR. $1 \le K \le NPDKST$ $6 \le IPR \le NDKREG$ PWLVL2 is a continuation of table POWLVL. See the description of POWLVL above.		
921-960	PWTIM2 (K,IPR-5)	Duration of initializing power level PWLVL2(K,IPR-5). PWTIM2 is a continuation of table POWTIM. See POWTIM above.	s	
961-968	QETOT (N)	Total recoverable energy per fission for the fissionable isotope associated with built-in standard decay curve N. See DKANSI above. Default is 200 MeV/fission.	MEV/ fission	
969-1000	DUMPNA	Not currently used.		

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
		Note: Suggested values refer to oxide fuel.		
1-3	COEFDS (1)	Solid fuel theoretical density at the reference temperature. Suggested value: 11.08E+3. Theoretical fuel density = COEFDS(1) / [1.0 + (COEFDS(2) + COEFDS(3) * (TK-273.15)) * (TK-273.15)].	kg/m^3	D F
	COEFDS (2)	First-order solid fuel volumetric thermal expansion coefficient, ALPHA1. Suggested value: 2.04E-5.	1/K	DF
	COEFDS (3)	Second-order solid fuel volumetric thermal expansion coefficient, BETA1 Suggested value: 8.70E-9. Used only if IRHOK > 0. (See Block 51, Loc. 3).	$1/K^2$	DF
4-10	COEFK	Fuel thermal conductivity coefficients.		
	(1-7)	Fuel thermal conductivity = ((COEFK(1) - FDEN) * FDEN - 1.0) * ((COEFK(2) + COEFK(3) * TK)$^{-1}$ + COEFK(4) * TK^3) if FDEN ≤ 0.95, and thermal conductivity = (3.0 * FDEN -1.0) * ((COEFK(5) + COEFK(6) * TK)$^{-1}$ + COEFK(7) * TK^3) if FDEN > 0.95, where FDEN is fractional fuel density. Suggested values: 2.1, 2.88E-3, 2.52E-5, 5.83E-10, 5.75E-2, 5.03E-4, 2.91E-11. Used only if IRHOK = 2. (See Block 51, Loc. 3).		
11-70	EXKTB (L,ICLAD)	Thermal conductivity of the cladding in table location L, 1 ≤ L ≤ 20. If only EXKTB(1) is entered, EXKTB is temperature-independent. (1 ≤ ICLAD ≤ ICLAD1; see Block 1, location 4)	W/m-K	
71-90	EXKTM (L)	Temperatures for EXKTB table.	K	

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
91-250	RHOTAB (L,IFUEL)	Theoretical fuel density in table location L, 1 ≤ L ≤ 20, for fuel type IFUEL. Used for IMETAL = 0. See RHOZN, locations 1316-1323 for IMETAL > 0.	kg/m^3	
251-410	RHOTEM (L,IFUEL)	Temperature in table location L, 1 ≤ L ≤ 20, for fuel type IFUEL. Note: Two entries must be made at the melting point temperature. First with the solid density, next with the liquid density. (See TMF and FDENS)	K	
411-418	TMF (IFUEL)	Not to be input. It is set to fuel solidus temperature in the code.	K	
419	TR	Reference design point temperature. Temperature at which pin dimensions are measured. Suggested value: 300.	K	CL DF
420-579	XKTAB (L,IFUEL)	Fuel conductivity in table location L, 1 ≤ L ≤ 20, for fuel type IFUEL.	W/m-K	
580-599	XKTEM (L)	Temperatures for XKTAB table.	K	
600	FGMM	Molecular weight of fission-gas atom. Suggested value: 131.		DF
601	GATPF	Gas atoms generated per fission. Suggested value: 0.246.		DF
602	ENPF	Energy per fission. Suggested value: 197.	MeV	DF
603	RLEQ	Fraction of the as-fabricated porosity which defines the equiaxed / columnar fuel boundary. Suggested value: 0.6. PRSTY2 < RLEQ * PRSTY - columnar fuel PRSTY2 > RLEQ * PRSTY - equiaxed fuel		DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
604	RUEQ	Grain size ratio at the equiaxed / as-fabricated boundary. Suggested value: 1.2. DGR2 < RUEQ * DGO - as-fabricated DGR2 ≥ RUEQ * DGO – equiaxed		DF
605	PRSMIN	Minimum attainable porosity during restructuring. Suggested value: 0.02.		DF
606-765	CPFTAB (L,IFUEL)	Fuel specific heat in table location L, 0 < L < 21, for fuel type IFUEL.	J/kg-K	
766-785	CPFTEM (L)	Temperatures for CPFTAB table.	K	
786-793	TFSOL (IFUEL)	Fuel solidus temperature.	K	
794-801	TFLIQ (IFUEL)	Fuel liquidus temperature.	K	
802-809	UFMELT (IFUEL)	Fuel heat of fusion.	J/kg	
810-812	TESOL (ICLAD)	Cladding solidus temperature.	K	
813-815	TELIQ (ICLAD)	Cladding liquidus temperature.	K	
816-818	UEMELT (ICLAD)	Cladding heat of fusion.	J/kg	
819-878	CPCTAB (L,ICLAD)	Cladding specific heat.	J/kg-K	
879-898	CPCTEM (L)	Temperatures for CPCTAB table.	K	

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
899-901	TME (ICLAD)	Not to be input. Set to cladding solidus temperature in the code.	K	
902-909	UMELT (IFUEL)	Not currently used.		
910-969	YLDTAB (L,ICLAD)	Cladding yield point in table location L, 1 ≤ L ≤ NYLDTB, for cladding type ICLAD.	Pa	DF
970-989	YLDTEM (L)	Temperatures for YLDTAB table.	K	DF
990-1049	CROETB (L,ICLAD)	Specific heat * density for cladding in table location l, 0 < L < 21. If only CROETB(1) is entered, CROETB is temperature independent.	J/m^3-K	
1050-1069	CROETM (L)	Temperatures for CROETB table.	K	
1070-1072	CE (ICLAD)	Cladding specific heat at solidus temp erature for CLAP cladding motion module. 1 ≤ ICLAD ≤ 3. Suggested value: 690.	J/kg-K	CL
1073-1080	PRSTY (IFUEL)	As-fabricated porosity for each fuel type. IFUEL < 9.		
1081	AC	Not currently used.		
1082	QSWL	Not currently used.		
1083	APORE	Pre-exponential factor in pore velocity. VPORE = APORE * (dT/dr) * exp(-QPORE/ (RGASSI * T)) / (T ** ABC) Suggested value: 20.704.	m^2-$K^{1.5}$/ s	DF
1084	QPORE	Pore migration activation energy Suggested value: 4.5281E05.	J/gm-mole	DF
1085	ABC	Exponent of temperature factor in pore velocity. Suggested value: 1.5.		DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1086	RGASSI	Ideal gas constant. Suggested value: 8.31434.	J/gm-mole-K	D F
1087	GAMMA	Fuel surface tension. Suggested value: 0.45. See location 1157.	J/m^2	DF
1088	APG	Pre-exponential factor in bubble radius parameterization. Suggested value: 5.0E04. RB = (2 * GAMMA/APG) * exp (-QPG / (RGASSI * TEMP))	Pa	DF
1089	QPG	Temperature dependence of bubble radius. Suggested value: 5.65065E04.	J/mole	DF
1090	GK	Pre-exponential factor in unlimited grain growth rate. DG ** NGRAIN = DGO ** NGRAIN + GK * TIME * exp (-QV / (RGASSI * TEMP)) Suggested value: 1.717E10.	m^3/s	DF
1091	QV	Activation energy of unlimited grain growth rate. Suggested value: 3.87E05.	J/gm-mole	DF
1092	GK1	Pre-exponential factor in limited grain growth rate. (Ainscough et al. model). Suggested value: 1.45556E-08.	m^2/s	DF
1093	QV1	Temperature dependence in limited grain growth rate. Suggested value: 2.67E+5.	J/mole-K	DF
1094	GRAINK	Pre-exponential factor in maximum grain size. DMAX = GRAINK * exp(-GRAINQ / (RGASSI* TEMP))	m	DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1095	GRAINQ	Temperature dependence in maximum grain size. Suggested value: 6.3375E+04.	J/gm-mole	DF
1096	CVXE	Xenon specific heat at constant volume. Suggested value: 94.69.	J/kg-K	DF
1097	CVHE	Helium specific heat at constant volume. Suggested value: 3.13E+03.	J/kg-K	DF
1098	ROFF	Surface roughness of fuel. Suggested value: 3.3E-06.	m	DF
1099	ROFC	Surface roughness of inner cladding. Suggested value: 1.78E-06.	m	DF
1100	AZEROX	Calibration factor in solid-solid conductance. Not currently used.		
1101	GAMGS	Cp/Cv parameter in jump distance calculation. Suggested value: 1.66.		DF
1102	HARDNS	Meyer's hardness of the softer contacting surface in solid-solid gap conductance. This is set to 3 * yield stress within the code.	Pa	DF
1103	ET	Exponent of the pressure dependence in solid-solid conductance. Suggested value: 1.		DF
1104	ACCHE	Accommodation coefficient of helium. Suggested value: 0.15.		DF
1105	ACCXE	Accommodation coefficient of xenon. Suggested value: 0.805.		DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1106	CZERO	Calibration constant for surface roughness in gap conductance calculation. Suggested value: 1.98.		DF
1107	STEBOL	Stefan-Boltzmann constant. Suggested value: 5.67E-08.	W/m^2-K^4	DF
1108	EMSF	Fuel emissivity. Suggested value: 0.9.		DF
1109	EMSC	Cladding emissivity. Suggested value: 0.8.		DF
1110	QA1	Parameter in Weisman fission-gas release model. Probability of escaping directly without being trapped, KPRIME = exp(-QA1/ TEMP - QA2 - QA3 * DEN) where DEN = percent of fuel theoretical density. Suggested value: 6.92E+3.	K	DF
1111	QA2	Parameter in Weisman fission-gas release model. Suggested value: 33.95.		DF
1112	QA3	Parameter in Weisman fission-gas release model. Suggested value: 0.338.		DF
1113	QA4	Parameter in Weisman fission-gas release model. Probability of trapped fission-gas atom getting released from trap and then escaping per second, K = exp(-QA4/ TEMP - QA5). K is in units of 1/s. Suggested value: 1.48E+04.	K	DF
1114	QA5	Parameter in Weisman fission-gas release model. Suggested value: 9.575.		DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1115	ALFSS	Pre-exponential factor in isotropic fission- gas release model. Fractional release rate= ALFSS * exp(-BETSS/TEMP). Suggested value: 2.0E-04.	1/s	DF
1116	BETSS	Temperature dependence in isotropic fission-gas release model. Suggested value: 1.1E+04.	K	DF
1117	CNU	Cladding Poisson ratio. Suggested value: 0.3.		DF
1118	FNU	Fuel Poisson ratio. Suggested value: 0.3265.		DF
1119	AM	Stress exponent in the fuel creep law for stress relaxation calculation. Strain rate = AONE * stress ** AM * exp(-QLAX/(RGASSI * Temp)). "AONE" is evaluated in the code depending on fractional fuel density and fuel grain size. Suggested value: 1.0.		DF
1120	QLAX	Activation energy for diffusion creep. Suggested value: 3.77E+05.	J/mole	DF
1121	QLAX2	Not currently used.		
1122	DDX	Not currently used.		
1123	DDX2	Not currently used.		
1124	RGAS	Gas constant per kilogram for fission-gas (as in PV = MRT). Suggested value: 65 for high burnups.	Pa-m^3/kg-K	DF
		PLUTO2 AND LEVITATE		
		Input (1125-1199, 1206-1217, 1229-1257)		
1125	CINAF0	Fraction of the coolant flow area occupied by the liquid sodium film left behind by moving coolant slugs in PLUTO2. This is also the maximum value in the voided channel. CINAF0 must be < CIVOID. See Block 64, locations 77 and 84 to input consistent values. Suggested value: 0.15.		PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1126	CIBBIN	If the liquid fuel volume fraction in the channel is greater than CIBBIN, the fuel flow regime is treated as a bubbly flow regime. See locations 1160 and 1174.		LE PL
1127	CIREFU	Reynolds number for annular or bubbly fuel flow above which the friction factor is assumed to be constant and equal to CIFRFU (See location 1128).		LE PL
1128	CIFRFU	Moody friction factor for turbulent bubbly fuel flow (See location 1127).		LE PL
1129	CIFUMO	Fraction of the axial momentum of the fuel flow in the pin which is retained by the fuel which is ejected into the coolant channel.		PL
1130	CIVOID	If the sodium void fraction in the coolant channel is less than CIVOID the heat-transfer and friction between sodium and cladding are based on single- phase correlations for the homogeneous mixture of the two phases of sodium. CIVOID must be > CINAF0 and < CIA4. For sodium void fractions greater than CIVOID see Block 13, locations 1134 and 1179. See Table 14.4-2.		PL
1131	CIA1	Constant in the fuel particle-to-sodium heat-transfer coefficient. H = CIA1*(conductivity of fuel)/(particle radius) * (1-Na void fraction) ** CIA2. (See Eqs. 14.4-94 and 14.4-98).		PL
1132	CIA2	(See CIA1 above).		PL
1133	CIA3	Constant in the molten fuel-to-cladding and molten fuel-to-solid fuel heat-transfer coefficient. Constant for oxide fuel but strongly dependent on Reynolds number for metal fuel. (See Eqs. 14.2-29, 14.4-118, and 14.4-125).		PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1134	CIA4	If the sodium void fraction is greater than CIA4, the heat-transfer coefficient between two-phase sodium and cladding, moving fuel and fuel crust is based on an interpolation. CIA4 must be > CIVOID. (See Eqs. 14.4-88, 14.4-103 and 14.4-107 in the documentation).		PL
1135	CIA5	Constant in the fuel particle-to-sodium / fission-gas drag which controls the dependence on the void fraction. (See Eq. 14.4-163 in the documentation). Suggested value: -1.7.		PL
1136	CIA6	Constant in the bubbly fuel flow drag calculation (See Eq. 7.4.170). Suggested value: 0.4272.		LE, PL
1137	CIFN	Not currently used.		
1138	FNFUAN	Not currently used.		
1139	CPFU	Average specific heat of moving liquid or solid fuel.	J/kg-K	LE PL
1140	CDFU	Average thermal conductivity of moving liquid or solid fuel.	J/m-s-K	LE PL
1141	CMNL	Average compressibility of liquid sodium at roughly the sodium temperature at the time of pin failure in the vicinity of failure.	Pa^{-1}	LE PL
1142	CDNL	Average thermal conductivity of liquid sodium at roughly the sodium temperature at the time of pin failure in the vicinity of failure.	J/m-s-K	LE PL
1143	CIETFU	Effectiveness of fuel particles to entrain or tear off a liquid sodium film. CIETFU = 1.0 means that the fuel acts as a gas with the gas density equal to the fuel smear density. For CIETFU = 0.1 only one tenth of the fuel density is used.		LE PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1144	CDVG	Average thermal conductivity of the sodium vapor / fission-gas mixture at temperatures roughly 200-300 K higher than the sodium temperature at the time of pin failure in the vicinity of failure. Used only in Dittus-Boetter correlation for Nusselt numbers. At present, use sodium vapor value.	J/m-s-K	LE PL
1145	VIFI	Average viscosity of fission-gas.	kg/m-s	LE PL
1146	CFNACN	Sodium condensation coefficient.	J/m^2-s-K	LE PL
1147	CFNAEV	Sodium evaporation coefficient. Should be larger than the above condensation coefficient.	J/m^2-s-K	LE PL
1148	FIFNGB	Fraction of the fission-gas entering the cavity with the melting-in fuel which is on grain boundaries. This fraction of the fission-gas becomes immediately available, whereas the remainder becomes available only after a coalescence time. Suggested value: 0.10. (See CIRTFS, Block 13, location 1170)		DF LE PL
1149	VINL	Average viscosity of liquid sodium at roughly the sodium temperature at the time of pin failure in the vicinity of failure.	kg/m-s	LE PL
1150	VIVG	Average viscosity of the fission-gas/ sodium-vapor mixture. (For temperature range and other comments, see location 1144).	kg/m-s	LE PL
1151	EGFUSO	Internal energy of fuel at the solidus point.	J/kg	LE PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1152	DZPLIN	Minimum length of the edge cells in the interaction region of PLUTO-2 and LEVITATE. Values between 0.005 and 0.05 meter are allowed. DZPLIN has to be smaller than the shortest mesh cell in all channels. Recommended and default value: 0.02.	m	LE, PL
1153	CFCOFV	Condensation heat-transfer coefficient for fuel vapor.	J/m^2-s-K	PL
1154	CFFURH	Not currently used.		
1155	C1VIPR	A dimensionless constant in the artificial viscous pressure calculation inside the pin. (See Eq. 14.2-38a)		PL
1156	C2VIPR	A dimensionless constant in the artificial viscous pressure calculation inside the pin. (See Eq. 14.2-38)		PL
1157	SUFU	Molten fuel surface tension. (See location 1087)	J/m^2	LE, PL
1158	RAFPLA	Radius of initial fuel particles.	m	PL
1159	RAFPSM	Radius of fuel particles after fragmentation, after TIFP s from initial injection. (See location 1173)	m	PL
1160	VFNALQ	Liquid sodium volume fraction in the coolant channels below which a continuous (annular or bubbly) fuel flow regime can be initiated (See locations 1126, 1174, and 1178 used in determining fuel flow regimes).		PL
1161	EGBBLY	If the fuel flow regime is annular or bubbly, fuel freezing may be initiated when the fuel internal energy drops below EGBBLY. Its value should be above the solidus energy.	J/kg	PL
1162	VIFULQ	Viscosity of the fuel above the fuel liquidus.	kg/m-s	LE PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1163	VFNARE	Liquid sodium volume fraction above which a continuous fuel flow becomes a particulate flow again. Suggested value: >0.5. (See Fig. 14.4-3)		
1164	DTPLIN	Initial and minimum PLUTO2 and LEVITATE time step. Suggested value: 2.E-5. Minimum value: 1.E-6. Maximum value: 2.E-4.	s	LE PL
1165	AXMX	Reference area for PLUTO2 and LEVITATE. This area times 1 meter is the volume to which all volume fractions in PLUTO2 or LEVITATE are referenced. It makes the volume fractions more meaningful if this area is equal to the area encompassing everything inside the outer perimeter of the subassembly wall (not per fuel-pin but per fuel subassembly).	m^2	LE PL
1166	EPCH	Not currently used.		
1167	TIPLMX	Time after PLUTO2 initiation when full PLUTO2 calculations are switched off and only the PLUTO2 energy equations are solved for all components which are then assumed to remain stagnant. Necessary for transient overpower calculations in which the lead channel fails many seconds before any other channel.	s	PL
1168	DTPLP	Full PLUTO2 or LEVITATE printout every DTPLP seconds.	s	LE, PL
1169	FNMELT	Molten fuel is added to the cavity when it has gone through a fraction FNMELT of the heat of fusion. Suggested value: 0.9 (for TREAT experiment analysis lower values may be necessary).		DF, LE, PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1170	CIRTFS	Determines how fast dissolved fission-gas in the pin cavity coalesces and becomes free gas: Mass of fission-gas coalescing per unit time = CIRTFS * current mass of dissolved fission-gas in this node. Suggested value: 16.667.	1/s	DF, LE
1171	CISP	Not currently used.		
1172	CIFUFZ	Controls the mode of fuel freezing in PLUTO2. = 0, Conduction type freezing. = 1, Bulk type freezing. Allowed range between 0.0 to 1.0. Suggested value: 1.		PL
1173	TIFP	Time delay for fragmentation of larger particles into smaller ones (relative to initial fuel injection time, see Block 51, location 74).	s	PL
1174	CIANIN	Channel fuel (moving fuel + frozen fuel) volume fraction above which the whole perimeter of the channel is wetted by molten fuel in annular flow.		LE, PL
1175	TEFAIL	Cladding temperature of a node above which the cladding failure propagates to this node if the pin pressure is greater than the channel pressure + PRFAIL and also the areal fuel melt fraction greater than FRNAME. Both cladding nodes must exceed this temperature. (See locations 1176 and 1177). Relevant only if axial pin failure propagation is determined by input, if KFAILP = 1. Suggested value: Steel solidus temperature TESOL.	K	LE PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1176	FNARME	Relevant for both axial pin failure propagation options (KFAILP = 0 or 1). FARME is the minimum areal fuel melt fraction of a node above which a cladding failure can propagate into this node if additional conditions depending upon the value of KFAILP are satisfied.		LE, PL
1177	PRFAIL	Relevant only if KFAILP = 1. (See location 1175).	Pa	LE, PL
1178	EGMN	The continuous fuel flow regimes cannot be initiated below this fuel internal energy. Its value should be above the solidus energy.	J/kg	LE, PL
1179	HCFFMI	Convective heat-transfer coefficient from the surface of a frozen fuel crust to two-phase sodium/fission-gas mixture (liquid sodium in the form of dispersed drops) with a void fraction > CIVOID (See location 1130).	J/m^2-s-K	PL
1180	HCFUBB	Convective heat-transfer coefficient between the interior of the molten fuel and two-phase sodium/fission gas mixture bubble surfaces in the bubbly flow regime.	J/m^2-s-K	PL
1181	FNHTFU	Fraction of the convective heat-transfer coefficient between liquid fuel and cladding which remains effective when the moving fuel consists of solid chunks.		PL
1182	XPL5	For future use in PLUTO2.		
1183	XPL6	For future use in PLUTO2.		
1184	TECLMN	Maximum outer cladding node temperature above which freezing fuel cannot stick to the cladding (the same input value limits the freezing on the inner structure node). (this is used in PLUTO2 only).	K	PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1185	TECLRL	Temperature of the middle cladding node above which plated-out fuel is released. (this is used in PLUTO2 only).	K	PL
1186	CIHCFU	Dimensionless coefficient in the Deissler heat-transfer correlation for inpin fuel motion. $Nu = CIHCFU*Pr*Re^{0.8}$		LE
1187	HCCLMI	Convective heat-transfer coefficient from hotter cladding to two-phase sodium/ fission-gas mixture (liquid sodium in the form of dispersed drops) with a void fraction > CIVOID. (See location 1130).	J/m^2-s-K	LE PL
1188	CMFU	Average adiabatic compressibility of liquid fuel.	Pa^{-1}	LE PL
1189	XPL7	For future use in PLUTO2.		
1190	XLP8	For future use in PLUTO2.		
1191	XLP9	For future use in PLUTO2.		
1192	XPL10	For future use in PLUTO2.		
1193	XPL11	For future use in PLUTO2.		
1194	XPL12	For future use in PLUTO2.		
1195	CDCL	Average conductivity of the solid cladding.	J/m-s-K	LE PL
1196	CPCL	Average specific heat of the solid cladding.	J/kg-K	LE PL
1197	CPCLRH	Average specific heat times density of the solid cladding.	J/m^3-K	LE PL
1198	RHSLBT	Average physical density of the lower liquid sodium slug.	kg/m^3	LE PL

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1199	RHSLTP	Average physical density of the upper liquid sodium slug.	kg/m^3	LE PL
1200	COEFDL (1)	Not currently used.		
1201	COEFDL (2)	Molten fuel volumetric thermal expansion coefficient, ALPHA2. (DEFORM uses with COEFDS(1)) Suggested value: 9.3E-5. Rho = COEFDS(1)/(1+COEFDL(2) *(T-273.15))	1/K	DF PL
1202	QSTAR	Not currently used.		
1203	ABCPU	Not currently used.		
1204	QPU	Not currently used.		
1205	DPUO	Not currently used.		
1206	RHSSLQ	Density of steel in the fuel crust. (See locations 1196, 1197, and 1215). Suggested value: 6000.	kg/m^3	LE
1207	CIBBDI	Liquid fuel volume fraction above which the transition from annular to bubbly fuel flow regime occurs in disrupted regions (i.e., regions having no pin geometry). Suggested value: 0.2.		LE
1208	CIANDI	Liquid fuel volume fraction above which the transition from partial perimeter annular to full perimeter fuel flow regime occurs in disrupted regions. Suggested value: 0.1.		LE
1209	CIVIMT	The fuel viscosity at solidus is set equal to CIVIMT times the value at liquidus (See location 1162). The fuel viscosity between solidus and liquidus is evaluated by interpolation between these two values. Suggested value: 200.		LE

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1210	EGSESO	Solidus energy of steel. Suggested value: 8.18E+5.	J/kg	LE, PL
1211	EGSELQ	Liquidus energy of steel. Suggested value: 1.076E+6.	J/kg	LE, PL
1212	CPSE	Specific heat of molten steel. (See locations 819, 1070, 1196, and 1197). Suggested value: 768.	J/kg-K	LE PL
1213	FRMRSE	The fraction of latent heat of fusion to be satisfied for steel to be considered a moving fluid in LEVITATE. Suggested value: 0.5.		LE
1214	FNSROS	Initial fraction of structure in the inner node (facing the channel). (See Block 61, locations 39-52 for consistent input). Suggested value: 0.1 to 0.9.		LE
1215	RHSSSO	Density of solid steel. (See locations 1196, 1197 and 1206). Suggested value: 6.95E+3.	kg/m^3	LE
1216	RGFV	Gas constant for the fuel vapor. Suggested value: 31.	J/kg-K	LE
1217	RGSV	Gas constant for the steel vapor. Suggested value: 145.	J/kg-K	LE
1218	TMIDFG	Not currently used.		
1219	FGSPRD	Not currently used.		
1220	FGPORX	Not currently used.		
1221	WST	Not currently used.		
1222	HECOND	Not currently used.		
1223	FGCOND	Not currently used.		
1224	AKCOND	Not currently used.		

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1225	HEMM	Molecular mass of helium atom. Suggested value: 4.		DF
1226	EPSSFP	Volume swelling fraction due to solid fission products. Suggested value: 3E-03.	Per a/o burn-up	DF
1227	HEMASX	Not currently used.		
1228	ZSWFAC	Not currently used.		
1229	FNDISR	Ratio of molten cavity radius to fuel pellet radius needed for disrupting pins in LEVITATE. Pins can also disrupt if the outermost fuel node is above the solidus. (DTDISR must also be met).		LE
1230	DTDISR	Fuel-pin disruption in LEVITATE is allowed if the cladding middle node temperature is greater than cladding solidus temperature minus DTDISR. (FNDISR must also be met). Not currently used.	K	LE
1231	SRFMLE	If SRFMLE = 0.0, liquid sodium film on structure is thrown away in LEVITATE. If SRFMLE > 1.E-10, the sodium in the structure film is conserved. LEVITATE mixes the sodium film with the sodium vapor in the channel. This can lead to an excessive pressure event in the channel due to fuel/sodium interactions.		LE
1232	XLE4	Not currently used.		
1233	XLE5	Not currently used.		
1234	XLE6	Not currently used.		
1235	XLE7	Not currently used.		
1236	XLE8	Not currently used.		
1237	XLE9	Not currently used.		

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1238	XLE10	Not currently used.		
1239	XLEPT1	Not currently used.		
1240	XLEPT2	Not currently used.		
1241	XLEPT3	Not currently used.		
1242	XLEPT4	Not currently used.		
1243	XLEPT5	Not currently used.		
1244	XLEPT6	Not currently used.		
1245	XLEPT7	Not currently used.		
1246	XLEPT8	Not currently used.		
1247	XLEPT9	Not currently used.		
1248	PLUT1	Not currently used.		
1249	PLUT2	Not currently used.		
1250	PLUT3	Not currently used.		
1251	PLUT4	Not currently used.		
1252	PLUT5	Not currently used.		
1253	PLUT6	Not currently used.		
1254	PLUT7	Not currently used.		
1255	PLUT8	Not currently used.		
1256	PLUT9	Not currently used.		
1257	PLUT10	Not currently used.		
1258	FAXIAL	Fraction of calculated axial expansion to be actually used by DEFORM. Suggested value: 1. (See location 1263).		DF

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1259	FCLDWK	Initial cold-work strain of the cladding. (Required if IYLD = 1).		DF
1260	FMELTD	Not currently used.		
1261	FSTRAN	Not currently used.		
1262	FTMPCH	Fraction of fuel or blanket melt temperature (TMF(IFUEL)) at which crack healing is assumed. (Required if IHEALC = 2).		DF
1263	EXPCOF	Fraction of the axial expansion reactivity calculated by DEFORM to be used for feedback effects. (See location 1258). 0.0 ≤ EXPCOF ≤ 1.0. Suggested value: 1.0.		DF
1264	PRTSTR	Time for the first transient printout if IPROPT = 1. (See Block 1, location 6).	s	DF
1265	PRTDEL	Time interval between printouts if IPROPT = 1. (See Block 1, location 6).	s	DF
1266	FIRLIM	Failure fraction at which the main time step is cut to DTFALL. For each fuel pin failure option a time-dependent fraction between 0.0 and 1.0 called failure fraction is defined for each fuel axial segment which indicates how close to pin failure the axial segment is at the current time. Failure fraction is 0.0 at the beginning of the transient, and equals 1.0 at the time of pin failure. (See Block 51, location 86).		
1267	SECLIM	Failure fraction at which the main time step is cut to DTFAL2.		
1268	THRLIM	Failure fraction at which the main time step is cut to DTFAL3.		

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1269	DTFAL1	Main time step when FIRLIM ≤ failure fraction < SECLIM.	s	
1270	DTFAL2	Main time step when SECLIM ≤ failure fraction < THRLIM.	s	
1271	DTFAL3	Main step when THRLIM ≤ failure fraction < 1.0.	s	
1272	AKD	Not currently used.		
1273	CKD	Not currently used.		
1274	QKC	Not currently used.		
1275	FGFI	Mole fraction of fission gas in the initial fill-gas. (Assumed same molecular weight as FGMM in Block 13, location 600).		DF
1276	CIPINJ	Controls the ejection of molten fuel/ fission gas from the pin cavity when the mechanistic ejection model is not used. See INRAEJ. Suggested value: 2.5E4.		
1277	DTPNIN	Initial and minimum PINACLE time step. Suggested value: 2.E-5.	s	PN
1278	TIPNMX	PINACLE maximum time. Not currently used.	s	PN
1279	DTPNP	Full PINACLE printout every DTPNP seconds.	s	PN
1280	ASRALU	Aspect ratio of cylindrical chunks = 2R/L. Recommended value = 1.		LE
1281	UN1281	Not currently used.		
1282	UN1282	Not currently used.		
1283	UN1283	Not currently used.		
1284	RALUDI	Radius of chunks generated by pin disruption.		LE

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1285	RALUFZ	Radius of chunks generated by freezing and crust break-up. If set to zero the code provides default values based on local geometry. Recommended value: 0.		LE
1286	CINAPN	= 0, All the sodium vapor pressure is added to the local pressure. = 1, Only the excess of the sodium vapor pressure over the fission gas and fuel vapor pressure is added to the local pressure. Note: This variable is relevant only if INAPN (Block 1, location 49) is equal to 1.		PN
1287	CPCM	Chemical equilibrium coefficient of Pu at center-to-middle zone interface used in computing zone formation in U-Pu-Zr alloy fuel. Suggested value: 1.177.		SC
1288	CPMO	Chemical equilibrium coefficient of Pu at center-to-outer zone interface used in computing zone formation in U-Pu-Zr alloy fuel. Suggested value: 1.0723.		SC
1289	CZCM	Chemical equilibrium coefficient of Zr at center-to-middle zone interface. Suggested value: 9.79.		SC
1290	CZMO	Chemical equilibrium coefficient of Zr at center-to-outer zone interface. Suggested value: 7.84.		SC
1291	CUCM	Chemical equilibrium coefficient of U at center-to-middle zone interface. Suggested value: 0.448.		SC

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1292	CUMO	Chemical equilibrium coefficient of U at center-to-outer zone interface. Suggested value: 0.5866.		SC
1293	EPSMS	Criterion for zonal fuel mass convergence in computing zone formation in U-Pu-Zr alloy fuel. Suggested value: 1.0E-6	kg	SC
1294	EPSCOM	Criterion for the convergence of zonal weight fractions of Pu and Zr. Suggested value: 1.0E-3		SC
1295	CIPNTP	Controls the calculation of the fuel pin top boundary temperature, which is important in triggering the axial in-pin fuel relocation. = 0, Boundary temperature is equal to the temperature of the material in the node above the active fuel. = 1, The boundary temperature is the same as the temperature of the central top node of the active fuel. = 2, This option is available for metal fuel pins only. The in-pin fuel motion is triggered by a mechanistic model using 2-d temperature distributions for the top fuel node. (This option is not yet available for SAS4A Release 2.)		PN
1296	ROGSPI	Mass of fission gas generated in the fuel pin per unit volume of the original pin and percent burnup. Used to set the fission gas arrays only if DEFORM is not used (ISSFUE = 0).		
1297	PRSFTN	Partial pressure of dissolved gas, due to surface tension. This pressure is calculated as 2 x SIGMA/R. The recommended value for oxide fuel is 320 x 10**5 Pa. (SIGMA = 400 x 10^{-3} N/m, R = 250 x 10**-10 m).		DF, LE, PL, PN

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1298	COLFAC	Multiplier on the sodium density in the coolant reactivity calculation. Suggested value: 1.0.		
1299	GAMGAS	Cp/Cv for pin plenum gas, P*V**GAMGAS = constant for adiabatic changes. Typical values: 1.3 - 1.6.		
		METAL FUEL PROPERTIES DATA		
1300-1315	PUZRTP (L,IFUEL)	Metal fuel plutonium and zirconium weight fractions by fuel type (IFUEL). Used for IMETAL > 1. L=1, Plutonium weight fraction. L=2, Zirconium weight fraction.		
1316-1323	RHOZN (IFUEL)	Metal fuel theoretical density at the reference temperature (TR) by fuel type (IFUEL). Used for IMETAL > 1. If RHOZN = -1.0, then it is internally evaluated based on the input composition (PUZRTP). If RHOZN = 0.0, then the fuel type IFUEL does not use the IFR Handbook-interpolated U-Pu-Zr alloy fuel properties of input option IFUELM = 0.		
1324-1331	XLOGNA (IFUEL)	Metal fuel porosity fraction logged by bond sodium by fuel type (IFUEL). Used for IMETAL > 1.		
1332	XSIGMC	To account for uncertainties in IFR handbook data for U-Pu-Zr and U-Zr alloy fuel heat capacity, add |XSIGMC| standard deviations (subtract if XSIGMC is negative) to the best estimate.		

Block 13 — PMATCM — Fuel and Cladding Properties

Location	Symbol	Description	Units	Used By
1333	XSIGMK	To account for uncertainties in IFR handbook data for U-Pu-Zr and U-Zr alloy fuel thermal conductivity, add |XSIGMK| standard deviations (subtract if XSIGMK is negative) to the best estimate. The standard deviation depends on fuel burnup (See BURNFU).		
1334	XSIGMD	To account for uncertainties in IFR handbook data for U-Pu-Zr and U-Zr fuel theoretical density, add |XSIGMD| standard deviations (subtract if XSIGMD is negative) to the best estimate.		
1335-1394	APROPI			
1395-1725	DUMPMC	Not currently used.		

Block 14 — PRIMIN — Primary Loop Input Data

Location	Symbol	Description	Units	Used By
1	PX	Coolant exit pressure at ZPLENU.	Pa	BL P4
2	PDEC	Pump head decay constant. (See PDEC1 and PDEC2).	1/s	
3-4	PDEC1 PDEC2	Pump head decays as exp (-PDEC*t - PDEC1*t^2 - PDEC2*t^3).	$1/s^2$ $1/s^3$	
5-24	PRETAB (L)	Normalized inlet coolant driving pressure or coolant flow rate table as a function of PRETME. Used only if IPRION = 0. The inlet coolant driving pressure is the pressure difference between the subassembly inlet and outlet minus the gravity head across the subassembly. (See IFLOW).		BL
25-44	PRETME (L)	Time for PRETAB table.	s	BL
45-64	T0TAB (L)	Inlet temperature. (See NT0TAB).	K	BL
65-84	T0TME (L)	Time for T0TAB table.	s	BL
85	TNTRY	Re-entry temperature. Used only if PRIMAR-4 is not used.	K	BL
86	DPGRV0	The primary loop gravity head. If 0.0, DPGRV0 is calculated at steady-state. Used only if IPRION = 0.	Pa	
87	ZPLENL	Reference elevation for the coolant inlet plenum. Default = bottom of assembly in channel 1.	m	BL P4
88	ZPLENU	Reference elevation for the coolant outlet plenum. Default = top of assembly in channel 1.	m	BL P4

Block 14 — PRIMIN — Primary Loop Input Data

Location	Symbol	Description	Units	Used By
89	ZIHX	Location of the thermal center of the intermediate heat exchanger. Used if IPRION = 0 and DPGRV0 = 0.	m	
90	DZBCGL	Minimum distance above subassembly exit for bubble breakaway. Suggested value: 0.1.	m	P4
91	DZBCGU	Maximum distance above subassembly exit for bubble breakaway. Suggested value: 0.25. Note: When the top of the bubble is above DZBCGU or the bottom is above DZBCGL, the portion above DZBCGL is broken away.	m	P4
92	TIMDBG	Time when PRIMAR1 debug prints start.	s	
93	XMXMSI	Coolant mass per pin in the mixing volume at the subassembly inlet.	kg	
94	XMXMSO	Coolant mass per pin in the mixing volume at the subassembly outlet. If this quantity varies from channel to channel, then input the value for channel which boils first.	kg	
95	TIMMIX	Time constant for heat flow between inlet mixing volume and bulk inlet plenum temperature, also between outlet mixing volume and bulk outlet plenum temperature.	s	
96	THT2VL	Minimum degree of implicitness for flow calculations in PRIMAR-4 and TSCNV1.		P4
97-150	DUMPRI	Not currently used. **DEFAULT VALUES** XMXMSI = 0.002 XMXMSO = 0.002 TIMMIX = 1.00 Note: Variables marked P4 must be input when using PRIMAR-4. Other variables in this block are used for PRIMAR-1.		

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

See ANL/RAS 89/6, Appendix B.

Note: The first-encountered FINBOP is saved and may not be redefined by subsequent data. Within the block, the data must be presented as defined in ANL/RAS 89/6. This block must follow Block 6, IINBOP.

The input format for each record in Block 15 is:

(2I3,I6,5E12.5)

The first integer on the line identifies the type of component for which data are being entered. The numbers run as follows:

1	compressible volume
2	segment
3	element
4	pump
5	simple heater model
6	standard valve
7	check valve
8	flow boundary condition
9	volume boundary condition
10	steam generator
11	open heater
12	condenser
13	reheater
14	flashed heater
15	drain cooler
16	desuperheating heater
17	desuperheater/drain cooler
18	steam drum
19	turbine stage
20	nozzle
21	superheater
22	relief valve.

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

The second integer is the continuation card number, NCONTN. The third integer is the user's number for the component. The floating point data entries are explained below. The units for each entry are given in parentheses at the end of the entry description.

Volumes

(2I3,I6,5E12.5): **1**, **1**, user's no., VOLCVW, ZCVW, X, Y, Z

VOLCVW: volume of the compressible volume (m^3),

ZCVW: elevation of the midpoint of the volume (m)

X, Y, Z: chosen by the user to be one of the following combinations (the user must set flag NENTRF on fixed point volume card (1,1) to signal to the code which combination is used):

NENTRF = 1:
X = PRESW4,
Y = TCVW,
Z = null,

PRESW4 is the steady state volume pressure (Pa),
TCVW is the steady state volume temperature (K).

NENTRF = 2:
X = PRESW4,
Y = HCVW,
Z = null,

HCVW is the steady state volume specific enthalpy (J/kg).

NENTRF = 3:
X = PRESW4,
Y = XCVW,
Z = null,

XCVW is the quality in the volume.

NENTRF = 4:
X = TCVW,
Y = XCVW,
Z = null.

NENTRF = 5:
X = PRESW4,
Y = TPFACE,
Z = TAMBNT,

TPFACE is the two-phase level in the volume (m),
TAMBNT is the ambient temperature (K).

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

NENTRF = 6:
X = TCVW,
Y = TPFACE,
Z = TAMBNT.

Segments

(2I3,I6,5E12.5): **2**, **1**, user's no., FLOWSS, ZINW, CVMLTW(1) , CVMLTW(2)

FLOWSS: steady-state flow in the segment (kg/s)

ZINW: elevation of the segment inlet (m)

CVMLTW(1): multiplicity factor at the segment inlet

CVMLTW(2): multiplicity factor at the segment outlet

(See ANL/RAS 89/6, Section 8.4 for an explanation of multiplicity factors. If the nodalization does not use multiplicity factors to take advantage of symmetries in the plant, the multiplicity factors at the ends of all segments must be set to 1.0).

(2I3,I6,5E12.5): **2**, **2**, user's no., SEGTMP(2)

SEGTMP tube-side temperature at the outlet of the tube bundle if the segment passes through a heater. See ANL/RAS 89/10 for more details on this parameter (K).

Elements

(2I3,I6,5E12.5): **3**, **1**, user's no., ZOUTLW, XLENW, AREAW, DHW, G2PW

ZOUTLW: elevation of the element outlet (m),

XLENW: length of the element (m),

AREAW: element cross-sectional area (m^2),

DHW: element hydraulic diameter (m), and

G2PW: orifice coefficient (G2PW is normally set to zero in the input and is then computed by the code, as the orifice coefficient is usually difficult for the user to determine. The user must choose between entering the orifice coefficient or the element endpoint pressure PELEW (See element card (3,2)) for any element for which the outlet does not interface with a compressible volume. Usually, the pressure is much more readily available to use as input data; however, there may be cases in which a user wishes to enter orifice coefficients instead, and so this option has been made available at this point.). G2PW is dimensionless.

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

(2I3,I6,5E12.5): **3**, **2**, user's no., ROUGHW, BENDW, PELEW

ROUGHW: surface roughness of the element wall (this parameter is used in the expression for the Moody friction factor; see L. F. Moody, Mech. Eng., 69, p. 1005 (1947), for a detailed explanation of surface roughness) (m).

BENDW: number of bends in the element.

PELEW: element endpoint pressure. This quantity is entered only for elements for which the outlet does not interface with a compressible volume (Pa).

The remaining element cards are used exclusively by the detailed heater models; see ANL/RAS 89/10 for details about any of these parameters.

(2I3,I6,5E12.5): **3**, **3**, user's no., TBTHIK, TBRHO, TBCP, TBKPM0, ZLOWST

TBTHIK: tube thickness (m),

TBRHO: density of the tube material (kg/m^3),

TBCP: specific heat of the tube material (J/kg-K),

TBKPM0: thermal conductivity of the tube material (W/m-K),

ZLOWST: lowest elevation of the tube bundle within the heater volume (m).

(2I3,I6,5E12.5): **3**, **4**, user's no., TBNODE, TBNMBR

TBNODE: number of nodes for the heat transfer calculation in the element,

TBNMBR: total number of tubes in the bundle.

(2I3,I6,5E12.5): **3**, **5**, user's no. TBNDLW TBLNLW

TBNDLW: number of nodes for the section of the element within the drain,

TBLNLW: length of the section of the element within the drain (m).

(2I3,I6,5E12.5): **3**, **6**, user's no., TBNDUP, TBLNUP

TBNDUP: number of nodes for the section of the element within the desuperheating section,

TBLNUP: length of the section of the element within the desuperheating section (m).

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

Pumps

Rated values of the pump parameters:

(2I3,I6,5E12.5): **4**, **1**, user's no., HEADWR, PMPFWR, PMPSWR, PMWEFR, PMWINR

HEADWR: rated pump head (Pa),

PMPFWR: rated pump flow (kg/s),

PMPSWR: rated pump speed (rad/s),

PMWEFR: rated pump efficiency, and

PMWINR: rated pump inertia (kg-m^2).

These definitions apply to the two centrifugal pump models (pump types 1 and 2). If the pump is modeled through a table of user-specified pump head vs. time (pump type 0), only HEADWR need be entered; the other four variables are not applicable.

(2I3,I6,5E12.5): **4**, **2**, user's no., TRKLSW

TRKLSW: windage (the torque coefficient for shaft friction).

This variable applies only to the two centrifugal pump models.

(2I3,I6,5E12.5): **4**, **3**, user's no., APMWHD(1-5)

APMWHD: contains the first five pump head coefficients in the case of the two centrifugal pump models and contains the first half of a table of normalized pump head in the case of user-specified pump head vs. time (pump type 0) or normalized pump head vs. normalized flow (to be used when the locked rotor option -2 has been invoked).

(2I3,I6,5E12.5): **4**, **4**, user's no., APMWHD(6-10)

APMWHD: contains the last five pump head coefficients in the case of the two centrifugal pump models and contains the continuation of a table of normalized pump head in the case of pump type 0 or locked rotor option -2.

(2I3,I6,5E12.5): **4**, **5**, user's no., APMWHD(11-15)

APMWHD: contains the first five pump torque coefficients in the case of the two centrifugal pump models and contains the continuation of the table of normalized pump head in the case of pump type 0 or locked rotor option -2.

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

(2I3,I6,5E12.5): **4**, **6**, user's no., APMWHD(16-20)

APMWHD: contains the last five pump torque coefficients in the case of the two centrifugal pump models and contains the end of the table of normalized pump head in the case of pump type 0 or locked rotor option -2.

(2I3,I6,5E12.5): **4**, **7**, user's no., WMOTTK(1-5)

WMOTTK: contains the first five entries in the motor torque table in the case of the two centrifugal pump models, the first five time entries for the relative pump head table in the case of pump type 0 (s), and the first five normalized flow entries in the case of locked rotor option -2.

(2I3,I6,5E12.5): **4**, **8**, user's no., WMOTTK(6-10)

WMOTTK: contains the last five entries in the motor torque table in the case of the two centrifugal pump models, the continuation of the time table in the case of pump type 0 (s), and the continuation of the normalized flow table in the case of locked rotor option -2.

(2I3,I6,5E12.5): **4**, **9**, user's no., WMOTTK(11-15)

WMOTTK: contains the first five entries in the table of times for the motor torque table in the case of the centrifugal pump models; the continuation of the time table in the case of pump type 0 (s); and the continuation of the normalized flow table in the case of locked rotor option -2.

(2I3,I6,5E12.5): **4**, **10**, user's no., WMOTTK(16-20)

WMOTTK: contains the last five entries in the table of times for the motor torque table in the case of the centrifugal pump models; the end of the time table in the case of pump type 0 (s); and the end of the normalized flow table in the case of locked rotor option -2.

Simple Heater Model

(2I3,I6,5E12.5): **5**, **1**, user's no., APRMHT, AXPMHT, DHPMHT, TSECHT

APRMHT: heat transfer area between the primary and secondary sides (m^2),

AXPMHT: primary side flow area (m^2),

DHPMHT: primary side hydraulic diameter (m), and

TSECHT: secondary side temperature (K).

The user's number for the heater is not the compressible volume number but rather the number entered in array NQFLG.

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

Standard Valve

(2I3,I6,5E12.5): **6**, **1**, user's no., VLVMSW, VDAMPW, VSPRGW, VSTEMW, VCONSW

VLVMSW: valve mass (kg),

VDAMPW: valve damping coefficient (kg-m/s),

VSPRGW: valve spring constant (kg/s^2),

VSTEMW: initial valve stem position (m)

VCONSW: constant of proportionality between the stem position and the valve characteristic.

(2I3,I6,5E12.5): **6**, **2**, user's no., VPHIW(1-5)

(2I3,I6,5E12.5): **6**, **3**, user's no., VPHIW(6-10)

VPHIW: valve coefficient table.

(2I3,I6,5E12.5): **6**, **4**, user's no., VPOSW(1-5)

(2I3,I6,5E12.5): **6**, **5**, user's no., VPOSW(6-10)

VPOSW: is the valve stem position table (m).

(2I3,I6,5E12.5): **6**, **6**, user's no., VTABDW(1-5)

(2I3,I6,5E12.5): **6**, **7**, user's no., VTABDW(6-10)

VTABDW: table of valve driver function (kg-m/s^2).

(2I3,I6,5E12.5): **6**, **8**, user's no., VTIMW(1-5)

(2I3,I6,5E12.5): **6**, **9**, user's no., VTIMW(6-10)

VTIMW: table of time corresponding to VTABDW (s).

Check Valve

(2I3,I6,5E12.5): **7**, **1**, user's no., CHPHIW, CHEPS1, CHEPS2

CHPHIW: valve characteristic when the valve is fully open,

CHEPS1: criterion for starting to close an open valve (Pa or kg/s, depending on whether the user has chosen to initiate valve closure on a pressure drop criterion or a flow criterion),

CHEPS2: criterion for starting to open a closed valve (Pa or kg/s, depending on whether the user has chosen to initiate valve opening on a pressure drop criterion or a flow criterion).

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

(2I3,I6,5E12.5): **7**, **2**, user's no., CVPHIC(1-5)

CVPHIC: normalized valve coefficient table for a valve which is closing.

(2I3,I6,5E12.5): **7**, **3**, user's no., CVPHIC(6-10)

(2I3,I6,5E12.5): **7**, **4**, user's no., CVTIMC(1-5)

CVTIMC: array of time entries corresponding to CVPHIC (s).

(2I3,I6,5E12.5): **7**, **5**, user's no., CVTIMC(6-10)

(2I3,I6,5E12.5): **7**, **6**, user's no., CVPHIO(1-5)

CVPHIO: normalized valve coefficient table for a valve which is opening.

(2I3,I6,5E12.5): **7**, **7**, user's no., CVPHIO(6-10)

(2I3,I6,5E12.5): 7, **8**, user's no., CVTIMO(1-5)

CVTIMO: array of time entries corresponding to CVPHIO (s).

(2I3,I6,5E12.5): **7**, **9**, user's no., CVTIMO(6-10)

Flow Boundary Condition

(2I3,I6,5E12.5): **8**, **1**, table no., entry no., TABSEG(1), TABSEG(2), X, Y

where the entry number indicates which entry is being made in this flow boundary condition table,

TABSEG(1): time (s),

TABSEG(2): absolute (not normalized) flow (kg/s),

X, Y: any of the following combinations for an inflow boundary condition (the flag NFLSEG on fixed point volume card (1,1) designates which combination is chosen):

NFSLEG = 0:
X = specific enthalpy (J/kg),
Y = 0,

NFLSEG = 1:
X = temperature (K),
Y = pressure (Pa) for a subcooled liquid boundary condition,

NFLSEG = 2:
X = temperature (K),
Y = pressure (Pa) for a superheated vapor boundary condition,

NFLSEG = 3:
X = quality,
Y = pressure (Pa),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

NFLSEG = 4:
X = quality,
Y = temperature (K).

X and Y are not required for an outflow boundary condition.

Volume Boundary Condition Card

(2I3,I6,5E12.5): **9**, **1**, table no., entry no., TABVOL(1), X, Y

where the entry number indicates which entry is being made in this flow boundary condition table.

TABVOL(1): time (s),

X, Y: any of the following combinations (the flag NTABVL on volume boundary condition card (6,1) designates which combination is chosen):

NTABVL = 1:
X = pressure (Pa),
Y = specific enthalpy (J/kg) for a subcooled liquid volume,

NTABVL = 2:
X = pressure (Pa),
Y = temperature (K) for a subcooled liquid volume,

NTABVL = 3:
X = pressure (Pa),
Y = specific enthalpy (J/kg) for a superheated vapor volume,

NTABVL = 4:
X = pressure (Pa),
Y = temperature (K) for a superheated vapor volume,

NTABVL = 5:
X = pressure (Pa),
Y = quality,

NTABVL = 6:
X = temperature (K),
Y = quality.

Steam Generator

(2I3,I6,5E12.5): **10**, **1**, steam gen. number, DEWI, ZONLE(1), ZONLE(3), XKTUBE, COILD

DEWI: booster tube outer diameter (m),

ZONLE(1): initial subcooled zone length (m),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

ZONLE(3): initial superheated zone length (m),

XKTUBE: tube thermal conductivity (W/m-K), and

COILD: average diameter of the coil in the helical coil geometry option for the evaporator/steam generator model.

(2I3,I6,5E12.5): **10**, **2**, steam gen. number, HTFI(1), HTFI(2), HTFI(3), HTFI(4), VRISE

HTFI(I): calibration factors for heat transfer coefficients for each regime,

VRISE: vertical rise per length of helical tube in the helical coil geometry option for the evaporator/steam generator model.

(2I3,I6,5E12.5): **10**, **3**, steam gen. number, ROCPTB, FOULRI(1), FOULRI(2), FOULRI(3) FOULRI(4)

ROCPTB: reserved,

FOULRI(I): fouling heat resistances on the water side for each heat transfer regime.

(2I3,I6,5E12.5): **10**, **4**, steam gen. number, PICHT, PICHL

PICHT: transverse pitch of the helical tubes in the helical coil geometry option for the evaporator/steam generator model,

PICHL: longitudinal pitch of the helical tubes in the helical coil geometry option for the evaporator/steam generator model.

(See Block 18, #3934-4173 for the remainder of the steam generator input).

Deaerator

(2I3,I6,5E12.5): **11**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m).

Condenser

(2I3,I6,5E12.5): **12**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m),

CSAREA: effective cross-sectional area of the heater (m^2),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

DHSHW: hydraulic diameter of the shell side of the heater (m).

(2I3,I6,5E12.5): **12**, **2**, user's volume number, SHHTCC

SHHTCC: shell side condensation coefficient (W/m-K).

Reheater

(2I3,I6,5E12.5): **13**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m),

CSAREA: effective cross-sectional area of the heater (m^2)

DHSHW: hydraulic diameter of the shell side of the heater (m).

(2I3,I6,5E12.5): **13**, **2**, user's volume number SHHTCC

SHHTCC: shell side condensation coefficient (W/m-K).

Flashed Heater

(2I3,I6,5E12.5): **14**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW, ,

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m),

CSAREA: effective cross-sectional area of the heater (m^2),

DHSHW: hydraulic diameter of the shell side of the heater (m).

(2I3,I6,5E12.5): **14**, **2**, user's volume number, SHHTCC

SHHTCC: shell side condensation coefficient (W/m-K),

Drain Cooler

(2I3,I6,5E12.5): **15**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m),

CSAREA: effective cross-sectional area of the heater (m^2),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

DHSHW: hydraulic diameter of the shell side of the heater (m).

(2I3,I6,5E12.5): **15**, **2**, user's volume number, SHHTCC, HIGHLW, XLENLW

SHHTCC: shell side condensation coefficient (W/m-K),

HIGHLW: height of the drain (m),

XLENLW: length of the drain (m).

(2I3,I6,5E12.5): **15**, **3**, user's volume number, ORIFLW, TEMPLW, VOLLW, CSARLW, DHLWW, , ,

ORIFLW: elevation of the drain orifice (m),

TEMPLW: drain temperature (K),

VOLLW: drain volume (m^3),

CSARLW: effective cross-sectional area of the drain (m^2),

DHLWW: hydraulic diameter of the drain (m).

Desuperheating Heater

(2I3,I6,5E12.5): **16**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m),

CSAREA: effective cross-sectional area of the heater (m^2),

DHSHW: hydraulic diameter of the shell side of the heater (m).

(2I3,I6,5E12.5): **16**, **2**, user's volume number, SHHTCC, HIGHUP, XLENUP

SHHTCC: shell side condensation coefficient (W/m-K),

HIGHUP: height of the desuperheating region (m),

XLENUP: length of the desuperheating region (m).

(2I3,I6,5E12.5): **16**, **3**, user's volume number, ORIFUP, TEMPUP, VOLUP, CSARUP, DHUPW

ORIFUP: elevation of the desuperheating region orifice (m),

TEMPUP: desuperheating region temperature (K),

VOLUP: desuperheating region volume (m^3),

CSARUP: effective cross-sectional area of the desuperheating region (m^2),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

DHUPW: hydraulic diameter of the desuperheating region (m).

Desuperheater/Drain Cooler

(2I3,I6,5E12.5): **17**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD, CSAREA, DHSHW, ,

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m).

CSAREA: effective cross-sectional area of the heater (m^2),

DHSHW: hydraulic diameter of the shell side of the heater (m),

(2I3,I6,5E12.5): **17**, **2**, user's volume number, SHHTCC, HIGHLW, XLENLW, HIGHUP, XLENUP

SHHTCC: shell side condensation coefficient (W/m-K),

HIGHLW: height of the drain (m),

XLENLW: length of the drain (m),

HIGHUP: height of the desuperheating region (m),

XLENUP: length of the desuperheating region (m).

(2I3,I6,5E12.5): **17**, **3**, user's volume number, ORIFLW, TEMPLW, VOLLW, CSARLW, DHLWW

ORIFLW: elevation of the drain orifice (m),

TEMPLW: drain temperature (K),

VOLLW: drain volume (m^3),

CSARLW: effective cross-sectional area of the drain (m^2)

DHLWW: hydraulic diameter of the drain (m).

(2I3,I6,5E12.5): **17**, **4**, user's volume number, ORIFUP, TEMPUP, VOLUP, CSARUP, DHUPW, , ,

ORIFUP: elevation of the drain orifice (m),

TEMPUP: drain temperature (K),

VOLUP: drain volume (m^3),

CSARUP: effective cross-sectional area of the drain, (m^2),

DHUPW: hydraulic diameter of the drain (m).

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

Steam Drum

(2I3,I6,5E12.5): **18**, **1**, user's volume number, QRATIO, HTRELV, HTRRAD

QRATIO: percentage of incoming energy lost due to imperfect insulation,

HTRELV: elevation of the lowest point of the heater (m),

HTRRAD: heater radius (m).

Turbine Stage

(2I3,I6,5E12.5): **19**, **1**, user's volume number, RROTER, (flag for last stage), TRGRMI, OMEGAR

RROTOR: rotor radius (m),

(flag for last stage) is a flag which is zero unless this volume is the last stage of the turbine; for the last stage of the turbine, the user must enter any positive number for this flag.

TRGRMI: turbine/generator rotor moment of inertia (kg-m^2),

OMEGAR: rotor angular velocity (rad/s).

Nozzle

(2I3,I6,5E12.5): **20**, **1**, user's segment number, CNNZCF, CRRXCF, CBBKCF, ALFANZ, GAMABL

CNNZCF: nozzle velocity coefficient,

CRRXCF: reactor coefficient,

CBBKCF: bucket coefficient,

ALFANZ: nozzle angle, the angle at which steam enters the turbine blade system (rad),

GAMABL: blade exit angle, the angle at which steam leaves the turbine blade system (rad).

(2I3,I6,5E12.5): **20**, **2**, user's segment number, CONSK1 CONSK2 CONSK3 XRXFR

CONSK1: rotation loss coefficient,

CONSK2: moisture loss coefficient,

CONSK3: exhaust loss coefficient,

XRXFR: reactor fraction, the fraction of stage energy released in the bucket system.

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

Superheater

(2I3,I6,5E12.5): **21**, **1**, user's number, DEWOS, DEWIS, DOUTS, DHNAS, ARNAS

DEWOS: steam tube inner diameter (m),

DEWIS: booster tube outer diameter (m),

DOUTS: steam tube outer diameter (m),

DHNAS: sodium hydraulic diameter per tube (m),

ARNAS: sodium flow area per tube (m^2).

(2I3,I6,5E12.5): **21**, **2**, user's number, TUBNOS, TBPODS, XKTUBS, COILDS, VRISES

TUBNOS: number of superheater tubes,

TBPODS: superheater bundle pitch-to-diameter ratio,

XKTUBS is reserved,

COILDS: average diameter of the coil for the helical coil geometry option in the superheater model,

VRISES: vertical rise per length of helical tube in the helical coil geometry option in the superheater model.

(2I3,I6,5E12.5): **21**, **3**, user's number, FOULSI, PICHTS, PICHLS

FOULSI: fouling heat resistance on the water side,

PICHTS: transverse pitch of the helical tube in the helical coil geometry option for the superheater model,

PICHLS: longitudinal pitch of the helical tube in the helical coil geometry option for the superheater model.

Relief Valve

(2I3,I6,5E12.5): **22**, **1**, user's relief valve number, RVA, DPBLD, DPSET, DPACC, RVFRAC

RVA: fractional valve area to which the valve opens when the set pressure drop is reached,

DPBLD: blowdown pressure drop, at which a partially open relief valve shuts (Pa),

DPSET: set pressure drop, at which a closed relief valve starts to open (Pa),

Block 15 — FINBOP — Balance-of-Plant Floating-Point Input

DPACC: accumulated pressure drop, at which the valve is completely open (Pa),

RVFRAC: fractional valve opening area (0 for a fully closed valve, 1 for a fully open valve).

(2I3,I6,5E12.5): **22**, **2**, user's relief valve number, PCVI, PCVO, HCVI, FLOWLS, TIMERV

PCVI: initial pressure upstream of the valve (Pa),

PCVO: initial pressure downstream of the valve (Pa),

HCVI: initial enthalpy upstream of the valve (J/kg),

FLOWLS: valve capacity at the accumulated pressure drop (kg/s),

TIMERV: delay time for opening or closing the valve; the delay time allows the code to avoid numerical problems with the discontinuities in the fractional valve opening area in the valve hysteresis curve of opening area versus valve pressure drop (s).

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
1	TMDBP4	Time when IDBPR4 is set to IDBP4N. (See Block 3, locations 507 and 508).	s	
2-41	FLOSSL (ISGL)	Initial flow rate in liquid flow segments. The value input for the single segment representing all SAS4A channels (except the bypass channel) is not used.	kg/s	
42-81	ZINL (ISGL)	Height of inlet to liquid segment.	m	
82-161	CVLMLT (M,ISGL)	Multiplicity factors at liquid segment ends. M=1 at inlet, M=2 at outlet.		
162-301	ZOUTEL (IELL)	Height at outlet of the liquid element. Note: ZOUTEL(IELL) is also the height at the inlet of element IELL+1 if IELL+1 is in the same segment.	m	
302-441	XLENEL (IELL)	Length of element. (See comment for all SAS4A channels in locations 2-41).	m	
442-581	AREAEL (IELL)	Cross-sectional flow area of liquid elements. (See comment for all SAS4A channels in Locs. 2–41).	m^2	
582-721	DHELEM (IELL)	Hydraulic diameter of liquid element.	m	
722-861	ROUGHL (IELL)	Pipe surface roughness, for friction factor.	m	
862-1001	BENDM (IELL)	Number of bends in each liquid element.		
1002-1141	G2PRDR (IELL)	Initial orifice coefficient. G^2 pressure-drop coefficient. ΔP=G2PRDR*G*ABS(G)/(2.*RHO).		
1142	BNDLOD	Effective L/D per bend.		
1143-1282	WALLMC (IELL)	Pipe wall mass * heat capacity /length.	J/m-K	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
1283-1422	WALLH (IELL)	Pipe wall heat-transfer coefficient.	W/m^2-K	
1423-1460	VOLLGC (ICV)	Total volume of the compressible volume, liquid + gas.	m^3	
1461-1498	PRESG0 (ICV)	Initial gas pressure in the compressible volume having gas.	Pa	
1499-1536	ALPHAP (ICV)	Volume pressure expansion coefficient, (1/V)dV/dP, for the compressible volume.	1/Pa	
1537-1574	ALPHAT (ICV)	Volume thermal expansion coefficient, (1/V)dV/dT, for the compressible volume.	1/K	
1575-1612	ZCVL (ICV)	Reference height for liquid pressure in the compressible volume.	m	
1613-1650	AREAIN (ICV)	Area of liquid-gas interface in the compressible volume. Input 1.0 if there is no interface.	m^2	
1651-1688	TREFCV (ICV)	Initial steady-state gas temperature if gas is present. Steady-state gas temperature = liquid temperature if input as 0. Not used for a liquid-only compressible volume.	K	
1689	GAMGSC	Cp/Cv for cover gas (P*V)^{GAMGSC} = constant. Used for all compressible volumes containing cover gas.		
1690	RGASC	Gas constant for cover gas, P * V = M * RGASC * T. Used for all compressible volumes containing cover gas. R = 8314/molecular weight. R = 2078. for He. R = 208.1 for Argon.	Pa-m^3/kg-K	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
1691	U0CVGS	Viscosity of cover gas at reference temperature TRFU (See location 1692). Suggested value: 1.94×10^{-5} at 293 K for He 2.22×10^{-5} at 293 K for Argon	Pa	
1692	TRFU	Reference temperature for gas viscosity.	K	
1693-1720	XLENGG (ISGG)	Length of gas segment.	m	
1721-1748	AREASG (ISGG)	Area.	m^2	
1749-1804	CVGMLT (M,ISGG)	Multiplicity factors at gas segment ends. M=1 at inlet, 2 at outlet. Inlet and outlet the same as for JCVG(M,ISGG).		
1805-1832	DHSEGG (ISGG)	Hydraulic diameter.	m	
1833-1860	ROUGHG (ISGG)	Surface roughness.	m	
1861-1898	TAUGAS (ICV)	Cover-gas temperature time constant.	s	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By

PUMP OPTIONS

IEMPMP	ILRPMP	Pump Option
Any	-2	User-specified normalized pump head vs. normalized flow.
-1	Any ≠ -2	E-M pump.
0	Any ≠ -2	Table look-up, user specified normalized pump head vs. time.
1	-1	Centrifugal pump option 1, user-specified normalized pump speed vs. time.
1	0	Centrifugal pump option 1, user-specified normalized motor torque vs. time.
1	1	Centrifugal pump option 1, locked rotor (pump speed = 0).
2	-1	Centrifugal pump option 2, ANL pump model, user-specified normalized pump speed vs. time.
2	0	Centrifugal pump option 2, ANL pump model, user-specified normalized motor torque vs. time.
2	1	Centrifugal pump optioin 2, ANL pump model, locked rotor (pump speed = 0).
3	Any ≠ -2	EBR-II pump model Note: See Block 3, locations 418-469, for IEMPMP and ILRPMP.

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		USER-SPECIFIED PUMP HEAD VS TIME (IEMPMP(IPMP) = 0)		
1899-1910		Not used.		
1911-1922	HEADR (IPMP)	Pump head at t = 0, computed by the code unless steady-state flow = 0.	Pa	
1923-1982		Not used.		
1983-2222	APMPHD (J,IPMP)	Table of relative pump head. Dimension (20, 12).		
2223-2462	AMOTTK (J,IPMP)	Times for pump head table. Dimension (20, 12).	s	
		CENTRIFUGAL PUMP (IEMPMP(IPMP) = 1)		
1899-1910	PMPINR (IPMP)	Moment of inertia, pump and motor.	kg-m^2	
1911-1922	HEADR (IPMP)	Rated pump head.	Pa	
1923-1934	PMPSPR (IPMP)	Rated pump speed.	Rad/s	
1935-1946	PMPFLR (IPMP)	Rated pump flow.	kg/s	
1947-1958	PMPEFR (IPMP)	Rated pump efficiency.		
1959-1970	TRKLSC (IPMP)	Torque coefficient for shaft friction, windage.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
1971-1982	EPSCAV (IPMP)	Cavitation coefficient = ANPSH/HEAD for cavitation, rated value.		
1983-2222	APMPHD (IPMP)	Pump head coefficients, J = 1 to 10, and pump torque coefficients, J = 11 to 20.		
2223-2462	AMOTTK (IPMP)	Motor torque table, J = 1 to 10, and times for motor torque table, J = 11 to 20.	s	
		HOMOLOGOUS PUMP MODEL (IEMPMP(IPMP) = 2)		
1899-1910	PMPINR (IPMP)	Moment of inertia, pump and motor.	kg-m^2	
1911-1922	HEADR (IPMP)	Rated pump head.	Pa	
1923-1934	PMPSPR (IPMP)	Rated pump speed.	Rad /s	
1935-1946	PMPFLR (IPMP)	Rated pump flow.	kg/s	
1947-1958	PMPEFR (IPMP)	Rated pump efficiency.		
1959-1970	TRKLSC (IPMP)	Torque coefficient for shaft friction, windage.		
1971-1982	EPSCAV (IPMP)	Cavitation coefficient = ANPSH/HEAD for cavitation, rated value.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description		Units	Used By
1983-2222	APMPHD (K,IPMP)	K	Comments		
		1-3	Torque loss coefficients A(K), low range for APMPHD(10,IPMP) ≥ SB Friction torque = $A(1)+A(2)*SB+A(3)*SB^2$ SB = normalized pump speed.		
		4-6	Torque loss coefficients, middle range for APMPHD(11,IPMP) ≥ SB > APMPHD(10,IPMP)		
		7-9	Torque loss coefficients, high range for SB > APMPHD(11,IPMP)		
		10-11	Limits of torque loss ranges.		
		12	Locked rotor loss coefficient.		
		13	Transition WB, normalized flow for transition from turbulent to laminar pump head.		
		14-17	Not used.		
		18	Pump curve number (1-3).		
		19	WB for locked rotor.		
		20	SB for locked rotor. ILRPMP(IPMP) is set to 1 if WB < APMPHD(19,IPMP) and SB < APMPHD(20,IPMP).		
2223-2462	AMOTTK (K,IPMP)	Normalized motor torque table, K = 1 to 10, and times for motor torque table, K = 11 to 20. Note: See also Blk. 3, loc. 418-469 and 990, and Blk. 18, loc. 3657-3800.			

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		EBR-II PUMP MODEL		
		(IEMPMP(IPMP) = 3)		
1983-2222	APMPHD (J,IPMP)	Pump head coefficients. Same input format as for the homologous pump model.		
2223-2462	AMOTTK	Table of normalized pump speed, j = 1 to 10, and times for pump speed, j = 11 to 20. Note: For an initial steady-state run, the normalization of the speeds in the AMOTTK table does not matter; the code renormalizes the table so that the speeds are relative to the rated speed (PMPSPR). If AMOTTK is input for a restart, then it must be normalized to the rated speed.		
		ELECTROMAGNETIC PUMP		
		(IEMPMP(IPMP) = −1)		
		Pump Head = Stall Head(t) $\times\left[1-\left(\frac{\text{Flow}}{\text{Synchronous Flow}}\right)^{B}\right]$		
1899-1910		Not used.		
1911-1922	HEADR (IPMP)	Stall head at $t = 0$, computed by the code if steady-state flow is not zero.		
1923-1934		Not used.		
1935-1946	PMPFLR (IPMP)	1/Synchronous velocity.	s/m	
1947-1958	PMPEFR (IPMP)	Coefficient B. Suggested value: 1.30.		
1959-1982		Not used.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
1983-2222	APMPHD (J,IPMP)	Table of normalized stall head.		
2223-2462	AMOTTK (J,IPMP)	Times for APMPHD table.	s	
		NORMALIZED PUMP HEAD VS. NORMALIZED FLOW (ILRPMP(IPMP) = −2)		
1899-1982		Not used.		
1983-2222	APMPHD (J,IPMP)	Table of normalized pump head.		
2223-2462	AMOTTK (J,IPMP)	Normalized flow for the APMPHD table.		
2463	GRAVTY	Acceleration of gravity. Code uses 9.80.	m/s^2	
2464-2501	BTAPNA (ICV)	Na isothermal compressibility for the compressible volume, (1/RHO) d RHO/dP, at the reference temperature TREFCV. Suggested value: 2.13E-10 at 720 K.	1/Pa	
2502-2539	BTATNA (ICV)	Na thermal expansion coefficient, (1/RHO) d RHO/dT, at the reference temperature TREFCV. Default: -2.8E-4, corresponds to 720 K.	1/K	
2540-2577	RHONAR (ICV)	Reference density of Na at TREFCV. Default: 844. Not currently used.	kg/m^3	
2578-2615	HWALL (ICV)	Wall-coolant heat-transfer coefficient for the compressible volume.	W/m^2-K	
2616-2653	AWALL (ICV)	Wall surface area for the compressible volume.	m^2	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
2654-2691	CMWALL (ICV)	Mass x specific heat for the wall of the compressible volume.	J/K	
2692	VOLMIX	Not currently used.		
2693	TAUUP	Not currently used.		
2694	C1BY	Coefficient in Lyon-Martinelli convective heat-transfer correlation for bypass channel. First coefficient set. (See Block 64 locations 3-5, Block 18 locations 4300-4308, Block 3 locations 1193-1208).		
2695	C2BY	See location 2694.		
2696	C3BY	See location 2694.		
2697-2704	XKALBY (IBYP)	Thermal conductivity of bypass wall A, lower part. 1 ≤ IBYP ≤ NBYP, (NBYP is input in Block 3 location 813).	W/m-K	
2705-2712	XKAUBY (IBYP)	Thermal conductivity of bypass wall A, upper part.	W/m-K	
2713-2720	XKBLBY (IBYP)	Thermal conductivity of bypass wall B, lower part.	W/m-K	
2721-2728	XKBUBY (IBYP)	Thermal conductivity of bypass wall B, upper part.	W/m-K	
2729-2736	XKDBY (IBYP)	Thermal conductivity of bypass wall D.	W/m-K	
2737-2744	DABY (IBYP)	Thickness of bypass wall A.	m	
2745-2752	DBBY (IBYP)	Thickness of bypass wall B.	m	
2753-2760	DDBY (IBYP)	Thickness of bypass wall D.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
2761-2768	RCALBY (IBYP)	Density * specific heat of bypass wall A, lower part.	J/m^3-K	
2769-2776	RCAUBY (IBYP)	Density * specific heat of bypass wall A, upper part.	J/m^3-K	
2777-2784	RCBLBY (IBYP)	Density * specific heat of bypass wall B, lower part.	J/m^3-K	
2785-2792	RCBUBY (IBYP)	Density * specific heat of bypass wall B, upper part.	J/m^3-K	
2793-2800	RCDBY (IBYP)	Density * specific heat of bypass wall D.	J/m^3-K	
2801-2856	PSHPBY (J,IBYP)	Power shape by nodes for each bypass channel. Dimension (7,8). Code normalizes distribution. For the number of nodes, see Block 3, locations 513-612.		
2857-2880	GAMNBY (IREG, IBYP)	Fraction of total reactor power by region for each bypass channel. If there are no nodes in region 2, then set GAMNBY(2,IBYP) to 0. Dimension (3,8). Note: See FRPR, location 69 in Block 12. Sum over all of the three regions of all the NBYP bypass channels of the array elements of GAMNBY = 1 - FRPR.		
2881-2904	GAMDBY (IREG, IBYP)	Fraction of decay power by region for each bypass channel. Set to 0. The code adds GAMNBY to GAMDBY for the total power fraction. Dimension (3,8).		
2905-2912	PRFRA1 (IBYP)	The fraction of the reactor power distributed in reflector A in region 1 of the bypass channel.		
2913-2920	PRFRA2 (IBYP)	The fraction of the reactor power distributed in reflector A in region 2 of the bypass channel.		
2921-2928	PERABY (IBYP)	Perimeter of wall B in bypass channel.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
2929-2936	PERDBY (IBYP)	Perimeter of wall D in bypass channel.	m	
2937-3104	DTMPTB (K,ITAB)	Table of normalized temperature drop for an IHX (See IHXCLC) or steam generator. (See ISGCLC). Table of IHX primary side outlet temperature or heat rejection (See IHXCLC). Table of valve pressure drop coefficient (See ITABVV). Table for DRACS (See IDRCLC). Dimension(14,12).		
3105-3272	ZCENTR (K,ITAB)	Height of thermal center for TABLE(ITAB) for an IHX or steam generator.	m	
3273-3440	TMPMTB (K,ITAB)	Times for DTMPTB and ZCENTR.	s	
3441-3444	DTEVPF (IIHX)	Fraction of total steam generator Na temperature drop in evaporator for the intermediate loop connected to IHX(IIHX). Will be reset to 0.7 if equal to 0. or 1. Suggested value: 0.9999 for table lookup option.		
3445-3448	PRSIHX (IIHX)	Steady-state intermediate side IHX inlet pressure.	Pa	
3449-3452	PRSDRC (IDRC)	Steady-state intermediate side DRACS inlet pressure. Not yet operational.	Pa	
3453	PINMIN	Minimum subassembly inlet pressure. Default: 10000.	Pa	
3454	DMP4I1	Not currently used.		
3455-3515	DZSHPX (IDZIHX)	Fractional axial node heights in IHX.	m	
3516-3519	PERSPX (IIHX)	Perimeter between shell and shell side coolant in IHX.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
3520-3523	PERSPD (IDRX)	Perimeter between shell and shell side coolant in DRACS Not yet operational.	m	
3524-3527	PERPTX (IIHX)	Perimeter between shell side coolant and tube in IHX.	m	
3528-3531	PERPTD (IDRX)	Perimeter between shell side coolant and tube in DRACS. Not yet operational.	m	
3532-3535	PERTIX (IIHX)	Perimeter between tube and tube side coolant in IHX.	m	
3536-3539	PERTID (IDRX)	Perimeter between tube and tube side coolant in DRACS. Not yet operational.	m	
3540-3543	DSHIHX (IIHX)	Shell thickness in IHX.	m	
3544-3547	DSHDRC (IDRX)	Shell thickness in DRACS. Not yet operational.	m	
3548-3551	DTUIHX (IIHX)	Tube thickness in IHX.	m	
3552-3555	DTUDRC (IDRX)	Tube thickness in DRACS. Not yet operational.	m	
3556-3559	RCSHHX (IIHX)	Density * specific heat of shell in IHX.	J/m^3-K	
3560-3563	RCSHDR (IDRX)	Density * specific heat of shell in DRACS. Not yet operational.	J/m^3-K	
3564-3567	RDTUHX (IIHX)	Density * specific heat of tube in IHX.	J/m^3-K	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
3568-3571	RCTUDR (IDRX)	Density * specific heat of tube in DRACS. Not yet operational.	J/m^3-K	
3572-3575	XKSHHX (IIHX)	Thermal conductance of shell in IHX.	W/m-K	
3576-3579	XKSHDR (IDRX)	Thermal conductance of shell in DRACS. Not yet operational.	W/m-K	
3580-3583	XKTUHX (IIHX)	Thermal conductance of tube in IHX.	W/m-K	
3584-3587	XKTUDR (IDRX)	Thermal conductance of tube in DRACS. Not yet operational.	W/m-K	
3588-3591	HFPIHX (IIHX)	Fouling heat-transfer coefficient for shell side flow in IHX.	W/m^2-K	
3592-3595	HFPDRC (IDRX)	Fouling heat-transfer coefficient for shell side flow in DRACS. Not yet operational.	W/m^2-K	
3596-3599	HFIIHX (IIHX)	Fouling heat-transfer coefficient for tube side flow in IHX.	W/m^2-K	
3600-3603	HFIDRC (IDRX)	Fouling heat-transfer coefficient for tube side flow in DRACS. Not yet operational.	W/m^2-K	
3604-3607	SLANTX (IIHX)	Slant-height factor for IHX, tubeside.		
3608-3611	SLANTD (IDRX)	Slant-height factor for DRACS, tubeside.		
3612-3649	VOLSG0 (ICV)	Initial gas volume. Used only for ITYPCV(ICV) = 6,7,8,9,10.	m^3	
3650	C1PIPE	Conductance coefficient for pipe. Recommended value: 0.025.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
3651	C2PIPE	Conductance coefficient for pipe. Recommended value: 0.8.		
3652	C3PIPE	Conductance coefficient for pipe. Recommended value: 4.8.		
3653	C1IHX	Conductance coefficient for IHX, shell side. Also for tube side if both are same; if tube side different, enter tube side value in location 4309 (Intermediate heat exchanger). Recommended value: 0.025.		
3654	C2IHX	Conductance coefficient for IHX, shell side. Also for tube side if both are same; if tube side different, enter tube side value in location 4310 (Intermediate heat exchanger). Recommended value: 0.8.		
3655	C3IHX	Conductance coefficient for IHX, shell side. Also for tube side if both are same; if tube side different, enter tube side value in location 4311 (Intermediate heat exchanger). Recommended value: 4.8.		
3656	ACHOPL	Not currently used.		
3657-3719	PMPHD	Pump head coefficients for range J for pump type (specific speed) K. Used only if IEMPMP=2. Dimensions (7,3,3).		
3720-3800	PMPTQ	Pump torque coefficients for range J for pump type K. Used only if IEMPMP=2. Dimensions (9,3,3).		
		AIR DUMP HEAT EXCHANGER		
3801-3804	RITB (IDHX)	Heat exchanger tube inner radius.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
3805-3808	ROTB (IDHX)	Tube outer radius.	m	
3809-3812	XKTB (IDHX)	Tube thermal conductivity.	W/m-K	
3813-3816	HOTB (IDHX)	Tube-to-air heat transfer coefficient.	W/m^2-K	
3817-3820	HITB (IDHX)	Tube-to-NaK or tube-to-Na heat transfer coefficient.	W/m^2-K	
3821-3824	AHT (IDHX)	Air side heat transfer area.	m^2	
3825-3828	SRLEN (IDHX)	Stack riser length.	m	
3829-3832	XKHXLS (IDHX)	Loss coefficient, air side of heat exchanger.		
3833-3836	XKRLS (IDHX)	Riser loss coefficient.		
3837-3840	XKSOLS (IDHX)	Stack outlet loss coefficient.		
3841-3844	AHX (IDHX)	Air flow area at heat exchanger.	m^2	
3845-3848	AR (IDHX)	Riser cross sectional area.	m^2	
3849-3852	ASI (IDHX)	Stack inlet cross sectional area.	m^2	
3853-3892	XKSILS (K,IDHX)	Table of stack inlet loss coefficient (IFCDHX=0) or air flow rate (IFCDHX=1) vs time.		
3893-3932	XKSITM (K,IDHX)	Times for XKSILS table.	s	
3933	AIRTMP	Air temperature.	K	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		FIRST STEAM GENERATOR		
3934	HFW	Inlet feedwater enthalpy.	J/kg	
3935	WEVI	Inlet evaporator mass flow rate estimate (readjusted during steady-state calculations to yield correct sodium-side temperature drop).	kg/s	
3936	PW	Evaporator waterside average pressure.	Pa	
3937	TNAX	Not currently used.		
3938	XEVO	Exit steam quality from the evaporator. Should be between 0 and 1 for IEVAP = 1 or 3.		
		GEOMETRIC CONSTANTS		
3939	EL	Evaporator active length.	m	
3940	DEW	Water hydraulic diameter per tube.	m	
3941	DNA	Tube outer diameter.	m	
3942	DENA	Sodium hydraulic diameter per tube.	m	
3943	ANA	Sodium flow area per tube.	m^2	
3944	POD	Tube pitch to diameter ratio.		
3945	PINSW	Number of tubes per unit.		
		EVAPORATOR HEAT TRANSFER NORMALIZATION		
3946	PWO	Evaporator average pressure.	Pa	
3947	TMO	Evaporator average metal temperature.	K	
3948	TNAO	Evaporator average sodium temperature.	K	
3949	HSCO	H_2O: Average subcooled region enthalpy (estimated).	J/kg	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
3950	HFBO	H_2O: Average post-DNB region enthalpy (estimated).	J/kg	
3951	HSHO	H_2O: Average superheat region enthalpy (estimated).	J/kg	
3952-3953	GWO (2)	H_2O: Average 2-phase mass velocity in the evaporator and superheater, respectively.	kg/m^2-s	
		GEOMETRIC CONSTANTS		
3954-3955	QFACT (2)	Heat transfer area multiplier for the evaporator and superheater respectively. For IEVAP = 1 or 3, QFACT(1) is internally adjusted such that the evaporator length and output steam quality correspond to their input values.		
3956	ELS	Superheater length.	m	
		INITIAL ENTHALPY		
3957	HWSHO	Initial estimate of the superheat water exit enthalpy (internally changed during steady-state calculations).	J/kg	
		INITIAL PRESSURE		
3958	PD	Initial drum pressure.	Pa	
3959	PHPTI	Initial high pressure turbine inlet pressure.	Pa	
		GEOMETRIC CONSTANTS		
3960	VOLD	Drum volume.	m^3	
3961	ELDRUM	Drum midpoint elevation measured from the evaporator inlet.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		RECIRCULATION MOMENTUM		
3962	DPFCLD	Rated cold leg (drum to active inlet of evaporator) friction pressure loss.	Pa	
3963	CUTOFF	Cutoff head fraction for recirculation pump rated head.		
3964	SLA	Recirculation loop characteristic length to flow area ratio.	1/m	
3965	DPFHOT	Rated hot leg (evaporator to drum) friction pressure loss.	Pa	
3966	REDPTO	Rated evaporator water/steam Reynolds number.		
3967	FDPTO	Evaporator friction pressure drop multiplier.		
3968-3973	FWTIME (6)	Array of time values corresponding to feedwater normalized flow rate profile (FWPROF).	s	
3974-3979	FWPROF (6)	Feedwater flow at times given in FWTIME. Normalized to steady-state flow = 1.0. This option selected by IFWC = 2 (Block 3, locations 1000-1003).		
3980-3985	PHTIME (6)	Array of time values corresponding to feedwater pump head normalized profile (PMPROF).	s	
3986-3991	PHPROF (6)	Pump head profile at times given in PHTIME. Normalized to feedwater pump ΔP at steady-state. This option is turned on by setting PHPROF(1) non-zero.		
3992-3993	DUM	Not currently used.		

END OF FIRST STEAM GENERATOR INPUT

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		SECOND STEAM GENERATOR		
3994	HFW	Inlet feedwater enthalpy.	J/kg	
3995	WEVI	Inlet evaporator mass flow rate estimate (readjusted during steady-state calculations to yield correct sodium-side temperature drop).	kg/s	
3996	PW	Evaporator waterside average pressure.	Pa	
3997	TNAX	Not currently used.		
3998	XEVO	Exit steam quality from the evaporator. Should be between 0 and 1 for IEVAP = 1 or 3.		
		GEOMETRIC CONSTANTS		
3999	EL	Evaporator active length.	m	
4000	DEW	Water hydraulic diameter per tube.	m	
4001	DNA	Tube outer diameter.	m	
4002	DENA	Sodium hydraulic diameter per tube.	m	
4003	ANA	Sodium flow area per tube.	m^2	
4004	POD	Tube pitch to diameter ratio.		
4005	PINSW	Number of tubes per unit.		
		EVAPORATOR HEAT TRANSFER NORMALIZATION		
4006	PWO	Evaporator average pressure.	Pa	
4007	TMO	Evaporator average metal temperature.	K	
4008	TNAO	Evaporator average sodium temperature.	K	
4009	HSCO	H_2O: Average subcooled region enthalpy (estimated).	J/kg	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4010	HFBO	H_2O: Average post-DNB region enthalpy (estimated).	J/kg	
4011	HSHO	H_2O: Average superheat region enthalpy (estimated).	J/kg	
4012-4013	GWO (2)	H_2O: Average 2-phase mass velocity in the evaporator and superheater, respectively.	kg/m^2-s	
		GEOMETRIC CONSTANTS		
4014-4015	QFACT (2)	Heat transfer area multiplier for the evaporator and superheater respectively. For IEVAP = 1 or 3, QFACT(1) is internally adjusted such that the evaporator length and output steam quality correspond to their input values.		
4016	ELS	Superheater length.	m	
		INITIAL ENTHALPY		
4017	HWSHO	Initial estimate of the superheat water exit enthalpy (internally changed during steady-state calculations).	J/kg	
		INITIAL PRESSURE		
4018	PD	Initial drum pressure.	Pa	
4019	PHPTI	Initial high pressure turbine inlet pressure.	Pa	
		GEOMETRIC CONSTANTS		
4020	VOLD	Drum volume.	m^3	
4021	ELDRUM	Drum midpoint elevation measured from the evaporator inlet.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		RECIRCULATION MOMENTUM		
4022	DPFCLD	Rated cold leg (drum to active inlet of evaporator) friction pressure loss.	Pa	
4023	CUTOFF	Cutoff head fraction for recirculation pump rated head.		
4024	SLA	Recirculation loop characteristic length to flow area ratio.	1/m	
4025	DPFHOT	Rated hot leg (evaporator to drum) friction pressure loss.	Pa	
4026	REDPTO	Rated evaporator water/steam Reynolds number.		
4027	FDPTO	Evaporator friction pressure drop multiplier.		
4028-4033	FWTIME (6)	Array of time values corresponding to feedwater normalized flow rate profile (FWPROF).	s	
4034-4039	FWPROF (6)	Feedwater flow at times given in FWTIME. Normalized to steady-state flow = 1.0. This option selected by IFWC = 2 (Block 3, locations 1000-1003).		
4040-4045	PHTIME (6)	Array of time values corresponding to feedwater pump head normalized profile (PMPROF).	s	
4046-4051	PHPROF (6)	Pump head profile at times given in PHTIME. Normalized to feedwater pump ΔP at steady-state. This option is turned on by setting PHPROF(1) non-zero.		
4052-4053	DUM	Not currently used.		

END OF SECOND STEAM GENERATOR INPUT

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		THIRD STEAM GENERATOR		
4054	HFW	Inlet feedwater enthalpy.	J/kg	
4055	WEVI	Inlet evaporator mass flow rate estimate (readjusted during steady-state calculations to yield correct sodium-side temperature drop).	kg/s	
4056	PW	Evaporator waterside average pressure.	Pa	
4057	TNAX	Not currently used.		
4058	XEVO	Exit steam quality from the evaporator. Should be between 0 and 1 for IEVAP = 1 or 3.		
		GEOMETRIC CONSTANTS		
4059	EL	Evaporator active length.	m	
4060	DEW	Water hydraulic diameter per tube.	m	
4061	DNA	Tube outer diameter.	m	
4062	DENA	Sodium hydraulic diameter per tube.	m	
4063	ANA	Sodium flow area per tube.	m^2	
4064	POD	Tube pitch to diameter ratio.		
4065	PINSW	Number of tubes per unit.		
		EVAPORATOR HEAT TRANSFER NORMALIZATION		
4066	PWO	Evaporator average pressure.	Pa	
4067	TMO	Evaporator average metal temperature.	K	
4068	TNAO	Evaporator average sodium temperature.	K	
4069	HSCO	H_2O: Average subcooled region enthalpy (estimated).	J/kg	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4070	HFBO	H_2O: Average post-DNB region enthalpy (estimated).	J/kg	
4071	HSHO	H_2O: Average superheat region enthalpy (estimated).	J/kg	
4072-4073	GWO (2)	H_2O: Average 2-phase mass velocity in the evaporator and superheater, respectively.	kg/m^2-s	
		GEOMETRIC CONSTANTS		
4074-4075	QFACT (2)	Heat transfer area multiplier for the evaporator and superheater respectively. For IEVAP = 1 or 3, QFACT(1) is internally adjusted such that the evaporator length and output steam quality correspond to their input values.		
4076	ELS	Superheater length.	m	
		INITIAL ENTHALPY		
4077	HWSHO	Initial estimate of the superheat water exit enthalpy (internally changed during steady-state calculations).	J/kg	
		INITIAL PRESSURE		
4078	PD	Initial drum pressure.	Pa	
4079	PHPTI	Initial high pressure turbine inlet pressure.	Pa	
		GEOMETRIC CONSTANTS		
4080	VOLD	Drum volume.	m^3	
4081	ELDRUM	Drum midpoint elevation measured from the evaporator inlet.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		RECIRCULATION MOMENTUM		
4082	DPFCLD	Rated cold leg (drum to active inlet of evaporator) friction pressure loss.	Pa	
4083	CUTOFF	Cutoff head fraction for recirculation pump rated head.		
4084	SLA	Recirculation loop characteristic length to flow area ratio.	1/m	
4085	DPFHOT	Rated hot leg (evaporator to drum) friction pressure loss.	Pa	
4086	REDPTO	Rated evaporator water/steam Reynolds number.		
4087	FDPTO	Evaporator friction pressure drop multiplier.		
4088-4093	FWTIME (6)	Array of time values corresponding to feedwater normalized flow rate profile (FWPROF).	s	
4094-4099	FWPROF (6)	Feedwater flow at times given in FWTIME. Normalized to steady-state flow = 1.0. This option selected by IFWC = 2 (Block 3, locations 1000-1003).		
4100-4105	PHTIME (6)	Array of time values corresponding to feedwater pump head normalized profile (PMPROF).	s	
4106-4111	PHPROF (6)	Pump head profile at times given in PHTIME. Normalized to feedwater pump ΔP at steady-state. This option is turned on by setting PHPROF(1) non-zero.		
4112-4113	DUM	Not currently used.		
		END OF THIRD STEAM GENERATOR INPUT		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		FOURTH STEAM GENERATOR		
4114	HFW	Inlet feedwater enthalpy.	J/kg	
4115	WEVI	Inlet evaporator mass flow rate estimate (readjusted during steady-state calculations to yield correct sodium-side temperature drop).	kg/s	
4116	PW	Evaporator waterside average pressure.	Pa	
4117	TNAX	Not currently used.		
4118	XEVO	Exit steam quality from the evaporator. Should be between 0 and 1 for IEVAP = 1 or 3.		
		GEOMETRIC CONSTANTS		
4119	EL	Evaporator active length.	m	
4120	DEW	Water hydraulic diameter per tube.	m	
4121	DNA	Tube outer diameter.	m	
4122	DENA	Sodium hydraulic diameter per tube.	m	
4123	ANA	Sodium flow area per tube.	m^2	
4124	POD	Tube pitch to diameter ratio.		
4125	PINSW	Number of tubes per unit.		
		EVAPORATOR HEAT TRANSFER NORMALIZATION		
4126	PWO	Evaporator average pressure.	Pa	
4127	TMO	Evaporator average metal temperature.	K	
4128	TNAO	Evaporator average sodium temperature.	K	
4129	HSCO	H_2O: Average subcooled region enthalpy (estimated).	J/kg	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4130	HFBO	H_2O: Average post-DNB region enthalpy (estimated).	J/kg	
4131	HSHO	H_2O: Average superheat region enthalpy (estimated).	J/kg	
4132-4133	GWO (2)	H_2O: Average 2-phase mass velocity in the evaporator and superheater, respectively.	kg/m^2-s	
		GEOMETRIC CONSTANTS		
4134-4135	QFACT (2)	Heat transfer area multiplier for the evaporator and superheater respectively. For IEVAP = 1 or 3, QFACT(1) is internally adjusted such that the evaporator length and output steam quality correspond to their input values.		
4136	ELS	Superheater length.	m	
		INITIAL ENTHALPY		
4137	HWSHO	Initial estimate of the superheat water exit enthalpy (internally changed during steady-state calculations).	J/kg	
		INITIAL PRESSURE		
4138	PD	Initial drum pressure.	Pa	
4139	PHPTI	Initial high pressure turbine inlet pressure.	Pa	
		GEOMETRIC CONSTANTS		
4140	VOLD	Drum volume.	m^3	
4141	ELDRUM	Drum midpoint elevation measured from the evaporator inlet.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		RECIRCULATION MOMENTUM		
4142	DPFCLD	Rated cold leg (drum to active inlet of evaporator) friction pressure loss.	Pa	
4143	CUTOFF	Cutoff head fraction for recirculation pump rated head.		
4144	SLA	Recirculation loop characteristic length to flow area ratio.	1/m	
4145	DPFHOT	Rated hot leg (evaporator to drum) friction pressure loss.	Pa	
4146	REDPTO	Rated evaporator water/steam Reynolds number.		
4147	FDPTO	Evaporator friction pressure drop multiplier.		
4148-4153	FWTIME (6)	Array of time values corresponding to feedwater normalized flow rate profile (FWPROF).	s	
4154-4159	FWPROF (6)	Feedwater flow at times given in FWTIME. Normalized to steady-state flow = 1.0. This option selected by IFWC = 2 (Block 3, locations 1000-1003).		
4160-4165	PHTIME (6)	Array of time values corresponding to feedwater pump head normalized profile (PMPROF).	s	
4166-4171	PHPROF (6)	Pump head profile at times given in PHTIME. Normalized to feedwater pump ΔP at steady-state. This option is turned on by setting PHPROF(1) non-zero.		
4172-4173	DUM	Not currently used.		

END OF FOURTH STEAM GENERATOR INPUT

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4174-4183	VSLEXP (K)	Length times thermal expansion coefficient for the K element or compressible volume. Used to represent the vessel wall for the control rod drive thermal expansion feedback calculation.	m/K	
		COMPONENT-TO-COMPONENT HEAT TRANSFER		
4184-4215	HABYBY (K,IBYP)	Heat transfer coefficient x area per unit height for bypass channel-bypass channel heat transfer. Dimensions (4,4). See IBYBY, Block 3, Loc. 1020	W/ m-K	
4216-4245	HAELHT (K)	Heat transfer coefficient x area per unit length for heat transfer from wall of liquid element IELHT(K) (Block 3, location 1084) to liquid in compressible volume IELHT2(K) (Block 3, location 1082). For heat transfer from compressible volume to compressible volume, HAELHT is h x area.	W/ m-K	
		RVACS		
4246-4251	XLRVC (IRVC)	Length of RVACS section. Used only if section K is a compressible volume.	m	
4252-4257	PERVAC (IRVC)	RV perimeter.	m	
		TABLE RVACS		
4258-4269	RVHTAB (K)	Table of h vs T.		
4270-4281	RVHTMP (K)	T for RVHTAB table.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		DETAILED RVACS		
4258-4263	EPSRV (IRVC)	Emissivity of reactor vessel.		
4264-4269	EPSGV (IRVC)	Emissivity of guard vessel inner surface.		
4270-4275	PERGV (IRVC)	Perimeter, GV-air.		
4276-4281	PERFS (IRVC)	Perimeter, finned shell inner surface – air.		
		TIME STEP CONTROLS		
4282	EPSF	Maximum fractional change in a liquid segment flow rate per PRIMAR time step.		
4283	EPSFC	Maximum fractional change in core inlet flow rate per PRIMAR time step.		
		STEADY-STATE INITIALIZATION		
4284-4287	DTIHX (IIHX)	Steady state temperature drop across IHX (primary side). Used only if ISSIHX > 0.		
4288-4299	DHPMP (IPMP)	Steady state pump head. Used only if ISSPMP > 0.		
		BYPASS CHANNEL HEAT TRANSFER CORRELATIONS		
4300	C1BY2	Second coefficient set for bypass channel heat transfer coefficient.		
4301	C2BY2	See location 4300.		
4302	C3BY2	See location 4300.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4303	C1BY3	Third coefficient set for bypass channel heat transfer coefficient.		
4304	C2BY3	See location 4303.		
4305	C3BY3	See location 4303.		
4306	C1BY4	Fourth coefficient set for bypass channel heat transfer coefficient. See Block 3 locations 1193-1208, and Block 18 locations 2694-2696		
4307	C2BY4	See location 4306.		
4308	C3BY4	See location 4306.		
		IHX HEAT TRANSFER CORRELATIONS		
		See Block 18, locations 3653-3655		
4309	C1IHXT	Heat transfer correlation coefficients for the tube side of an IHX.		
4310	C2IHXT	Heat transfer correlation coefficients for the tube side of an IHX.		
4311	C3IHXT	Heat transfer correlation coefficients for the tube side of an IHX.		
4312	EPSSTB	Reserved for future use.		
		ANNULAR ELEMENTS		
4313-4342	WALMC2 (IAEL)	Second wall mass x heat capacity / length for annular element IAEL.	J/m-K	
4343-4372	WALLH2 (IAEL)	Second wall heat transfer coefficient.	W/m^2-K	
4373-4402	PERWL2 (IAEL)	Second wall perimeter.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		RVACS, CONTINUED		
4403	TAIRVC	Air inlet temperature.	K	
4404	ZBRVC	Z at bottom of RVACS.	m	
		THE FOLLOWING RVACS INPUT IS ONLY FOR THE DETAILED MODEL		
4405	C1RV	Heat transfer correlation coefficient for air in the RVACS.		
4406	C2RV	Heat transfer correlation coefficient for air in the RVACS.		
4407	C3RV	Heat transfer correlation coefficient for air in the RVACS. See C1, C2, C3.		
4408	XLAIRV	Length of air inlet section.	m	
4409	DHAIRV	Dh, air inlet section.	m	
4410	AARIRV	Area, air inlet section.	m^2	
4411	XLAORV	Length of air outlet (stack).	m	
4412	DHAORV	Dh, stack.	m	
4413	AARORV	Area, stack	m^2	
4414-4419	AIRARV (IRVC)	Air flow area, GV-FS.	m^2	
4420-4425	AIRAR2 (IRVC)	Air flow area, FS – concrete wall.	m^2	
4426-4431	PERGVO (IRVC)	Perimeter for radiation from guard vessel outer surface to outer shell inner surface.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4432-4437	PERFSI (IRVC)	Not currently used.		
4438-4443	PERSFO (IRVC)	Perimeter for radiation from finned shell outer surface to outer wall, also finned shell outer surface to air.	M	
4444-4449	HGASRV (IRVC)	Gas h, RV – GV.	W/m^2-K	
4450-4455	SLRVC (IRVC)	Slope: = 0, Vertical. = 1, Horizontal.		
4456-4461	HFSRV (IRVC)	Heat transfer coefficient across finned shell.	W/m^2-K	
4462-4467	HCONRV (IRVC)	Heat transfer coefficient between concrete nodes.	W/m^2-K	
		COMPONENT – COMPONENT HEAT TRANSFER		
4468-4497	CPCPMP (K)	Multiplicity for component – component heat transfer, default = 1.0.		
		RVACS		
4498-4503	GVMC (IRVC)	Mass x specific heat / length, guard vessel.	J/m-K	
4504-4509	FSMCI (IRVC)	MC/L, finned shell inner node.	J/m-K	
4510-4515	FSMCO (IRVC)	MC/L, FS outer node.	J/m-K	
4516-4521	CRMCI (IRVC)	MC/L, concrete inner node.	J/m-K	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4522-4527	CRMCO (IRVC)	MC/L, concrete outer node.	J/m-K	
4528-4533	TW6RV (IRVC)	Temperature of outer wall node.	K	
4534	EPSFS	Emissivity, finned shell outer surface.		
4535	SIGSTB	Stefan-Boltzmann constant. Suggested value: 5.672E-8.	W/m^2-K	
4536	RW5RV	Thermal resistance between surface of outer wall and inner node (node 5).	m^2-K/W	
4537	REYTRV	Reynolds number for transition from laminar to turbulent in air.		
4538	AFRTRV	Turbulent friction factor = AFRTRV*Re**BFRTRV.		
4539	AFRLRV	Laminar friction factor = AFRLRV/Re.		
4540	ORFIN	Inlet orifice coefficient.		
4541	XLUNRV	Length of upper node between liquid level and top of vessel.	m	
4542	BFRTRV	Turbulent friction factor parameter, see AFRTRV.		
4543	UNGVMC	MC/L for GV in upper node.	J/m-K	
4544	UNFSMC	MC/L for FS inner node in upper node.	J/m-K	
4545	AIRAUN	Air flow area, upper node.	m^2	
4546	EPSOW	Emissivity, outer wall.		
4547-4552	EPSGVO (IRVC)	Emissivity, guard vessel outer surface.		
4553-4558	EPSFSI (IRVC)	Emissivity, finned shell inner surface.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		CHECK VALVE TABLES		
4559-4618	CKVORF (K,ICKV)	Check valve coefficient table. Dimensions: 10,6.		
4619-4678	CKVFLO (K,ICKV)	Check valve normalized flow. Dimension: 10,6.		
		DEGREE OF IMPLICITNESS		
4679	THT2CV	Minimum degree of implicitness for a compressible volume for liquid flow rate calculations. Suggested values: 0.5 for rapid transients, 0.75 for slow transients		
		PUMP CAVITATION		
4680	CPC0	Pump cavitation coefficients required net positive suction head = $S*S(CPC0+ CPC1*Z+CPC2*Z^2+CPC3*Z^3+CPC4*Z^4)$. Z = W/S W = normalized flow S = normalized pump speed Typical values for FFTF: CPC0 = 457,488 CPC1 = -2,161,072 CPC2 = 4,266,337 CPC3 = -3,636,676 CPC4 = 1,141,003 (See locations 4680 - 4684, Block 18)		
4681	CPC1	See locations 4680 - 4684, Block 18.		
4682	CPC2	See locations 4680 - 4684, Block 18.		

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
4683	CPC3	See locations 4680 - 4684, Block 18.		
4684	CPC4	See locations 4680 - 4684, Block 18.		
		MULTIPLE INLET/OUTLET PLENA		
4685-4722	TPLCV (ICV)	Temperature of volume ICV. Entered only for inlet plena to core or bypass channels. Not required for IFMIOP = 0.	K	
4723-4760	PPLCV (ICV)	Pressure of volume ICV. Entered only for outlet plena to core or bypass channels. Not required for IFMIOP = 0.	Pa	
4761-4798	ZPLENC (ICV)	Reference elevation for volume ICV. Entered only for inlet and outlet plena for core and bypass channels. (ZPLENL and ZPLENU are set from ZPLENC in the channel subroutines). Not required for IFMIOP = 0.	m	
		ELEMENT/WALL THERMAL ADJUSTMENT		
4799-4938	WALTHK (IELL)	Element wall thickness, used only if ITHPEN > 0. (See Block 3, Loc. 1312).	m	
4939-4976	THKWAL (ICV)	Compressible volume wall thickness, used only if ITHPEN > 0, (See Block 3, Loc. 1312).	m	
4977	TAUPEN	Time constant for thermal penetration depth adjustments to wall thermal treatments, used only if ITHPEN > 0.	s	
4978-5007	WALTH2 (IAEL)	Annular element second wall thickness, used only if ITHPEN > 0.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		STRATIFIED COMPRESSIBLE VOLUME		
5008	RCORE	Core radius for use in the Richardson number.	m	
5009-5017	HCSTWL (IW)	Coolant heat transfer coefficient at the inner surface of the wall section.	W/m^2-K	
5018-5026	HCSTW2 (IW)	Coolant heat transfer coefficient at the outer surface of the wall section.	W/m^2-K	
5027-5035	ASTWL (IW)	Area of the wall section.	m^2	
5036-5107	HINVWL (I,IW)	Thickness/thermal conductivity of node I in the wall section. I = 1 - 8.	m^2-K/W	
5108-5179	XMCSTW (I,IW)	Mass x heat capacity of node I in the wall.	J/K	
5180-5182	ZINST (ICVST)	Z of inlet, used only for a vertical wall. Otherwise ZOUTEL(IELL) is used.	m	
5183-5185	VOLBLI (ICVST)	Volume below the inlet, not used if there is a cover gas in the CV. In this case, the information is obtained from other input for the CV.	m^3	
5186-5188	EPSTST (ICVST)	Minimum temperature difference for switching stages.	K	
5189-5191	XLENTR (ICVST)	Entrainment length. A hot plume with a flow rate WH, rising through a cool layer of thickness DZ, will entrain cool liquid at a rate (DZ/XLENTR) * WH.	m	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		PARAMETRIC TWO-REGION IHX MODEL		
5192-5195	DTSIHX (IIHX)	Initial temperature difference between regions in parametric two-region IHX model for IHXCLC(IIHX) < 0 and DTMPTB(1) = 1.0.	K	
5196-5199	VSIHX1 (IIHX)	First region volume in parametric two-region IHX model for IHXCLC(IIHX) < 0 and DTMPTB(1) = 1.0.	m^3	
5200-5203	VSIHX2 (IIHX)	Second region volume in parametric two-region IHX model for IHXCLC(IIHX) < 0 and DTMPTB(1) = 1.0.	m^3	
		THICK-WALLED PIPES		
5204-5243	TPWMC (L,K)	Mass*heat capacity/length for wall node L+1 of thick-walled pipe K. Dimensions (4,10). Note: Use WALLMC(IELL) for node 1.	J/m-K	
5244-5283	TPWH (L,K)	Thermal conductivity/node thickness for node L+1 of thick walled pipe K. Dimensions (4,10). Note: Use WALLH(IELL) for node 1 for h from the mid-point of the first wall node to the wall surface.	W/m^2-K	
		STEADY-STATE INITIALIZATION		
5284-5293	TCVSSI (II)	Steady-state coolant temperature in compressible volume ICVSSI(II).	K	
5294-5303	PCVSSI (II)	Steady-state liquid pressure in compressible volume ICVSSI(II).	Pa	

Block 18 — PMR4IN — PRIMAR-4 Floating-Point Input

Location	Symbol	Description	Units	Used By
		DETAILED AIR DUMP HEAT EXCHANGER MODEL		
		IADHX(IDHX) > 0		
		Not currently used.		
5304-5307	EFFIN (IDHX)	Fin height. Not currently used	m	
5308-5311	FINTHK (IDHX)	Fin thickness. Not currently used.	m	
5312-5315	SPFIN (IDHX)	Center-to-center spacing between fins. Not currently used.	m	
5316-5319	XLTUBE (IDHX)	Tube spacing parallel to flow. Not currently used.	m	
5320-5323	XTTUBE (IDHX)	Tube spacing perpendicular to the flow. Not currently used.	m	
5324-5500	DMP4IN	Not currently used.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
1	IDBUGV	Channel-dependent debug flag. (See IDBUG0 and IERSTP). = 0, For no debugging output. = 1, For steady-state debugging output. Time step control output for 2 ≤ IDBUG0 ≤ 6. = 2, Time step, also steady-state fuel behavior output if IDBUG0 = 0 (See INPCOM location 2). = 3, Coolant calculation output. (See IERSTP). = 4, For more coolant debugging output. (See IERSTP). = 5, For transient heat-transfer debugging output. = 6, Print out all reactivity changes. = 7, Primary loop calculation debug. = 8, Coolant-cladding temperature calculations only.		
2	IERSTP	Main time step number when debugging output starts. Relevant only if IDBUGV > 0. If IERSTP is negative, debug output starts on step |IERSTP| of a null transient (ISSNUL > 0).		
3	IROK	Fuel density, heat capacity and thermal conductivity selection parameter. ≤ 0, Temperature dependent tabular forms. See Block 13, locations 91-250, 420-579, and 606-765 for tables. > 0, Correlations that depend on temperature, and in case of binary/ ternary fuel, also on composition. <u>Correlations for oxide fuel (IMETAL=0):</u> > 0, Temperature and porosity dependent correlations for fuel density. Inputs COEFDS, COEFDL are required. = 1, Correlation for fuel conductivity from GEAP-13582.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		= 2, Correlation for fuel conductivity from WARD-FTM-FI-RJS-17. Input COEFDK is required. = 3, Correlation for fuel conductivity based on COMETH3J-FBR. Note: The parameter values associated with IRHOK=1 or 3 need not be input. For oxide fuel, tabular heat capacity is used even if IRHOK > 0. <u>Correlations for U-Fs fuel (IMETAL=1):</u> > 0, Correlation for fuel density uses input REFDEN with thermal expansion function subprogram ALPHF. Correlation for fuel conductivity depends on temperature. Porosity and sodium logging is accounted for by the method of ANL/RAS 85-19. Note: For U-Fs fuel, tabular heat capacity is used even if IRHOK > 0. <u>Correlations for ternary/binary fuel (IMETAL=2,3):</u> Note: Input IFUELM is required for this fuel. IFUELM: = 0, IFR handbook data interpolations; = 1, ANL/RAS 85-19 correlations; = 2, Mark-V fuel or U-10Zr fuel according to input IMETAL = 2 or 3. For IFUELM=0: > 0, Correlation for fuel density depends on temperature. Input RHOZN is required. Correlation for fuel heat capacity depends on alloy composition/type and temperature. Inputs PUZRTP, TFSOL, TFLIQ are required. Correlation for fuel conductivity depends on composition/ type, temperature, porosity and sodium logging. Inputs PRSTY and XLOGNA are		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		required. For IFUELM=1: > 0, Correlation for fuel density depends on alloy composition and temperature. Correlation for fuel heat capacity depends on alloy composition and temperature. Correlation for fuel conductivity depends on composition, temperature, porosity and sodium logging. Inputs POROSS, PORMSS, PORCSS, FPORNA are required. For IFUELM=2: > 0, Correlation for Mark-V & U-10Zr fuel densities. Input composition from array PUZRTP is used with thermal expansion. Correlation for Mark-V & U-10Zr fuel heat capacities depend on temperature. Correlation for Mark-V & U-10Zr fuel conductivities depend on composition, temperature and burnup. Input BURNFU is required, based on memos of Billone to Briggs dated 1/14/91, 3/8/91 & 10/21/91.		
4	NPLN	Number of segments in gas plenum. 1 ≤ NPLN ≤ 6.		BL
5	NREFB	Number of reflector zones below the pin section. 1 ≤ NREFB ≤ 5.		BL
6	NREFT	Number of reflector zones above the pin section. 1 ≤ NREFT ≤ 5. NREFB + NREFT ≤ 6.		BL

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
7-13	NZNODE (KZ)	Number of segments in zone KZ. (KZ ≤ 7). Total number of all segments in all zones ≤ 48. Only one segment per node is necessary, but if the LEVITATE or PLUTO2 region can extend into a node the segments there should be in the range from 0.03 meters to 0.1 meters. Neighboring cells for PLUTO2 and LEVITATE should not differ much in length. A length ratio of 1.5 is still reasonable.		BL
14	NT	Number of radial temperature nodes within the fuel, 3 < NT < 12.		DF
15	IFUELV	Table number of property value to be used for core fuel. 0 < IFUELV ≤ IFUEL1.		BL DF
16	IFUELB	Table number of property value to be used for blanket fuel. 0 < IFUELB ≤ IFUEL1.		BL DF
17	ICLADV	Table number of property value to be used for cladding table.		BL CL DF
18	NGRDSP	Number of spacer grids in pin. 2 ≤ NGRDSP ≤ 10. Not yet operational. = 0, No spacer grids.		
19	KTING	Fission-gas release model option. = 0, Isotropic release model. = 1, Weisman model.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
20	NAXOP	Model selection for axial expansion and crack volume.		DF

NAXOP	Crack Volume	Axial Plane Strain	Axial Swelling
0	No	No	No
1	No	Yes	No
2	No	No	Yes
3	No	Yes	Yes
4	Yes	No	No
5	Yes	Yes	No
6	Yes	No	Yes
7	Yes	Yes	Yes

If NAXOP = X with X above, mixed plane strain.

= 3X with X above, cladding controlled axial plane strain.
= 2X with X above, then free fuel axial plane strain.
= 1X constrained plane strain.

21	MSTEP	Number of main steady-state power change and constant power intervals. One required for each power change. One required for each constant power interval. (≤ 8).		DF
22	ITAU	Irradiation induced cladding swelling incubation parameter options. =-2, No cladding swelling. =-1, Lower limit. = 0, Nominal value. > 0, Upper limit.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
23	IRATE	Irradiation induced cladding swelling rate options. =-2, No cladding swelling. =-1, Lower limit. = 0, Nominal value. > 0, Upper limit.		DF
24	IHGAP	Fuel-cladding gap conductance selection. = 0, SAS3D method for calculating HB (See Block 63, locations 2-7). = 1, SAS4A method (Ross-Stoute model). Note: When using the simple bond gap conduction model (ISSFU2 = -1), set IHGAP=0. (See Block 51, location 122).		DF
25	NPIN	Number of pins per subassembly.		BL DF
26	NSUBAS	Number of subassemblies in channel.		BL DF
27	MZUB	Number of segments in upper blanket.		BL DF
28	MZLB	Number of segments in lower blanket.		BL DF
29	IHEX	= 0, No hexadecimal printout of the sum of the coolant temperatures. > 0, Hexadecimal printout of the sum of the coolant temperatures.		BL
30	IRELAX	Stress relaxation options. Use IRELAX = 0. = 0, No relaxation. = 1, Creep law estimate, not operational. = 2, Exact solution, not operational.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
31	NGRAIN	Model selection for grain growth theory. = 0, Limited grain growth theory. > 0, Unlimited grain growth theory. Suggested value: 4.		DF
32	ISSFUE	= 0, Bypass dynamical model calculations in steady-state, no fuel restructuring and no deformation of fuel and cladding. = 1, Use dynamic calculation of DEFORM in steady-state.		DF
33	IRAD	Not currently used.		
34	ILAG	= 0, Use Eulerian coolant temperature calculation until flow reversal. = 1, Use Lagrangian coolant temperature calculation from the start. Suggested value: 0.		BL
35	NOSTRN	Option to avoid radial strain in the cladding even if conditions would produce strain. = 0, Strain cladding if conditions warrant. = 1, Allow no cladding strain.		DF
36	JRUPT	Not currently used.		
37-44	NPLIN (M)	Number of subdivisions in each of the MSTEP divisions. There should be enough subdivisions to allow for reasonable feedback of the restructuring into the thermal calculation. At least 4 subdivisions for each power change and enough constant power subdivisions so that each does not exceed about 10 days (preferably 2 days during early irradiation). (M = 1, MSTEP)		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
45	IROR	Controls assumption used when molten cavity extends to the cracked fuel zone. = 0, Cavity pressure reduced by R/R before acting on cladding, no crack volume included in cavity. = 1, Cavity pressure acts on the cladding, all crack volume included in cavity if molten to cracked region.		DF
46	JPRNT1	The lowest axial node for which debug output is produced from DEFORM.		DF
47	JPRNT2	The highest axial node for which debug output is produced from DEFORM. Note: The debug output is produced for all nodes from JPRNT1 to JPRNT2 inclusive. If these two values are set to 0 but the time step controls and IDBUGF are activated, then the debug output is from the molten cavity routine and the axial expansion and feedback calculation only (the axial node independent part of the calculation).		DF
48	NNBUG1	The time step at which to start the debug output from DEFORM.		DF
49	NNBUG2	The time step which is the last time step for debug output from DEFORM		DF
50	IDBUGF	The control for the type of debug output desired from DEFORM. = 3, NNBUG1 and NNBUG2 refer to the steady-state time step. =13, NNBUG1 and NNBUG2 refer to the transient time step. =23, NNBUG1 and NNBUG2 refer to both the steady-state and the transient time steps. =-1, Initiates a print option that writes out when DEFORM (the transient DEFORM driver) is entered and left beginning at transient time step NNBUG1.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		=-2, This is a special option that produces standard DEFORM output at every time step from NNBUG1 to NNBUG2 inclusive. NNBUG1 and NNBUG2 must be entered as negative numbers. This is active only in the transient calculation.		
51-58	NSKIP (M)	Print control for each of the MSTEP divisions in DEFORM. There is one value for each NPLIN value. < NPLIN, the DEFORM results are printed after each NSKIP subdivisions. = NPLIN, the DEFORM results are printed at the end of the MSTEP division. > NPLIN, no DEFORM results are printed. (M = 1, MSTEP)		DF
59	MPL1	Plots channel pressure history at node MPL1. The nodes MPL1 -MPL7 must be a node in the zone KZPIN.		
60	MPL2	Plots channel pressure history at node MPL2.		
61	MPL3	Plots channel pressure history at node MPL3.		
62	MPL4	Plots channel temperature history at node MPL4.		
63	MPL5	Plots channel temperature history at node MPL5.		
64	MPL6	Plots channel temperature history at node MPL6.		
65	MPL7	Plots channel coolant volumetric flow rate at node MPL7. (MPL7 should correspond to the location of upper flowmeter in experiments, the volumetric flowrate of lower coolant slug is plotted with it.)		
66	MPL8	Not currently used.		
67	MPL9	Not currently used.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
68	KKSBTP	Not currently used.		
69	KKSBRI	Not currently used.		
70	NRPI	Not currently used.		
71	NRPI1	Number of pins per assembly that are assumed to fail (number of unfailed pins is NPIN - NRPI1, NPIN is at input location 25) when the fuel-pin failure option MFAIL (location 86) is satisfied.		PL
72	NRPI2	Not currently used.		
73	NRPI3	Not currently used.		
74	IPSIZE	Fuel particle size option in PLUTO2 and LEVITATE. = 1, RAFPLA (Block 13, location 1158) is used from the initial fuel ejection to time TIFP (See Block 13, location 1173). = 2, RAFPSM (Block 13, location 1159) is used all the way.		
75	IBUGPL	Debug flag, should currently always be 0.		PL
76	ICFINE	= 0, Automatic time step selection in LEVITATE and PLUTO2 using DTPLIN (Block 13, location 1164) as the initial and later on the minimum time step. = 1, Initial time step DTPLIN (Block 13, location 1164) is used all the time if the main and primary loop time steps remain multiples of DTPLIN. If this is not the case, then the PLUTO2 and LEVITATE time steps are temporarily smaller than DTPLIN.		PL
77	IPRINT	Should currently always be 0.		PL

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
78	IPLOT	> 0, Plotting file (Logical units 12, 13 and and 14) for PLUTO2 is written every IPLOT milliseconds if IPLOT is greater than zero. = 0, No plotting data is saved.		PL
79	IBGO	Debug printout starting at LEVITATE and PLUTO2 cycle IBGO.		LE PL
80	IBSTOP	PLUTO2 or LEVITATE printout debug ends at cycle IBSTOP.		LE PL
81	IBNEW	Debug levels: = 0, No debug output. = 1, Time step debug. = 2, Some debug output. = 3, More debug output. = 4, Lots of debug output.		LE PL
82	IPGO	Between cycles IPGO and IPSTOP regular full LEVITATE or PLUTO2 output at every IPNEW cycles.		LE PL
83	IPSTOP	See location 82.		LE PL
84	IPNEW	See location 82.		LE PL
85	ICLADB	= 0, Cladding is ignored after melting. = 1, Cladding motion occurs. = 2, Cladding motion does not occur, but heat transfer to molten cladding does occur.		BL CL

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
86	MFAIL	Fuel-pin failure option. (See FSPEC). = 0, No pin failure. = 1, FSPEC is failure time. = 2, FSPEC is fuel failure temperature. = 3, FSPEC is fuel mass melt fraction at failure. = 4, FSPEC is cavity pressure at failure. = 5, FSPEC is cladding yield stress at failure. Not yet operational. = 6, Eutectic penetration correlation for U-5fs fuel. FSPEC (Block 65, location 1) is eutectic temperature. = 7, Failure criteria consistent with PLUTO2/LEVITATE rip propagation model. Functional ultimate tensile strength used and fully cracked fuel assumed. = 8, Eutectic penetration and stress-based failure for metal fuel. = 9, Failure time based on melt fraction at FSPEC with location based on maximum MFAIL = 7 failure criterion.		BL
87	IFAIL	Relevant for MFAIL = 2, the radial node to test.		
88	JFAIL	Relevant for MFAIL = 1,2,3,4,5, the axial fuel-pin node to test. Note: If IFAIL or JFAIL are not specified, the peak value of the pertinent failure quantity is used. If MFAIL = 1, JFAIL must be specified.		
89	ISUBAS	Subassembly number, only required for the detailed coolant sub-channel model.		
90	JCLN	Axial heat-transfer segment, JCLN, output on the plotting unit for fuel information, 1 ≤ JCLN ≤ MZ.		
91	JNEN	Axial heat-transfer segment, JNEN, output on the plotting unit for the cladding temperature, 1 ≤ JNEN ≤ MZ.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
92	JNCN	Axial coolant node, JNCN, output on the plotting unit for coolant temperature, 1 ≤ JNCN ≤ MZC.		
93	JNSN	Axial coolant node, JNSN, output on the plotting unit for structure temperature, 1 ≤ JNSN ≤ MZC.		
94	JRPRO	Axial heat-transfer segment, JRPRO, 1 ≤ JRPRO ≤ MZ, output on the plotting unit for total radial profile (written each time the mass averaged fuel temperature, TBAR, increases by DTFUEL degrees). Not currently operational.		
95	IPSIG	Hydrostatic pressure for fuel swelling: = 1, Use SIGR. = 2, Use (SIGR + SIGC)/ 2. = 3, Use (SIGR + SIGC + SIGZ)/ 3.		DF
96	IHTPRS	= 1, Hot pressing of fuel to PRSMIN, not yet operational. = 0, No hot pressing. (Recommended IHTPRS = 0)		DF
97	IPRD	Controls the amount of DEFORM output in the transient calculation. (For steady-state control see NSKIP, Loc. 51-58 above) = 0, Only short form output. = 1, Radial stress, total porosity, crack volume + short form. = 2, All above + circumferential stresses retained fission-gas distribution, fission-gas porosity. = 3, All above + axial stresses, grain size distribution, radial mesh locations.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
98-107	IDBFLG (10)	IDBFLG(4) > 0 gives reentry temperature debug print. IDBFLG(5) > 2 gives TSCA debug print. IDBFLG(6) > 0 gives subassembly-subassembly heat transfer prints. IDBFLG(7) > 0 for film motion of debugs. IDBFLG(8) > 0 for Wallis flooding correlation debugs. IDBFLG(9) > 0 for sub-channel analysis coolant debugs IDBFLG(10) > 0 for sub-channel analysis heat transfer debugs		BL
108-117	IDBSTP	TSCA debug print starts at coolant step IDBSTP(5).		BL
118	IEQMAS	Radial fuel mesh size assumption. = 0, Equal radial distances between points at which temperatures are calculated. > 0, Equal cylindrical areas associated with each radial temperature node.		BL
119	IBLPRN	Number of coolant dynamics time steps between boiling printouts. (See INPCOM, locations 12-14). Default: 100.		BL
120	IDBGBL	IDBGBL > 3 gives boiling debug print.		BL
121	IDBLST	Boiling debug print starts at coolant step IDBLST.		BL
122	ISSFU2	= 0, Omit DEFORM calculation during the transient. (See IAXEXP, location 181). = 1, Use DEFORM calculation during the transient. =-1, Simple bond gap conduction model.		DF

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
123	IHEALC	= 0, No crack healing. = 1, Crack healing based on fuel swelling rate parameters. (Not operational) = 2, Cracking healing based on 100% healed if temperature above FTMPCH*TMF(IFUEL).		DF
124	IAXTHF	Determine components active in the axial expansion calculation in DEFORM. = 0, Only thermal effects. = 1, Thermal and force effects.		DF
125	IDCLGO	Value of ICOUNT (number of cladding time steps) when cladding debug print begins.		CL
126	IDCLSP	Value of ICOUNT when CLAP debug print ends.		CL
127	IDCLDE	CLAP debug is printed after every IDCLDE call to the CLAP module.		CL
128	IFILM	Number of nodes dried out before switch from wet (a few boiling segments) to dry (larger boiling length) minimum film thickness. Suggested value: 3 or 4. Do not input 0.		BL
129-131	NZONF	Not currently used.		
132-155	IFUELI	Not currently used.		
156-179	NODSUM	Not currently used.		
180	IFUOPT	Not currently used.		
181	IAXEXP	Simple axial expansion reactivity feedback model. Can not be used with DEFORM-4. See ISSFUE and ISSFU2, locations 32 and 122. See Block 1, location 55 for model choice. = 0, No simple axial expansion feedback. = 1, Calculate feedback. = 2, Calculate and print simple axial expansion feedback for each channel.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
182	IMOMEN	LEVITATE option referring to the convective momentum flux formulation. = 0, Central formulation (recommended). = 1, Upstream formulation.		LE
183	JSTRDX	Axial node number in structure corresponding to the above core load pad. Use only if IRADEX = 1,2,3 or -1,-2,-3.		
184	IFAE	Fuel adjacency effect in Kramer-DiMelfi cladding failure model. = 0, No = 1, Yes		
185	ICLADK	Cladding thermal conductivity option. = 0, Table lookup. = 1, Functional form cladding conductivity option. (Not currently operational, use = 0)		
186	IFRFAC	>0, Add turbulent and laminar friction factors for liquid sodium.		
187	IRDEXP	= 0, Use this channel in the radial expansion feedback calculation. = 1, Skip this channel.		
188	IBUGPN	Debug flag, should currently always be 0.		PN
189	IMETAL	Indicates fuel type. = 0, Oxide fuel. > 0, Metal fuel. = 1, Uranium-fissium metal fuel. = 2, U-Pu-Zr ternary alloy fuel. = 3, U-Zr binary alloy fuel.		
190	IPNPLT	=1, The PINACLE module produces a printer plot of the axial fuel distribution with every full printout.		PN

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
191	IFUELO	Option for annular zone formation model in U-Pu-Zr alloy fuel (for the case of IMETAL = 2 only). = 0, User input zonal compositions and radii (See IFUELC, IZNC, IZNM, MFTZN, RIZNC, and RIZNM. See also PUZRTP, RHOZN, XLOGNA, PRSTY, TFSOL, and TFLIQ). = 1, Zonal composition and radii computed using the SSCOMP physical model (See TTRANM, TTRANC, POROSS, PORMSS, PORCSS, FPORNA, THOREF, WUREF, WPUREF, WZRREF, PUBYU, CPCM, CPMO, CZCM, CZMO, CUCM, CUMO, EPSMS, EPSCOM, IDSSC, and BURNFU).		SC
192	IFUELM	Option for the thermal properties of the U-Pu-Zr alloy fuel (for the case of IMETAL > 1 only). = 0, Use properties interpolated from the IFR metallic fuels handbook data. = 1, Use properties in the report ANL/RAS 85-19. = 2, Use Mark-V fuel or U-10Zr fuel properties (depending on IMETAL = 2 or 3) based on the metallic fuels handbook data		
193	IFUELC	User input fuel zone specification flag. = 0, Single radial fuel zone (See IFUELV, IFUELB, MZLB, MZUB). = 1, Multiple radial fuel zones (See IZNC, IZMN, MFTZN, RIZNC, RIZNM). = 2, Each radial mesh interval is a unique fuel zone for IMETAL > 1, with input mesh point porosities and compositions determined in interface routine LIFEIF.		
194	IPNGO	Between cycles IPNGO and IPNSTP a full PINACLE output is obtained at cycle intervals containing IPNNEW cycles.		PN

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
195	IPNSTP	See location 194.		PN
196	IPNNEW	See location 194.		PN
197-202	IDM51	Not currently used.		
203	IDKCRV	Power or decay heat curve for this channel.		
204	ITP20	Fuel, cladding, and coolant temperatures and voiding data are written on unit 20 every ITP20 time steps. If ITP20 ≤ 0, no unit 20 output.		
		CHANNEL-TO-CHANNEL HEAT TRANSFER		
205	NCHCH	Number of other channels that this channel is in contact with for duct wall-to-duct wall heat transfer. Maximum 8. If NCHCH < 0, Q(ICH to JCH) = -Q(JCH to ICH)		
206-213	ICHCH	Channel number of the K-th channel that this channel is in contact with. See also Block 63, locations 82-89, HACHCH. If ICHCH < 0, then -ICHCH is a bypass channel number. If ICHCH(1) < -8, then -ICHCH(K) is the temperature of a constant temperature heat sink in axial zone K. If ICHCH > 1000, transfer heat from structure of ICH to coolant of ICHCH-1000. If ICHCH > 500000, transfer heat from structure of ICH to coolant of ICHCH - 500000. If ICHCH > 750000, transfer heat from coolant of ICH to coolant of ICHCH - 750000.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		MULTIPLE PIN OPTION		
214	JJMLTP	Multiple pin option. =0, No multiple pin treatment for this subassembly. Use single-pin model. >0, This is the first of JJMLTP channels used to represent the subassembly. <0, This is one of the additional channels used to represent the subassembly. Notes: 1) JJMLTP and ICHCH refer to different phenomena: Intra-subassembly heat transfer and inter-subassembly heat transfer. 2) JJMLTP is used for intra-subassembly coolant-to-coolant heat transfer from channel I to I + 1 and from I to I - 1. UACH1 and UACH2 (Block 64, locations 189 and and 190) must be supplied to determine the heat transfer coefficients. 3) If M channels are used to represent a subassembly, then they must be consecutive channels, starting with channel ICHN and going to channel ICHN + M - 1. For channel ICHN, JJMLTP = M. For channels ICHN + 1 through ICHN + M - 1, JJMLTP is negative. 4) The maximum value of M is 56 (no more than 56 channels can be used to represent a subassembly). 5) The axial zones outside the pin section go only with the first channel (channel ICHN). In these zones, the coolant flow area per pin and the reflector and structure perimeters per pin must be based on the number of pins in channel ICHN. The reflector zones are ignored for channels ICHN + 1 to ICHN + M - 1. 6) ICHCH refers to subassembly-to-subassembly		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		heat transfer from the current channel to channel ICHCH. This heat transfer is from outer surface node to outer surface node. ICHCH > 1000 is an exception. This exception was included for modeling the thimble flow region of the XX09 subassembly in EBR-II. If ICHCH ≠ 0 then the heat transfer coefficient times area per unit height is specified by HACHCH (Block 63, location 82-89).		
		DETAILED COOLANT SUB-CHANNEL MODEL		
215-218	JCHMPN (K)	Other channel this coolant sub-channel is in contact with. Used only if ISCH = 1, JJMLTP ≠ 0 Reserved for the detailed coolant sub-channel model.		
219	NUMKLT	Number of other channels this coolant sub-channel is in contact with. Used only if ISCH = 1, JJMLTP ≠ 0 Reserved for the detailed coolant sub-channel model.		
220	KSWIRL	Value of K in JCHMPN(K) for swirl flow. Normally KSWIRL=0 except in an edge or corner sub-channel. Used only if ISCH = 1, JJMLTP ≠ 0 Reserved for the detailed coolant sub-channel model.		
221	NULST1	Number of time steps in a null transient for this subassembly or group of channels. Used only if ISCH = 1, JJMLTP ≠ 0 Reserved for the detailed coolant sub-channel model.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		SSCOMP METAL FUEL BEHAVIOR MODEL		
222	IPORC	Options to control open porosity considerations in metal fuel axial swelling during transient calculation. = 0, Close open porosity by fraction given in Block 63, location 68 (FCLOP) before axial movement takes place. = 1, Treat open porosity like closed porosity.		
223	IDSSC	= 0, Debug output from SSCOMP routine (for computing the pre-transient formation of annular zones of different compositions in U-Pu-Zr alloy fuel) not printed. = 1, Debug output from SSCOMP routine (for computing the pre-transient formation of annular zones of different compositions in U-Pu-Zr alloy fuel) printed.		SC
		END SSCOMP METAL FUEL BEHAVIOR MODEL		
224	IDRY	= 1, For film motion.		BL
225	ICTYPE	Cladding material indicator for DEFORM-5 (metal fuel DEFORM). = 1, 316 = 2, D9 = 3, HT9		
		SUBASSEMBLY-TO-SUBASSEMBLY HEAT TRANSFER		
226-233	IOPCH (K)	Subassembly-to-subassembly heat transfer option. = 0, Q(JCH,ICH) = - Q(ICH,JCH) = 1, Q(JCH,ICH) not set by Q(ICH,JCH)		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
234-249	KTRANC	Not currently used.		
250-273	KTRANM	Not currently used.		
274	IPRSKP	Skip the prints for channel ICH if IPRSKP is nonzero. To be used to reduce the volume of printed output from TSPRNT.		
275	ITREAT	For use with oxide fuel TREAT experiment analysis. = 1, Completely crack fuel at start of transient.		
276	IOPPL	Not currently used.		
277	IBUBND	= 0, Form bubbles at node mid-points. = 1, Form bubbles at node boundaries.		
278	IGASRL	= 0, No gas release. = 1, Gas release in the boiling model, requires DEFORM-5 life fraction calculation and FRUPT(1) (Block 64, location 81). = 2, Gas release in the boiling model by pin group at the times given by TMFAIL (Block 64, location 186) at axial node INDFAL.		
279	IGRLTM	Not currently used.		
280	IRAPEN	Rapid eutectic formation rate assumption. = 0, Use exponential eutectic formation rate formula for all temperatures (i.e. no eutectic formation temperature threshold and no rapid eutectic penetration allowed). = 1, Allow rapid eutectic penetration if molten fuel is available (i.e. cladding temperature above fuel solidus temperature) and temperatures are in rapid penetration region (1353K to 1506K).		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		> 1, Use exponential eutectic formation rate formula above 923K (650 deg. C) and allow rapid eutectic penetration in the range from 1353K to 1506K (EBR-II Mark-V safety case).		
281	LCHTYP	Core channel designator. = 1, Fuel channel. = 2, Reflector channel. = 3, Control rod channel.		
282	IGSPRS	Controls fission gas assumptions used with metal fuel pins. = 0, Equilibrium maintained between plenum and axial segments of fuel by instantaneous gas relocation. = 1, After initiation of equilibrated pressure during first transient time stop, gas remains in axial segments and may locally pressurize.		
283	INDFAL	Failure node number on the fuel pin axial mesh for pin failure and gas release if IGASRL=2.		
284	IAXCON	Axial coolant heat conduction option. = 0, No axial heat conduction in the coolant. = 1, Axial heat conduction in the coolant. Only operative with the multiple pin option (JJMLTP not equal to 0).		
		FPIN-2 INPUT		
285	IFPIN2	= 0, Do not use FPIN2 metal fuel model. = 1, Use FPIN2 metal fuel model. No other data required when IFPIN2=0.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
286	IFPI01	= 0, Use FPIN2 in interfaced mode. = 1, Use FPIN2 in stand-alone mode. No other data required when IFPI01=1.		
287	IHTFLG	= 0, Bypass FPIN2 heat transfer calculation. = 1, Include FPIN2 heat transfer calculation (for debugging purposes only).		
288	LHTOPT	= 0, Perform heat transfer calculation including coolant and structure. = 1, Perform heat transfer calculation with input values of cladding outer surface temperature. This input is required only for IHTFLG=1.		
289	LCRACK	Fuel cracking option. = 0, No cracking. = 1, Radial cracks included.		
290	LFPLAS	Option for creep-plastic strains in fuel. = 0, Allow creep-plastic strains. = 1, Suppress creep-plastic strains.		
291	LCPLAS	Option for creep-plastic strains in cladding. = 0, Allow creep-plastic strains. = 1, Suppress creep-plastic strains.		
292	LFSWEL	Option for swelling-hotpressing strains in fuel. = 0, Allow swelling-hotpressing strains. = 1, Suppress swelling-hotpressing strains.		
293	LCSWEL	Option for swelling strains in cladding. = 0, Allow swelling strains. = 1, Suppress swelling strains.		
294	LLRGST	Option for strain analysis. = 0, Large strain analysis. = 1, Small perturbation analysis.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
295	LFCSLP	= 0, Fuel-cladding locked when gap is closed. = 1, Independent fuel-cladding axial displacement.		
296	LOUTSW	Print option. = 0, No detailed printing of results - summary only. = 1, Normal detailed printout under LFREQA, MFREQA, and LFREQB control.		
297	LFREQA	Initial print frequency, number of time steps between normal detailed printout.		
298	MFREQA	Total number of time steps under LFREQA control.		
299	LFREQB	Final print frequency.		
300	LGRAPH	Graphics file option. = 0, Do not write graphics file. = 1, Write a graphics datafile.		
301	LDBOUT	= 0, No debug output. = 1, Add debug output to regular LOUTSW=2 output.		
302	LDBSTP	= 0, FPIN2 calculation stops when molten cavity freezes. = 1, Ignore this program stop.		
303	LDBFPL	= 0, Use recommended fuel flow stress. = 1, Simple power law fuel creep (EPSDOT=C0*SIGE**C1). See XFPLC0 and XFPLC1.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
304	LDBFDV	= 0, Use recommended fuel swelling – hot pressing. (Fuel swelling option for metal fuel is the simple grain boundary swelling model, ANL-IFR-27 and ANL/RAS 83-33). = 1, Use equilibrium swelling model (ANL-IFR-6 & -23). = 2, Simple power law fuel swelling (EPVDOT=C0*SIGM**C1). See XFDVC0 and XFDVC1.		
305	LDBCPL	= 0, Use recommended cladding flow stress. = 1, Ideal plastic flow for cladding (SIGY=C0+C1*EPBAR). See XCIPL0 and XCIPL1. = 2, Use high-temperature power-law creep. = 3, Use simple power law cladding creep (EPSDOT=C0*SIGE**C1). See XCIPL0 and XCIPL1.		
306	LGPRES	Not currently used.		
307	LGAPCL	= 0, Use fuel-cladding opening/closure model. = 1, Fuel-cladding gap always closed.		
308	LCPROP	= 0, Use material property correlations. = 1, Use temperature independent material properties. (SAS thermal properties are used for IFPI01=0).		
309	LSKIPM	= 0, Perform mechanical calculations. = 1, Bypass mechanical calculations.		
310	LGCLOS	= 0, Use gap closure routine at 100% fuel melting. = 1, Do not close gap (if open) at 100% fuel melting.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
311-334	LDBOTA (J)	Axial debug print vector. = 0, No print. = 1, Print.		
335-345	LDBOTF (IF)	Fuel radial debug print vector. = 0, No print. = 1, Print.		
346-348	LDBOTC (IC)	Clad radial debug print vector. = 0, No print. = 1, Print.		
349-360		Reserved.		
		PRIMAR-4 MULTIPLE INLET/OUTLET PLENA		
361	NSEGMP	PRIMAR-4 segment number to which this channel is assigned in the multiple inlet/outlet plena model (See IFMIOP).		
		CONTROL ROD DRIVE FEEDBACK		
362	ICHUIS	= 0, Coolant from channel ICH is included in the upper internal structure temperature calculation for control rod drive expansion reactivity. = 1, This channel is not used.		
		PINACLE		
363	LQSLTP	= 0, Wall friction is not considered in calculating the velocity of the sodium slug above the fuel. = 1, Wall friction is considered.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
		POWER AND REACTIVITY MESH		
364	IPOWRZ	Axial power shape input option. = 0, Enter channel axial power shape in array PSHAPE on the MZ axial mesh; JMAX=24. = 1, Enter channel axial power shapes for core and axial blanket fuel in arrays PSHAPC (core fuel power shape) and PSHAPB (blanket fuel power shape) on the MZC axial mesh; JMAX=48.		
365	IREACZ	Axial reactivity worth input option. = 0, Enter channel axial reactivity worths for Doppler, coolant void, cladding motion, and fuel motion in arrays WDOPA, VOIDRA, CLADRA, and FUELRA on the MZ axial mesh; JMAX=24. = 1, Enter channel axial reactivity worths for Doppler, coolant void, cladding motion, and fuel motion in arrays WDOPA, VOIDRA, CLADRA, and FUELRA on the MZC axial mesh; JMAX=48.		
		FUEL ZONE TYPE ASSIGNMENT		
366-389	IZNC (J)	Outermost radial mesh interval of central zone at axial segment J. Maximum value = NT. See also RIZNC, Block 61, locations 224-247. Used only for IFUELC = 1.		
390-413	IZNM (J)	Outermost radial mesh interval of middle (intermediate) zone at axial segment J. Maximum value = NT. See also RIZNM, Block 61, locations 248-271. Used only for IFUELC = 1.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
414-485	MFTZN (L,J)	Fuel type (IFUEL) assignment to radial zones at axial segment J. Maximum value = 8. Used only for IFUELC = 1. L=1, fuel type assigned to central (inner) zone. L=2, fuel type assigned to middle intermediate) zone. L=3, fuel type assigned to outer zone. Note: A maximum of three radial zones may be specified at each axial level. Fewer than three zones may also be specified, with a minimum of a single zone assigned to all the fuel in the pin at a given axial location. Zones are assigned assuming azimuthal symmetry; the central (inner) zone begins at the fuel centerline and extends outward radially through radial mesh interval IZNC(J). The middle (intermediate) zone begins at radial mesh interval IZNC(J)+1 and extends outward radially through radial mesh interval IZNM(J). The outer zone begins in radial mesh interval IZNM(J)+1 and extends outward radially to the fuel surface (radial temperature node NT). The central zone may be eliminated by setting IZNC(J) = 0. The middle zone may be eliminated by setting IZNM(J) = IZNC(J). The outer zone may be eliminated by setting IZNM(J) = NT. Both inner and middle zones may be eliminated by setting IZNC(J) = IZNM(J) = 0. The central zone is present only if IZNC(J) > 0. The middle zone is present only if IZNM(J) > IZNC(J). The outer zone is present only if IZNM(J) < NT. The MFTZN array assigns a fuel type to a zone; fuel types and zones have a one- to-one correspondence at each axial level. The fuel types assigned here specify the fuel thermo-physical properties to be used in the solution of the fuel pin heat transfer equations. See IFUELC, loc. 193.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
486	IPINFG	Metal fuel fission gas model flag. = 0, Use DEFORM-5 fission gas formulation. > 0, Use PINACLE fission gas formulation.		
487	IPINRE	PINACLE ejected fuel re-entry flag. = 0, Re-entry of fuel ejected into above-core region not permitted. > 0, Allow re-entry into active core region of fuel ejected into above-core region.		
488	IPORFG	Density correction to porosity in DEFORM-5 fission gas model. = 0, Neglect transient temperature/density impact on open porosity volume. > 0, Adjust open porosity volume accounting for transient temperature/density changes.		
489	IPRSS1	Steady state fuels characterization initial values print in subroutine SSINC1. = 0, Print initial values for pointwise fuel mass and porosity; Pu content for IMETAL = 2; Zr content for IMETAL = 2 or 3; Fe and Ni content for IMETAL = 2 and IFUELO = 1; Na content for IMETAL > 0. = 1, No prints.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
490	IMKVPL	EBR-II Mark-V safety case plotting data. = 0, Do not save data for post-processing. > 0, Compute and save maximum fuel temperature in low Zr zone, maximum inner cladding temperature, and minimum coolant saturation temperature in the channel on each main time step (Entry TSPLT1 in subroutine TSPLOT). Compute and save reactor power, flow, and power-to-flow ratio on each main time step (Entry TSPLT3 in subroutine TSPLOT).		
491	MZCHCH	See FED.		
492	KZEMFM	See FED.		
493	MTREAT	TREAT fuel channel modeling flag. = 0, Use standard fuel channel models. > 0, Use special TREAT fuel channel models. See also CFLAT and FFLAT. RBR, RER, and ROUTFP contain TREAT fuel assembly half-thickness dimensions. In fuel and cladding heat transfer calculations, the correct periphery will be used in place of the circumference. The structure field will be eliminated. The fission gas plenum will be eliminated. Air properties will be used for the coolant. The coolant pressure drop calculation will be eliminated. One pin per channel will be used. The DEFORM, PRIMAR, and multiple pin models are not allowed. Only equally-spaced radial heat transfer mesh (IEQMAS=0) is allowed.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
494	IFLOOD	= 0, Use FVAPM (Block 64, loc. 174) to determine the friction factor multiplier for the vapor. = 1, Use Wallis flooding correlation to determine whether to use the Wallis friction factor multiplier for the vapor. This option should only be used with the film motion model, IDRY (Block 51, loc. 224) = 1.		
		DETAILED COOLANT SUB-CHANNEL MODEL ISCH = 1 and JJMLTP ≠ 0		
495	IFT24	Output detailed coolant sub-channel model variables on fort.24 every IFT24 time steps. If IFT24 = 0, no output on fort.24. Reserved for the detailed coolant sub-channel model		
496	ILATF	Always use ILATF = 0 to include lateral flow terms in the momentum equation for the detailed coolant sub-channel model. Reserved for the detailed coolant sub-channel model.		
497-500	IDMICH	Not currently used.		
501	NFT24	Number of items to be output on fort.24 Reserved for the detailed coolant sub-channel model.		
502-521	JCFT24 (K)	Axial node for the Kth output on fort.24. Reserved for the detailed coolant sub-channel model.		

Block 51 — INPCHN — Channel-Dependent Options and Integer Input

Location	Symbol	Description	Units	Used By
522-541	ITYP24 (K)	Variable type for the Kth output on fort.24 = 1, PCBAR2 (coolant pressure, middle of the node) = 2, W2RT2 (coolant flow rate) = 3, TCOOL2 (coolant temperature at the bottom of the node) = 4, TCBAR2 (coolant temperature at the middle of the node) = 5, PCOOL2 (coolant pressure, bottom of the node) = 6, WLAT2(1) (coolant lateral flow rate to first adjacent subchannel = 7, WLAT2(2) (coolant lateral flow rate to second adjacent subchannel = 8, WLAT2(3) (coolant lateral flow rate to third adjacent subchannel = 9, WLAT2(4) (coolant lateral flow rate to fourth adjacent subchannel =10, NITER (number of iterations for the last solution in SOLVIT Reserved for the detailed coolant sub-channel model.		
542	NULPT1	Print results every NULPT1 steps for the null transient (see NULST1, loc. 221) Reserved for the detailed coolant sub-channel model.		
543-600	IDMICH	Not currently used.		

Block 61 — GEOMIN — Channel-Dependent Geometry Data

Location	Symbol	Description	Units	Used By
1-7	ACCZ (KZ)	Coolant flow area per fuel-pin in zone KZ. For example, core plus axial blankets plus fission-gas plenum, i.e., the whole fuel-pin length, is one zone. Each axial reflector is a separate zone.	m^2	BL
8-31	AXHI (J)	Length of axial segment J, $1 \le J \le MZ$. MZ is the number of axial segments in core plus blankets. Note: All should be as equal in size as possible.	m	BL DF
32-38	DHZ (KZ)	Hydraulic diameter in zone KZ.	m	BL
39-45	DSTIZ (KZ)	DSTI (thickness of inner structure node) in zone KZ. (See Block 13, location 1214 for consistent input).	m	BL
46-52	DSTOZ (KZ)	DSTO (thickness of outer structure node) in zone KZ. (See Block 13, location 1214 for consistent input)	m	BL
53	PLENL	Length of fission-gas plenum.	m	BL
54-77	RBR (J)	Cladding inner radius for axial segment J, $1 \le J \le MZ$. Note: If all values are the same, only the first must be input.	m	BL DF
78-101	RER (J)	Cladding outer radius for axial segment J, $1 \le J \le MZ$. Note: If all values are the same, only the first must be input.	m	BL DF
102	RBRPL	Cladding inner radius in gas plenum.	m	BL DF
103	RERPL	Cladding outer radius in gas plenum.	m	BL DF

Block 61 — GEOMIN — Channel-Dependent Geometry Data

Location	Symbol	Description	Units	Used By
104-127	RINFP (J)	Fuel inner radius for axial segment J, 1 ≤ J ≤ MZ. (Minimum of 1.0E-6 if ISSFUE = 1). Note: If all values are the same, only the first must be input.	m	DF
128-151	ROUTFP (J)	Fuel outer radius for axial segment J, 1 ≤ J ≤ MZ. Note: If all values are the same, only the first must be input.	m	DF
152-158	ZONEL (KZ)	Length of zone KZ.	m	BL
159-165	SRFSTZ (KZ)	SFR, structure perimeter in zone KZ per pin.	m	BL
166	AREAPC	APC, coolant plus pin area per pin, in the pin section.	m^2	BL
167	CFLAT	Beveled corner dimension on outer cladding surface for MTREAT > 0.	m	BL
168	FFLAT	Beveled cormer dimension on outer fuel surface for MTREAT > 0.	m	BL
169-175	DRFO (KZ)	KZ = 1, NZONE. For KZ not equal to KZPIN, DRFO is the thickness of the outer reflector node in zone KZ. Note that a two-node, slab-geometry treatment is used for heat transfer to the reflector. (See locations 189-195 for the inner node thickness). For KZ = KZPIN, DRFO = cladding thickness in the plenum region (RERPL - RBRPL).	m	BL
176	STCOR	Not currently used.		
177	VFPLNT	Not currently used.		
178	VFLREF	Not currently used.		
179	VFUREF	Not currently used.		

Block 61 — GEOMIN — Channel-Dependent Geometry Data

Location	Symbol	Description	Units	Used By
180	RBR0	Nominal cladding inner radius.	m	BL
181	RER0	Nominal cladding outer radius.	m	BL
182-188	SER (KZ)	For KZ not equal to KZPIN, SER is the reflector perimeter per pin wetted by coolant in the reflector zone. For KZ = KZPIN, SER is the pin perimeter in the gas plenum region.	m	BL
189-195	DRFI (KZ)	KZ = 1,...,NZONE. DRFI is the thickness of the inner reflector node in zone KZ.	m	BL
196	VFC	Not currently used.		
197-220	RAFUZ	Not currently used.		
221	ZCHOBT	Axial coordinates lower end of the hodoscope field of view referenced to the fuel pin bottom. Used only for TREAT experiment analysis.		LE PL
222	ZCHOTP	Axial coordinates upper end of the hodoscope field of view referenced to the fuel pin bottom. Used only for TREAT experiment analysis.		LE PL
223	ZOFFST	Axial (Z) offset, elevation of the bottom of the lower blanket. Default = 0.	m	
224-247	RIZNC (J)	Outer radius of central zone corresponding to IZNC(J). Default value of zero results in central zone outer radius being set by IZNC(J) and the assumption of an equal delta R radial mesh. Used only for IFUELC = 1.	m	
248-271	RIZNM (J)	Outer radius of intermediate zone corresponding to IZNM(J). Default value of zero results in intermediate zone outer radius being set by IZNM(J) and the assumption of an equal delta R radial mesh. Used only for IFUELC = 1	m	
272	TWASTI	Initial wastage thickness on the cladding inner surface. Used in DEFORM-5 and FPIN2.	m	

Block 61 — GEOMIN — Channel-Dependent Geometry Data

Location	Symbol	Description	Units	Used By
273	TWASTO	Initial wastage thickness on the cladding outer surface. Used in DEFORM-5 and FPIN2.	m	
274	XXNPIN	Number of pins per subassembly. Used only by the multiple pin model. See also NPIN (Block 51, loc. 25). If XXNPIN is 0.0, then the code will set XXNPIN = NPIN. If XXNPIN is not 0.0, then NPIN will be set to XXNPIN, rounded (not truncated) to the nearest integer.		
275-284	DZEMFM	See FED.		
285-350	DUMGEO	Not currently used.		

Block 62 — POWINC — Channel-Dependent Power and Reactivity Input

Location	Symbol	Description	Units	Used By
1	FPDAYS	Effective full power days during the steady state irradiation. Used with FLTPOW (Block 62, location 61) to determine cladding fluence when BURNFU (Block 65, location 54) is not used.		
2	GAMSS	Fraction of total power in direct heating of structure.		BL
3	DUM002	Not currently used.		
4	GAMTNC	Fraction of total power in direct heating of coolant.		BL
5	GAMTNE	Fraction of total power in direct heating of cladding.		BL
6-29	PSHAPE (J)	Ratio of pin power at axial segment J to the power POW in the peak axial fuel pin segment, $1 \le J \le MZ$. MZ is the number of axial heat transfer segments in the core plus axial blankets. Enter only for IPOWRZ = 0. The first entered segment value (J=1) is for the lower-most segment in the lower axial blanket. Values are normalized to POW or POWTOT using NPIN, NSUBAS, and PRSHAP at the initial steady-state.		BL
30-44	PSHAPR (I)	Radial power shape within pin by radial node, I, normalized power per unit fuel mass, $1 \le I \le NT$.		BL
45-52	PLIN (M)	Relative power level at the end of the M steady-state division. It is required that PLIN is 1.0 at the end of the steady-state. It is assumed that during power change periods, the power varies linearly over the time interval from the previous value to the current PLIN(M) value. (M = 1, MSTEP)		DF
53-60	TPLIN (M)	Time (from fresh start-up) at the ends of the M steady-state divisions (seconds). M = 1, MSTEP.		DF

Block 62 — POWINC — Channel-Dependent Power and Reactivity Input

Location	Symbol	Description	Units	Used By
61	FLTPOW	Fast flux to linear power ratio.	(#/m^2-s)/(W/m)	DF
62	ADOP	Doppler coefficient for this channel when part of the core represented by this channel is not voided.	Δk/k	
63	BDOP	Doppler coefficient for this channel when part of the core represented by this channel is fully voided.	Δk/k	
64-111	WDOPA (J)	Doppler axial weighting factor. Enter MZ values for IREACZ=0. Enter MZC-1 values for IREACZ=1.		
112-159	VOIDRA (J)	Coolant void reactivity worth per unit coolant mass. Enter MZ values for IREACZ=0. Enter MCZ-1 values for IREACZ=1.	Δk/k-kg	
160-207	CLADRA (J)	Cladding reactivity worth per unit cladding mass. Enter MZ values for IREACZ=0. Enter MCZ-1 values for IREACZ=1.	Δk/k-kg	
208-255	FUELRA (J)	Fuel reactivity worth per unit fuel mass. Enter MZ values for IREACZ=0. Enter MCZ-1 values for IREACZ=1.	Δk/k-kg	
256	PRSHAP	Ratio of power per subassembly averaged over this channel to the power per sub- assembly averaged over all channels. Note: These values are normalized by SAS4A over all assemblies such that the average is 1.0.		

Block 62 — POWINC — Channel-Dependent Power and Reactivity Input

Location	Symbol	Description	Units	Used By
257-261	PSHPTP (J)	In PINACLE, PLUTO2, and LEVITATE for IPOWRZ=0, ratio of active fuel power at axial segment KCORE2+J to the power POW in the peak axial fuel segment. 1 ≤ J ≤ 5. KCORE2 is the top active fuel node. This array is used when active fuel relocates above the original active fuel, either in-pin (PINACLE) or ex-pin (PLUTO2, LEVITATE).		
262-266	PSHPBT (J)	In PLUTO2 and LEVITATE for IPOWRZ=0, ratio of active fuel power at axial segment KCORE1 - J to the power POW in the peak axial fuel segment. 1 ≤ J ≤ 5. KCORE1 is the bottom active fuel node. This array is used when active fuel relocates below the original active fuel due to ex-pin fuel motion (PLUOT2, LEVITATE).		
267	FLOWBU	Fraction of subassemblies in channel that have low (<2.9 at.%) burnup.		
268	XRFSHP	Relative reactivity worth of fuel in the channel. Used in EBR-II feedback model.		
269	XRNSHP	Relative reactivity worth of sodium in the channel. Used in EBR-II feedback model.		
270	XRSSHP	Relative reactivity worth of stainless steel in the channel. Used in EBR-II feedback model.		
271-318	PSHAPC (J)	Ratio of core fuel pin power at axial segment J to the power POW in the peak axial fuel pin segment, 1 ≤ J ≤ MZC-1. MZC-1 is the number of axial coolant segments. Enter only for IPOWRZ = 1. The first entered segment value (J=1) is for the lower-most segment in the lower axial reflector. Values are normalized to POW or POWTOT using NPIN, NSUBAS, PRSHAP, PSHAPB, and the core fuel and blanket fuel mass distributions at the initial steady-state.		

Block 62 — POWINC — Channel-Dependent Power and Reactivity Input

Location	Symbol	Description	Units	Used By
319-366	PSHAPB (J)	Ratio of blanket fuel pin power at axial segment J to the power POW in the peak axial fuel pin segment, 1 ≤ J ≤ MZC-1. MZC-1 is the number of axial coolant segments. Enter only for IPOWRZ = 1. The first entered segment value (J=1) is for the lower-most segment in the lower axial reflector. Values are normalized to POW or POWTOT using NPIN, NSUBAS, PRSHAP, PSHAPC, and the core fuel and blanket fuel mass distributions at the initial steady-state.		
		EBR-II MK-V SAFETY CASE INPUT		
367	FHTCLD	Cladding steady-state hot channel factor.		
368	FUNKCL	Transient cladding thermal conductivity uncertainty factor.		
369	FUNKFU	Transient fuel thermal conductivity uncertainty factor. Used for IMETAL > 0 and IFUELM = 2.		
370	FUNFLM	Transient film heat transfer uncertainty factor.		
371	FHTFUL	Fuel steady-state hot channel factor.		
372	FUNCOL	Transient coolant flow uncertainty factor.		
373	FPKNG	Peaking factor.		
374	FUNPOW	Transient power uncertainty factor.		
		END OF EBR-II MK-V SAFETY CASE INPUT		
375	COILP0	See FED.		
376	COILP1	See FED.		
377	COILP2	See FED.		
378-400		Not currently used.		

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
1	TIMCNS	Time constant for fuel pin heat transfer. Default = 0.1.	s	
2-4	AHBPAR BHBPAR CHBPAR	If all three parameters are not equal to 0.0, the bond correlation is of the form: HB = AHBPAR + 1.0/(BHBPAR +(gap size + CHBPAR)/HBPAR)	W/m^2-K m^2-K/W-m	
5	HBMAX	Maximum value of bond conductance when a gap exists; minimum value when a gap does not exist. Default when AHBPAR, BHBPAR, and CHBPAR > 0.0: HBMAX = AHBPAR + 1.0/(BHBPAR+CHBPAR/HBPAR)	W/m^2-K	DF
6	HBMIN	Minimum value of bond conductance.	W/m^2-K	DF
7	HBPAR	If all three parameters in locations 2-4 are zero, then the bond conductance equation when a gap exists is of the form: Bond conductance = HBPAR/gap.	W/m-K	
8	HSNK	Should be set to 0.0.		
9	TSNK	Should be set to 0.0.		
10	DPRSTY	Not currently used.		
11-17	XKSTIZ (KZ)	Inner structure thermal conductivity in zone KZ.	W/m-K	
18-24	XKSTOZ (KZ)	Outer structure thermal conductivity in zone KZ.	W/m-K	
25	DEL	Stefan-Boltzmann's constant*emissivity. (See Block 13, locations 1107-1109).	W/m^2-K^4	
26	DGO	Initial grain size. Suggested value: 1.0E-05.	m	DF

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
27	P0GAS	Initial plenum gas pressure at reference temperature TR.	Pa	DF
28-34	XKRF (KZ)	Thermal conductivity of reflector for values of KZ not equal to KZPIN. XKRF(KZPIN) = thermal conductivity of cladding in the gas plenum region.	W/m-K	
35	DENSS	Density of solid cladding at the reference temperature TR.		CL
36	COOLDN	Not currently used.		
37-43	RHOCSI (KZ)	Density * heat capacity for the inner structure.	J/m^3-K	
44-50	RHOCSO (KZ)	Density * heat capacity for the outer structure.	J/m^3-K	
51-57	RHOCR (KZ)	Density * heat capacity for the reflector. For KZ = KZPIN (the pin zone), RHOCR is for the cladding in the gas plenum.	J/m^3-K	
58	RHOCG	Density * heat capacity for the gas in the gas plenum..	J/m^3-K	
59	RG	Thermal resistance of plenum gas, typical value = 0.06.	m^2-K/W	
60	FGMIN	Fraction of retained fission gas that assists non-equilibrium fission gas bubble induced fuel swelling (burnup dependent).		
61	RST	Not currently used.		
62	WRF	Not currently used.		
63	RREF	Not currently used.		
64	EMF	Not currently used.		
65	EMS	Not currently used.		
66	EMNA	Not currently used.		

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
67	HMELT	Not currently used.		
68	FCLOP	Fraction of open porosity that must be removed before axial movement allowed with metal fuels 0 ≤ FCLOP ≤ 1. =0, Open porosity volume remains constant. =1, All open porosity volume used before axial movement allowed.		
69	TSEP1	Fuel plasticity temperature = TSEP1 + TSEP2 * (fuel-cladding interface pressure - plenum gas pressure). The fuel pellet annulus at this temperature does not move radially inward or outward during calculations of fuel mesh boundaries. Suggested value: 2700 for oxide fuel.	K	DF
70	TSEP2	Pressure adjustment to plasticity temperature. Recommended value: 10^{-8}.	K/Pa	DF
71	BONDNA	Mass of sodium added to fuel pin to produce the fuel-cladding bond.	kg	
72	REFDEN	Theoretical density of metal fuel at the reference temperature. Used for IFUELM = 2.	kg/m^3	
73	FUELEX	Fuel axial expansion coefficient. Used only with simple axial expansion feedback calculation. (See Block 51, location 181). Typical value: 1.1E-5.	1/K	
74	CLADEX	Cladding axial expansion coefficient. Used only with simple axial expansion feedback calculation. (See Block 51, location 181). Typical value: 2E-5.	1/K	
75	YFUEL	Fuel young's modulus. Typical value: 1.5E11. Used with simple axial expansion and EBR-II feedback calculations.	Pa	

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
76	YCLAD	Cladding Young's modulus. Typical value: 1.4E11. Used with simple axial expansion and EBR-II feedback calculations.	Pa	
77	FULREX	Fuel linear expansion coefficient for bond gap conductance calculation.	1/K	
78	CLDREX	Cladding linear expansion coefficient for bond gap conductance calculation. Note: FULREX and CLDREX are used only if ISSFU2 = -1 (Block 51, loc 122) and IHGAP = 0 (Block 51, loc 24).	1/K	
79	EXPCFF	Effective axial expansion multiplier, for simple axial expansion feedback model only.		
80	TTRANM	Transition temperature for determining the outer boundary of the middle fuel zone in the SSCOMP model for IFUELO = 1.	K	SC
81	TTRANC	Transition temperature for determining the outer boundary of the central fuel zone in the SSCOMP model for IFUELO = 1.	K	SC
82-89	HACHCH	Channel-to-channel (duct wall-to-duct wall) heat transfer coefficient x area per unit height. Used only if NCHCH > 0. Note: Use the total duct wall contact area for all subassemblies involved.		
90-92	POROSS	Porosity of the outer zone, middle zone, and central zone of metal fuel at the end of steady-state irradiation. Used in the SSCOMP model for IFUELO = 1.		SC
93-103	FPORNA	Ratio of sodium filled porosity to total porosity in the metal fuel by radial mesh node at the end of the pre-transient irradiation. Used in SSCOMP for IFUELO = 1.		SC

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
104	TAUINV	Inverse of heat transfer time constant. Degree of implicitness, THETA2, is: THETA2 = (1 + X)/(2 + X) X = DT * TAUINV DT = time step size Currently only used with the multiple pin option (JJMLTP not equal to 0). Suggested value: 5.0 for metal fuel, 1.0 for oxide fuel.	1/s	
		FPIN-2 INPUT		
105	XEUTHR	Eutectic threshold temperature (K). Default value = 988. (See FSPEC for consistent input).	K	
106	XGBFRA	Not currently used.		
107-130	XCLDHR (J)	Pre-transient hardness parameter used in cladding flow stress calculation. Default value is 0.223, the value appropriate to 20% CW un-irradiated stainless steel.		
131	XFPLC0	Fuel power law creep constant C0.		
132	XFPCL1	Fuel power law creep constant C1.		
133	XFDVC0	Fuel power law swelling constant C0.		
134	XFDVC1	Fuel power law swelling constant C1.		
135	XCIPL0	Cladding idealized flow stress constant C0.		
136	XCIPL1	Cladding idealized flow stress constant C1.		
137	XHTERR	Relative convergence criterion for heat transfer calculation. Default value = 0.0005.		

Block 63 — PMATCH — Channel-Dependent Properties Input

Location	Symbol	Description	Units	Used By
138	XEPSCA	Relative convergence criterion for cavity pressure. Default value = 0.001.		
139	XEPSFE	Relative convergence criterion for finite element analysis. Default value = 0.0005.		
140	XEPTES	Relative convergence criterion for plastic creep strains. Default value = 0.0005.		
141	XEVTES	Relative convergence criterion for swelling strains. Default value = 0.0005.		
		END FPIN-2 INPUT		
142	XMCFMC	See FED.		
143	HACIFM	See FED.		
144	HACOFM	See FED.		
145	HAFMOP	See FED.		
146	HAGPFM	See FED.		
147	TOPLSS	See FED.		
148-200	DUMPCH	Not currently used.		

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
1-2	AFR BFR	Liquid slug friction factor coefficients. Default values: AFR = 0.1875, BFR = -0.2.		BL
3-5	C1 C2 C3	Coefficients in convection heat-transfer coefficient equation: Hc = Kc*(C1*(Re*Pr)**C2 + C3)/Dh (Lyon-Martinelli correlation). Kc: coolant thermal conductivity Re: Reynolds number Pr: Prandtl number Dh: channel hydraulic diameter		BL CL
6	DWMAX	Maximum fractional change per heat-transfer step in coolant flow rate before boiling. Default: = 0.2		
7	RELAM	Reynolds number for switch between turbulent friction factor and laminar friction factor.		
8	AFLAM	Laminar friction factor = AFLAM/Re, where Re is the Reynolds number. Suggested value: 64.		
9-46	DUM000	Not currently used.		
47	W0	W, steady-state coolant flow rate per fuel-pin.	kg/s	
48-63	XKORI (K,M)	Orifice coefficients. K < 8: K = 1,2, ..., NREFB+NREFT+1: XKORV(K,M) is the coefficient at the bottom of zone K. K = NREFB+NREFT+2: XKORV(K,M) is the coefficient at the top of the subassembly. M = 1, for upward flow. M = 2, for downward flow. Example: ((K=1,2,...),M=1,2)		

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
64	XKORGD	Orifice coefficient for spacer grids in pin. See NGRDSP.		
65	DZIAB	Effective coolant inertial term below the subassembly inlet. Suggested value: D/(2*ACC), where D is the subassembly inlet hydraulic diameter and ACC is the inlet cross-sectional flow area per pin.	1/m	BL
66	DZIAT	Effective coolant inertial term above the subassembly outlet. Suggested value: D/(2*ACC), where D is the subassembly outlet hydraulic diameter and ACC is the outlet cross-sectional flow area per pin.	1/m	BL
67	THETA1	= 0.5 normally; = 0.0 for implicit calculation.		BL
68	THETA2	= 0.5 normally; = 1.0 for implicit calculation.		BL
69	DTLMAX	Maximum temperature change/coolant time step in liquid. Suggested value: 15.	K	BL
70	DTVMAX	Maximum temperature change/coolant time step in vapor. Suggested value: 50.	K	BL
71	DZIMAX	Maximum interface motion/coolant time step. Suggested value: 0.1.	m	BL
72	HCOND	Condensation heat-transfer conductance of coolant.	W/m^2-K	BL
73	SLMIN	Minimum initial liquid slug length. Recalculated as cladding melting is approached. Default: 0.02.	m	BL

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
74	TUPL	Temperature of liquid coolant re- entering the subassembly from above. Used only with PRIMAR-1.	K	BL PL
75	WFMIN	Minimum film thickness on cladding. Burnout is assumed for film thickness less than WFMIN. For static film option WFMIN is approximately 0.667*WF0. Film motion model is not operational. Default: 1.0E-7. (See locations 172–173).	m	BL
76	WFMINS	Minimum film thickness on structure. Default: WFMIN	m	BL
77	WFS00	Initial film thickness on structure. Default: WF0.	m	BL
78-80	FRACP (M)	Fraction of pins in this channel in failure group M. See IGASRL.		BL
81-83	FRUPT (M)	Cladding life fraction for cladding failure in group M. See IGASRL.		BL
84	WF0	Initial thickness of liquid coolant film left on the cladding in a voided region. Suggested value: That thickness corresponding to a total liquid volume fraction of 0.15 (spread between cladding and structure films) in the voided region.	m	BL
85-104	TFIS (I)	Not currently used.		
105-124	PFIS (I)	Not currently used.		
125-144	ZFISU (I)	Not currently used.		

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
145-162	ZFISD (I)	Not currently used.		
163	DTSWCH	Switch from pre-boiling to boiling when coolant temperature is within DTSWCH of boiling. Default: 5 K.	K	BL
164	DTSI	Superheat for bubble formation near a liquid-vapor interface.	K	BL
165	DTS	Superheat before any sodium vapor bubble can be formed.	K	BL
166	RESMLT	Not currently used.		
167	TEMDLT	Not currently used.		
168-169	AFRV BFRB	Vapor friction factor = AFRV*(Re)**BFRV. Default values: AFRV = 0.316, BFRV = -0.25.		BL CL
170	XMINL	Vapor pressure gradient calculation starts when vapor bubble length is XMINL. Default: 0.05.	m	BL
171	DTCMIN	Minimum coolant time-step size before boiling. Suggested value: 1.0E-6.	s	
172	WFMIND	Minimum cladding film thickness after IFILM (Block 51, location 128) film nodes have dried out. Suggested value: 1.0E-7	m	BL
173	WFMNSD	Minimum structure film thickness after IFILM nodes have dried out. Suggested value: 1.0E-7	m	BL
174	FVAPM	Fraction of two-phase friction factor to be used in vapor calculation. =0, For single-phase friction factor. =1, For two-phase friction factor.		BL

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
175	AFRF	Liquid film friction factor coefficient. Friction factor = AFRF * (Re) ** BFRF Default: 0.316.		BL
176	BFRF	Liquid film friction factor coefficient. Default: -0.25.		BL
177	TPDMIN	Minimum coolant time step size during boiling. Suggested value: 1.0E-6.	s	BL
178	DTACCL	Acceleration term is dropped from the momentum equation for Na vapor in a pressure drop bubble if the time step size is less than DTACCL. Suggested value: 1.0E-5.	s	BL
179	REFLAM	Reynolds number for switch to laminar friction factor for liquid film.		BL
180	AFFLAM	Laminar film friction factor = AFFLAM/Re, where Re is the Reynolds number.		BL
181	AGSRLS	Flow area between gas plenum and rupture point, used only if IGASRL = 1.	m^2	BL
182	GASKOR	Orifice coefficient between gas plenum and rupture point, used only if IGASRL =1.		BL
183	PGRMIN	Shut off gas release when plenum pressure falls below PGRMIN, used only if IGASRL = 1.	Pa	BL
184	GASMW	Molecular weight of plenum gas. Suggested value: 100-130.		BL
185	HEBOIL	Boiling heat transfer enhancement factor. Suggested value: 1.0 for Na, 50-100 for D2O.		BL
186-188	TMFAIL (M)	Pin failure time for pin group M for the gas release model. Used only if IGASRL=2.	s	BL

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
189-190	UACH1 UACH2	Channel-to-channel heat flow per pin per unit height at axial node J from coolant in channel I to coolant in channel I+1 is calculated as: Q(J)=(UACH1(I)*K(J)+UACH2(I)*C(J)*(W(I)+W(I+1)))*(T(I,J)-T(I+1,J)) Where T(I,J) = Coolant temperature K(J) = Coolant thermal conductivity C(J) = Coolant specific heat W(I) = Coolant flow rate Note: UACH1 and UACH2 are used only if JJMLTP is not equal to 0.		
191	REORFT	Transition Reynolds number for the inlet orifice. The inlet orifice goes laminar for smaller Reynolds numbers. Used only if JJMLTP > 0 (See Block 51, Loc. 214).		
192	FLSWCH	Switch to lumped node coolant temperature treatment when |W/W0| < FLSWCH. Only in reflector zones. Only in the pre-boiling calculation.		
193	RELAMV	Vapor Reynolds number for switch from laminar to turbulent.		
194	AFLAMV	Vapor laminar friction factor = AFLAMV/Re.		
195	FLODTM	Film flooding time. Only used if IFLOOD = 1 (Block 51, loc. 494).	s	
196	QEMAX	Maximum heat flux from clad to vapor in a voided region. Default: no limit.	W/m^2	

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
		DETAILED COOLANT SUB-CHANNEL MODEL		
197-200	UACHM1 (K)	Coolant sub-channel to sub-channel heat flow per pin per unit height at axial node J from channel I to channel L is calculated as: Q(J)= (UACHM1*k(J)+UACHM2*C(J)*(W(I)+W(L+1))) *(T(I,J)-T(L,J)) where T(I,J) = coolant temperature k(J) = coolant thermal conductivity C(J) = coolant heat capacity W(I) = coolant flow rate L = the Kth channel that channel I is in contact with Note: UACH1 and UACH2 were used for a previous multiple pin model. UACHM1(K) and UACHM2(K) are used for the current detailed coolant sub-channel model. Reserved for the detailed coolant sub-channel model.		
201-204	UACHM2 (K)	See UACHM1. Reserved for the detailed coolant sub-channel model.		
205-208	ALATRL (K)	ALATRL Coolant lateral flow area per pin per unit height. Reserved for the detailed coolant sub-channel model.	m	
209-212	XKLAT (K)	Lateral flow orifice coefficient. Reserved for the detailed coolant sub-channel model.		

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
213	DPLTLM	Lateral flow goes laminar if pressure difference between adjacent sub-channels is less than DPLTLM. Reserved for the detailed coolant sub-channel model.	Pa	
214	XKSWRL	Swirl flow between sub-channels = XKSWRL*DZ*WAV DZ = axial node height WAV = average of sub-channel axial coolant flow rates See also KSWIRL, Block 51, loc. 220. Reserved for the detailed coolant sub-channel model.	1/m	
215	DTNUL1	Time step for the single sub-assembly null transient. Reserved for the detailed coolant sub-channel model.	s	
216	EPSFLW	Iteration convergence criterion, flow rates Reserved for the detailed coolant sub-channel model.	kg/s	
217	EPSTMP	Iteration convergence criterion, coolant temperatures. Reserved for the detailed coolant sub-channel model.	K	
218	EPSPRS	Iteration convergence criterion, coolant pressures. Reserved for the detailed coolant sub-channel model.	Pa	

Block 64 — COOLIN — Channel-Dependent Coolant Input

Location	Symbol	Description	Units	Used By
219	XCMPRS	Compressibility multiplier for the mass conservation equation. Default = 1.0 Reserved for the detailed coolant sub-channel model.		
220	XLINRT	Inertial length for sub-channel to sub-channel flow. Reserved for the detailed coolant sub-channel model.	m	
221-300	DUMCOO	Not currently used.		

Block 65 — FUELIN — Channel-Dependent Fuel Input

Location	Symbol	Description	Units	Used By
1	FSPEC	Fuel-pin failure criterion, threshold value. (See also Block 65, loc 2 and 19). See MFAIL.		
2	FMELTM	The minimum fuel melt fraction that must exist at the failure node before PLUTO2 or LEVITATE is allowed to be called. Suggested value: 0.2 (must be input > 0).		DF PL
3	DENS	Liquid cladding density at the liquidus.	kg/m^3	CL
4	AE	Coefficient of linear expansion of solid cladding (=1/3 volume coefficient).	1/K	CL
5	RHOCD	Volumetric coefficient of expansion for liquid cladding.	1/K	CL
6	VISMC	Viscosity of cladding at liquidus temperature. At higher temperatures, viscosity=VISMC*EXP(AVISC/TELIQ-AVISC/T).	Pa-s	CL
7	VISTR	Viscosity of cladding at solidus temperature. Between solidus and liquidus, viscosity=(VISTR-VISMC)* (1-FMELTC)**XVISC+VISMC where FMELTC is the melt fraction. (See location 9 to input XVISC).	Pa-s	CL
8	VISSC	Viscosity of refrozen cladding. This is used as viscosity below solidus.	Pa-s	CL
9	XVISC	Exponent in viscosity equation.		CL
10	CLADFR	Moody friction factor for the molten cladding during turbulent cladding flow over the fuel rod.		CL
11	REBRK	Laminar to turbulent transition Reynolds number for molten cladding flow.		CL

Block 65 — FUELIN — Channel-Dependent Fuel Input

Location	Symbol	Description	Units	Used By
12	GMULTF	Constants in molten cladding and sodium vapor two-phase friction multiplier. Multiplier = CHOR*(1.0+GMULTF*(1.0-MAX(ALPH,ALPHCR))) where ALPH is void fraction. The incoherence (time delay) factor is: CHOR=MAX(0.01, MIN(1.0,(FPS/FPS0)**EXPFPS)) where FPS is the time in full-power seconds since cladding first moved in the channel.		CL
13	ALPHCR	See location 12.		CL
14	FPS0	See location 12.		CL
15	EXPFPS	See location 12.		CL
16	AMELT	Not currently used.		CL
17	CLSTHR	Multiplier for frozen cladding-structure heat transfer. Suggested value: 1.0.		CL
18	FRACPD	Not currently used.		
19	PCFAIL	Pin cavity pressure at pin failure time. Only necessary if the transient DEFORM calculation is not used (ISSFU2.NE.1) or if CLAP preceded LEVITATE in this channel. May also be useful for overriding the DEFORM calculated cavity pressure for parametric studies. For PCFAIL < 1, the DEFORM calculated cavity pressure is used in PLUTO2 and LEVITATE. This is the recommended option when it can be used.	Pa	LE PL
20	AVISC	Constant in viscosity equation. (See VISMC).	K	CL
21	CPC	Specific heat capacity of molten cladding at the liquidus temperature.	J/kg-K	CL

Block 65 — FUELIN — Channel-Dependent Fuel Input

Location	Symbol	Description	Units	Used By
22	FPINAC	Areal fraction of fuel, with enthalpy exceeding the melting threshold of at least FNMELT of the heat of fusion, required to initiate PINACLE; i.e. for in-pin pre-failure fuel motion to begin. See FNMELT and CPINAC. Recommended value: 2 radial nodes.		PN
23	CPINAC	Also, at least 3 contiguous axial nodes must satisfy the condition: Molten fuel fraction > FPINAC x CPINAC in order to initiate PINACLE. Recommended value: 0.5.		PN
24	RHOREF	Not currently used.		
25-27	WUREF WPUREF WZRREF	Fabricated uranium, plutonium, and zirconium weight fractions in the metal fuel in the SSCOMP model (IFUELO = 1).		
28-51	DFUELX	Not currently used.		
52	FUSLDT	Maximum axial displacement of the upper fuel blanket or/and sodium slug above the fuel active top.	m	PN
53	FUSLMA	Total mass of the upper fuel blanket or/and sodium slug above fuel pin top.	kg/pin	PN
54	BURNFU	Axially averaged fuel pin burnup for metal fuel pins used in the SSCOMP model (IFUELO = 1). Also used for IFUELM = 2. = 0, FPDAYS and FLTPOW used to calculate cladding fluence. > 0, BURNFU determines cladding fluence.	at%	SC

Block 65 — FUELIN — Channel-Dependent Fuel Input

Location	Symbol	Description	Units	Used By
55-198	XPUZR	Post-zone formation plutonium and Zirconium weight fractions in the central zone, followed by those in the middle zone and those in the outer zone. Not currently used.		SC
199	GASRTM	Not currently used.		
200	TIRRFU	Cladding steady state irradiation temperature at the top of the fuel region for metal fueled pins. Used in life fraction calculation. ≤ 0, Maximum temperature during steady state at each axial node used. > 0, And ISSFUE = 0, value applied to each axial node	K	
201-300	DFUELI	Not currently used.		

Alphabetical Listing of Input Variables

Input	Blk	Loc
AARIRV	18	4410
AARORV	18	4413
ABC	13	1085
ABCPU	13	1203
AC	13	1081
ACCHE	13	1104
ACCXE	13	1105
ACCZ	61	1–7
ACHOPL	18	3656
ACLPEL	12	448
ACLPRC	12	421
ACRDEX	12	73
ADOP	62	62
AE	65	4
AFFLAM	64	180
AFLAM	64	8
AFLAMV	64	194
AFR	64	1
AFRF	64	175
AFRLRV	18	4539
AFRTRV	18	4538
AFRV	64	168
AGSRLS	64	181
AHBPAR	63	2
AHT	18	3821–3824
AHX	18	3841–3844
AIRAR2	18	4420–4425
AIRARV	18	4414–4419
AIRAUN	18	4545
AIRTMP	18	3933
AKCOND	13	1224
AKD	13	1272
ALATRL	64	205–208
ALFSS	13	1115
ALPHAP	18	1499–1536
ALPHAT	18	1537–1574
ALPHCR	65	13
AM	13	1119
AMELT	65	16
AMOTTK	18	2223–2462
AMOTTK	18	2223–2462
AMOTTK	18	2223–2462
AMOTTK	18	2223–2462
AMOTTK	18	2223–2462
AMOTTK	18	2223–2462
ANA	18	3943
ANA	18	4003
ANA	18	4063
ANA	18	4123
APG	13	1088
APMPHD	18	1983–2222
APMPHD	18	1983–2222
APMPHD	18	1983–2222
APMPHD	18	1983–2222
APMPHD	18	1983–2222
APMPHD	18	1983–2222
APORE	13	1083
APROPI	13	1335–1394
AR	18	3845–3848
AREACR	12	446
AREAEL	18	442–581
AREAIN	18	1613–1650
AREAPC	61	166
AREASG	18	1721–1748
ASCRAM	11	23
ASI	18	3849–3852
ASRALU	13	1280
ASTWL	18	5027–5035
ATMDEN	16	512–1111
AVISC	65	20
AWALL	18	2616–2653
AXHI	61	8–31
AXMX	13	1165
AZEROX	13	1100
BCRDEX	12	74
BDOP	62	63
BENDNM	18	862–1001
BETADK	12	260–289
BETADN	12	4–9
BETAHT	12	320–324
BETSS	13	1116
BFR	64	2
BFRF	64	176
BFRTRV	18	4542
BFRV	64	169
BHBPAR	63	3
BNDLOD	18	1142
BNDMM1	12	414
BNDMM2	12	415
BONDNA	63	71
BTAPNA	18	2464–2501
BTATNA	18	2502–2539
BURNFU	65	54
C1	64	3
C1BY	18	2694
C1BY2	18	4300
C1BY3	18	4303
C1BY4	18	4306
C1IHX	18	3653
C1IHXT	18	4309
C1PIPE	18	3650
C1RV	18	4405
C1VIPR	13	1155
C2	64	4
C2BY	18	2695
C2BY2	18	4301
C2BY3	18	4304
C2BY4	18	4307
C2IHX	18	3654
C2IHXT	18	4310
C2PIPE	18	3651
C2RV	18	4406
C2VIPR	13	1156
C3	64	5
C3BY	18	2696
C3BY2	18	4302
C3BY3	18	4305
C3BY4	18	4308
C3IHX	18	3655
C3IHXT	18	4311
C3PIPE	18	3652
C3RV	18	4407
CB2TC	12	454
CDCL	13	1195
CDFU	13	1140
CDNL	13	1142
CDVG	13	1144
CE	13	1070–1072
CFCOFV	13	1153
CFFURH	13	1154
CFLAT	61	167
CFNACN	13	1146
CFNAEV	13	1147
CHBPAR	63	4
CIA1	13	1131
CIA2	13	1132
CIA3	13	1133
CIA4	13	1134
CIA5	13	1135
CIA6	13	1136
CIANDI	13	1208
CIANIN	13	1174
CIBBDI	13	1207
CIBBIN	13	1126
CIETFU	13	1143
CIFN	13	1137
CIFRFU	13	1128
CIFUFZ	13	1172
CIFUMO	13	1129
CIHCFU	13	1186
CINAF0	13	1125
CINAPN	13	1286
CIPINJ	13	1276
CIPNTP	13	1295
CIREFU	13	1127
CIRTFS	13	1170
CISP	13	1171
CIVIMT	13	1209
CIVOID	13	1130
CKD	13	1273
CKVFLO	18	4619–4678
CKVORF	18	4559–4618
CLADEX	63	74
CLADFR	65	10
CLADRA	62	160–207
CLDREX	63	78
CLSTHR	65	17
CMFU	13	1188

Input	Blk	Loc
CMNL	13	1141
CMWALL	18	2654–2691
CNU	13	1117
COEFDL	13	1200
COEFDL	13	1201
COEFDS	13	1–3
COEFK	13	4–10
COILP0	62	375
COILP1	62	376
COILP2	62	377
COLFAC	13	1298
CONDCR	12	442
COOLDN	63	36
CPC	65	21
CPC0	18	4680
CPC1	18	4681
CPC2	18	4682
CPC3	18	4683
CPC4	18	4684
CPCL	13	1196
CPCLRH	13	1197
CPCM	13	1287
CPCPMP	18	4468–4497
CPCTAB	13	819–878
CPCTEM	13	879–898
CPFTAB	13	606–765
CPFTEM	13	766–785
CPFU	13	1139
CPINAC	65	23
CPMO	13	1288
CPSE	13	1212
CRDEXP	12	72
CRDHA	12	76
CRDLEN	12	71
CRDMC	12	75
CRMCI	18	4516–4521
CRMCO	18	4522–4527
CROETB	13	990–1049
CROETM	13	1050–1069
CRSAC	12	426
CUCM	13	1291
CUMO	13	1292
CUTOFF	18	3963
CUTOFF	18	4023
CUTOFF	18	4083
CUTOFF	18	4143
CVGMLT	18	1749–1804
CVHE	13	1097
CVLMLT	18	82–161
CVXE	13	1096
CZCM	13	1289
CZERO	13	1106
CZMO	13	1290
D3EFFK	16	1115
D3EPS1	16	1112
D3EPS2	16	1113
D3EPS3	16	1114
D3EPST	16	1118
D3FISM	16	1116
D3POWI	16	1117
DABY	18	2737–2744
DBBY	18	2745–2752
DDBY	18	2753–2760
DDX	13	1122
DDX2	13	1123
DECCON	12	10–15
DEL	63	25
DELPUM	11	151
DELSCR	11	150
DELTWO	16	1119
DENA	18	3942
DENA	18	4002
DENA	18	4062
DENA	18	4122
DENBLK	16	3
DENCLD	16	4
DENCOL	16	5
DENCON	16	7
DENCOR	16	2
DENREF	16	8
DENS	65	3
DENSS	63	35
DENSTR	16	6
DEW	18	3940
DEW	18	4000
DEW	18	4060
DEW	18	4120
DFLTCS	12	419
DFLTSS	12	420
DFUELX	65	28–51
DGO	63	26
DHAIRV	18	4409
DHAORV	18	4412
DHELEM	18	582–721
DHPMP	18	4288–4299
DHSEGG	18	1805–1832
DHZ	61	32–38
DKANSI	12	801–880
DKBET2	12	511–630
DKFRAC	12	751–800
DKLAM	12	290–319
DKLAM2	12	631–750
DMP4I1	18	3454
DNA	18	3941
DNA	18	4001
DNA	18	4061
DNA	18	4121
DPFCLD	18	3962
DPFCLD	18	4022
DPFCLD	18	4082
DPFCLD	18	4142
DPFHOT	18	3965
DPFHOT	18	4025
DPFHOT	18	4085
DPFHOT	18	4145
DPGRV0	14	86
DPINMX	11	19
DPLTLM	64	213
DPRSTY	63	10
DPUO	13	1205
DPWMAX	11	22
DRCOLL	12	425
DRFI	61	189–195
DRFO	61	169–175
DSHDRC	18	3544–3547
DSHIHX	18	3540–3543
DSTIZ	61	39–45
DSTOZ	61	46–52
DT0	11	5
DTACCL	64	178
DTCLAD	11	11
DTCMIN	64	171
DTDISR	13	1230
DTEVPF	18	3441–3444
DTFAL1	13	1269
DTFAL2	13	1270
DTFAL3	13	1271
DTFUEL	11	10
DTIHX	18	4284–4287
DTINMX	11	20
DTLMAX	64	69
DTMIN	11	95–104
DTMMAX	11	94
DTMMXB	11	21
DTMPTB	18	2937–3104
DTMXB	11	6
DTNUL1	64	215
DTNULL	11	88
DTP0	11	13
DTPBOI	11	15
DTPFCI	11	17
DTPICL	11	93
DTPICP	11	92
DTPLEV	11	16
DTPLIN	13	1164
DTPLP	13	1168
DTPMAX	11	14
DTPNIN	13	1277
DTPNP	13	1279
DTS	64	165
DTSHPM	16	1230
DTSHPS	16	1232–1241
DTSI	64	164
DTSIHX	18	5192–5195
DTSSCP	11	26
DTSWCH	64	163
DTUDRC	18	3552–3555
DTUIHX	18	3548–3551
DTVMAX	64	70
DUM002	62	3
DWMAX	64	6
DXMAPR	11	28–87
DZBCGL	14	90
DZBCGU	14	91
DZCINP	16	3252–3311
DZEMFM	61	275–284
DZIAB	64	65
DZIAT	64	66
DZIMAX	64	71
DZPLIN	13	1152

Input	Blk	Loc
DZSHPX	18	3455–3515
EFFIN	18	5304–5307
EGBBLY	13	1161
EGFUSO	13	1151
EGMN	13	1178
EGSELQ	13	1211
EGSESO	13	1210
EI1BCF	16	3812
EI1BCT	16	3813
EI2BCF	16	3814
EI2BCT	16	3815
EJ1BCF	16	3816
EJ1BCT	16	3817
EJ2BCF	16	3818
EJ2BCT	16	3819
EK1BCF	16	3820
EK1BCT	16	3821
EK2BCF	16	3822
EK2BCT	16	3823
EL	18	3939
EL	18	3999
EL	18	4059
EL	18	4119
ELDRUM	18	3961
ELDRUM	18	4021
ELDRUM	18	4081
ELDRUM	18	4141
ELS	18	3956
ELS	18	4016
ELS	18	4076
ELS	18	4136
EMF	63	64
EMNA	63	66
EMS	63	65
EMSC	13	1109
EMSF	13	1108
ENPF	13	602
EPCH	13	1166
EPSCAV	18	1971–1982
EPSCAV	18	1971–1982
EPSCOM	13	1294
EPSF	18	4282
EPSFC	18	4283
EPSFLW	64	216
EPSFS	18	4534
EPSFSI	18	4553–4558
EPSGAM	11	4
EPSGV	18	4264–4269
EPSGVO	18	4547–4552
EPSMS	13	1293
EPSOW	18	4546
EPSPK3	16	1224
EPSPOW	11	3
EPSPRS	64	218
EPSREA	11	2
EPSRV	18	4258–4263
EPSSCP	11	27
EPSSFP	13	1226
EPSSTB	18	4312
EPSTEM	11	1
EPSTMP	64	217
EPSTST	18	5186–5188
ET	13	1103
EXKTB	13	11–70
EXKTM	13	71–90
EXPCFF	63	79
EXPCOF	13	1263
EXPFPS	65	15
EXSOTB	12	471–490
EXSOTM	12	491–510
EXTRAP	16	9
FATIST	16	1231
FAXIAL	13	1258
FCDTCB	12	453
FCDTR1	12	422
FCDTR2	12	423
FCDTRF	12	424
FCLDWK	13	1259
FCLOP	63	68
FCR	12	468
FDPTO	18	3967
FDPTO	18	4027
FDPTO	18	4087
FDPTO	18	4147
FFLAT	61	168
FGCOND	13	1223
FGFI	13	1275
FGMIN	63	60
FGMM	13	600
FGPORX	13	1220
FGSPRD	13	1219
FHTCLD	62	367
FHTFUL	62	371
FIFNGB	13	1148
FINTHK	18	5308–5311
FIRLIM	13	1266
FLODTM	64	195
FLOEXP	12	447
FLOSSL	18	2–41
FLOWBU	62	267
FLSHRD	12	445
FLSWCH	64	192
FLTPOW	62	61
FMELTD	13	1260
FMELTM	65	2
FNARME	13	1176
FNDISR	13	1229
FNFUAN	13	1138
FNHTFU	13	1181
FNMELT	13	1169
FNSROS	13	1214
FNU	13	1118
FPDAYS	62	1
FPINAC	65	22
FPKNG	62	373
FPORNA	63	93–103
FPS0	65	14
FRACP	64	78–80
FRACPD	65	18
FREFHI	16	11
FREFLO	16	10
FRFLOW	12	70
FRMRSE	13	1213
FRPR	12	69
FRUPT	64	81–83
FSMCI	18	4504–4509
FSMCO	18	4510–4515
FSPEC	65	1
FSTRAN	13	1261
FTIMST	16	1225
FTMPCH	13	1262
FUELEX	63	73
FUELRA	62	208–255
FULREX	63	77
FUNCOL	62	372
FUNFLM	62	370
FUNKCL	62	368
FUNKFU	62	369
FUNPOW	62	374
FUSLDT	65	52
FUSLMA	65	53
FVAPM	64	174
FWPROF	18	3974–3979
FWPROF	18	4034–4039
FWPROF	18	4094–4099
FWPROF	18	4154–4159
FWTIME	18	3968–3973
FWTIME	18	4028–4033
FWTIME	18	4088–4093
FWTIME	18	4148–4153
G2PRDR	18	1002–1141
GAMDBY	18	2881–2904
GAMGAS	13	1299
GAMGS	13	1101
GAMGSC	18	1689
GAMMA	13	1087
GAMNBY	18	2857–2880
GAMSS	62	2
GAMTNC	62	4
GAMTNE	62	5
GASKOR	64	182
GASMW	64	184
GASRTM	65	199
GATPF	13	601
GENTIM	12	2
GK	13	1090
GK1	13	1092
GMULTF	65	12
GRAINK	13	1094
GRAINQ	13	1095
GRAVTY	18	2463
GSCRAM	11	25
GVMC	18	4498–4503
GWO	18	3952–3953
GWO	18	4012–4013
GWO	18	4072–4073
GWO	18	4132–4133
HABYBY	18	4184–4215
HACHCH	63	82–89
HACIFM	63	143

Input	Blk	Loc
HACOFM	63	144
HAELHT	18	4216–4245
HAFMOP	63	145
HAGPFM	63	146
HARDNS	13	1102
HAUIS	12	406
HBMAX	63	5
HBMIN	63	6
HBPAR	63	7
HCCLMI	13	1187
HCFFMI	13	1179
HCFUBB	13	1180
HCOND	64	72
HCONRV	18	4462–4467
HCSTW2	18	5018–5026
HCSTWL	18	5009–5017
HEADR	18	1911–1922
HEADR	18	1911–1922
HEADR	18	1911–1922
HEADR	18	1911–1922
HEBOIL	64	185
HECOND	13	1222
HEMASX	13	1227
HEMM	13	1225
HEXPCH	16	1
HFBO	18	3950
HFBO	18	4010
HFBO	18	4070
HFBO	18	4130
HFIDRC	18	3600–3603
HFIIHX	18	3596–3599
HFILM	12	444
HFPDRC	18	3592–3595
HFPIHX	18	3588–3591
HFSRV	18	4456–4461
HFW	18	3934
HFW	18	3994
HFW	18	4054
HFW	18	4114
HGASRV	18	4444–4449
HINVWL	18	5036–5107
HISOMT	17	701–1300
HISON1	17	1301–1900
HISON2	17	1901–2500
HISON3	17	2501–3100
HISON4	17	3101–3700
HITB	18	3817–3820
HMACAT	17	3701–3710
HMACBT	17	3721–4520
HMACIV	17	3711–3720
HMATMX	17	1–50
HMATUN	17	51–400
HMELT	63	67
HMIXRG	17	401–700
HMPERB	17	4521–5020
HOTB	18	3813–3816
HSCO	18	3949
HSCO	18	4009
HSCO	18	4069
HSCO	18	4129
HSHO	18	3951
HSHO	18	4011
HSHO	18	4071
HSHO	18	4131
HSNK	63	8
HTCPCR	12	441
HWALL	18	2578–2615
HWSHO	18	3957
HWSHO	18	4017
HWSHO	18	4077
HWSHO	18	4137
I1BC	7	9380
I1PERB	7	15088–15587
I2BC	7	9381
I2PERB	7	15588–16087
IADHX	3	1390–1393
IAREXT	1	40
IAXCON	51	284
IAXEXP	51	181
IAXTHF	51	124
IB3DM2	3	1144–1152
IBGO	51	79
IBINOT	3	893–971
IBINST	3	892
IBL3D2	3	498–506
IBLPRN	51	119
IBLPRT	1	14
IBNEW	51	81
IBOP	1	70
IBOPLT	1	90
IBOWTP	1	102
IBSTOP	51	80
IBUBND	51	277
IBUGPL	51	75
IBUGPN	51	188
IBYBY	3	1020–1051
ICCVFS	3	1154
ICFINE	51	76
ICHCH	51	206–213
ICHCHT	1	79
ICHUIS	51	362
ICHUNK	1	47
ICLAD1	1	4
ICLADB	51	85
ICLADK	51	185
ICLADV	51	17
ICLCMP	1	24
ICLPRP	1	118
ICPDBG	3	498
ICRDDB	1	71
ICREXP	1	31
ICRNOD	1	75–77
ICRTMP	1	72–74
ICTYPE	51	225
ICV2WL	3	1353–1361
ICVNAK	3	1378
ICVSSI	3	1380–1389
ICVSTR	3	1314–1316
ID2O	1	67
IDBDKH	1	85
IDBFLG	51	98–107
IDBGBL	51	120
IDBHTN	3	1142
IDBLST	51	121
IDBP4N	3	508
IDBPR4	3	507
IDBPWI	1	35
IDBRV	3	1290
IDBRVS	3	1291
IDBSTP	51	108–117
IDBSTR	3	1362
IDBUG0	1	2
IDBUGF	51	50
IDBUGV	51	1
IDCLDE	51	127
IDCLGO	51	125
IDCLSP	51	126
IDKCRV	51	203
IDKTYP	3	822–829
IDNFLW	1	68
IDRCLC	3	493–496
IDRY	51	224
IDSSC	51	223
IEDCIV	7	9335
IEDFD3	7	8744–8753
IEDHXP	7	9338
IEDIXS	7	8763
IEDMAC	7	8828
IEDMAS	7	9337
IEDMXS	7	8764
IEDNVF	7	8765
IEDREA	7	9336
IEDTPR	7	8762
IELANE	3	1244–1273
IELBYP	3	830–837
IELDHX	3	992–995
IELDRP	3	477–480
IELDRS	3	485–488
IELHT	3	1052–1081
IELHT2	3	1082–1111
IELIHX	3	473–476
IELLCK	3	876–881
IELPMP	3	406–417
IELRVC	3	1276–1281
IELSGN	3	840–851
IELTPW	3	1367–1376
IELVLV	3	974–981
IEMGEM	1	104
IEMPMP	3	418–429
IEQMAS	51	118
IERSTP	51	2
IEVAP	3	864–875
IEXPFB	3	1009–1018
IFAE	51	184
IFAIL	51	87
IFCDHX	3	996–999
IFILM	51	128
IFIT	1	95–100
IFLOOD	51	494
IFLOW	1	20

Input	Blk	Loc
IFMIOP	3	1311
IFPI01	51	286
IFPIN2	51	285
IFRFAC	51	186
IFSTEL	3	613–712
IFSTWL	3	1323–1325
IFT16	3	1365
IFT19	1	57
IFT1TM	1	119
IFT24	51	495
IFUEL1	1	3
IFUELB	51	16
IFUELC	51	193
IFUELI	51	132–155
IFUELM	51	192
IFUELO	51	191
IFUELV	51	15
IFULL	7	17091
IFUOPT	51	180
IFWC	3	1000–1003
IGASRL	51	278
IGHC	3	1004–1007
IGRLTM	51	279
IGSPRS	51	282
IHARM	7	17095
IHEALC	51	123
IHEX	51	29
IHGAP	51	24
IHTBYB	3	1193–1200
IHTBYD	3	1201–1208
IHTFLG	51	287
IHTPRS	51	96
IHXBYP	3	1172–1181
IHXCLC	3	489–492
ILAG	51	34
ILATF	51	496
ILIHXS	3	481–484
ILRPMP	3	430–469
ILSTEL	3	713–812
ILUBLK	1	48
IMACR1	7	9386–10185
IMACR2	7	10186–10985
IMCVTY	1	34
IMELTV	1	28
IMETAL	51	189
IMKVPL	51	490
IMOMEN	51	182
INAKDR	3	509
INAPN	1	49
INAS3D	1	29
INCART	7	9379
INDFAL	51	283
INEDIT	1	25
INEUPR	7	1
INRAEJ	1	44
INULLT	3	972
IOMEG	7	17090
IOPCH	51	226–233
IOPFLX	7	4
IOPPL	51	276
IP4PRT	3	890
IPARD3	7	9330
IPBDEN	1	106
IPERTV	7	17094
IPGO	51	82
IPIC	1	101
IPINFG	51	486
IPINRE	51	487
IPIPTM	3	1310
IPL2A	3	1019
IPLOT	51	78
IPLPWD	7	9339
IPLTSG	1	69
IPLUP	1	5
IPMDFT	3	990
IPMPBY	3	1183–1192
IPNEW	51	84
IPNGO	51	194
IPNNEW	51	196
IPNPLT	51	190
IPNSTP	51	195
IPO	1	12
IPOBOI	1	13
IPORC	51	222
IPORFG	51	488
IPOWER	1	8
IPOWOP	1	9
IPOWRZ	51	364
IPRADJ	3	497
IPRBED	7	9333
IPRD	51	97
IPRINT	51	77
IPRION	1	27
IPROPT	1	6
IPRSKP	51	274
IPRSNL	1	88
IPRSS1	51	489
IPSIG	51	95
IPSIZE	51	74
IPSTOP	51	83
IQSOPT	7	9332
IRAD	51	33
IRADEX	1	36
IRAPEN	51	280
IRATE	51	23
IRDEXP	51	187
IREACT	1	58
IREACZ	51	365
IRELAX	51	30
IROK	51	3
IROPT	1	65
IROR	51	45
IRVOPT	3	1275
ISCH	1	115
ISEXTR	7	8761
ISGCLC	3	852–863
ISGLNK	3	1377
ISIMPG	1	91
ISIMPL	7	17092
ISKDOT	1	116
ISLREA	3	1293–1300
ISNKRP	3	511
ISRCRP	3	510
ISSCPC	3	1288
ISSFU2	51	122
ISSFUE	51	32
ISSIHX	3	1155–1158
ISSNUL	1	87
ISSPMP	3	1159–1170
ISST15	3	1289
ISSTP	3	838
ISTDBS	3	1363
ISTGTB	3	1394–1397
ISTHTH	3	1143
ISTRVT	3	1317–1319
ISTSTP	3	1364
ISUBAS	51	89
ISYMF	7	8759
ITABVV	3	982–989
ITARGE	1	103
ITAU	51	22
ITHPEN	3	1312
ITKEL	1	7
ITP20	51	204
ITREAT	51	275
ITYP24	51	522–541
ITYPCV	3	11–48
ITYPEL	3	49–188
IUM883	3	882–889
IWLHRZ	3	1326–1334
IWNHFL	7	17093
IXSTPC	1	32
IXSTPF	1	33
IYLD	1	26
IZNC	51	366–389
IZNM	51	390–413
J1BC	7	9382
J1PERB	7	16088–16587
J2BC	7	9383
J2PERB	7	16588–17087
JCFT24	51	502–521
JCHMPN	51	215–218
JCLN	51	90
JCRIND	1	66
JCVG	3	269–324
JCVL	3	189–268
JFAIL	51	88
JFSELL	3	365–404
JJMLTP	51	214
JMACZ1	7	10986–11785
JMACZ2	7	11786–12585
JNCN	51	92
JNEN	51	91
JNSN	51	93
JPRNT1	51	46
JPRNT2	51	47
JREEXT	1	56
JRPRO	51	94
JRUPT	51	36
JSTRDX	51	183

Input	Blk	Loc
K1BC	7	9384
K2BC	7	9385
KCHUIS	3	1209–1242
KDEBUG	1	82
KDENBU	1	94
KEBRS1	1	83
KEBRS2	1	84
KFAILP	1	37
KFIRR	1	93
KHDBK	1	92
KKSBRI	51	69
KKSBTP	51	68
KPROPI	1	114
KQSCRA	1	113
KSWIRL	51	220
KTING	51	19
KTRANC	51	234–249
KTRANM	51	250–273
KTREAT	1	112
KZEMFM	51	492
L3EXIT	7	9329
LBYP	3	1301
LCHTYP	51	281
LCPLAS	51	291
LCPROP	51	308
LCRACK	51	289
LCSWEL	51	293
LDBCPL	51	305
LDBFDV	51	304
LDBFPL	51	303
LDBOTA	51	311–334
LDBOTC	51	346–348
LDBOTF	51	335–345
LDBOUT	51	301
LDBSTP	51	302
LELBYP	3	1302–1309
LFCSLP	51	295
LFPLAS	51	290
LFREQA	51	297
LFREQB	51	299
LFSWEL	51	292
LGAPCL	51	307
LGCLOS	51	310
LGPRES	51	306
LGRAPH	51	300
LHTOPT	51	288
LLRGST	51	294
LOUTSW	51	296
LQSLTP	51	363
LSKIPM	51	309
MACREG	7	8768–8827
MACXIV	7	8829–8928
MACXR1	7	8929–9028
MACXR2	7	9029–9128
MACXZ1	7	9129–9228
MACXZ2	7	9229–9328
MACYIV	7	12588–13087
MACYR1	7	13088–13587
MACYR2	7	13588–14087
MACYZ1	7	14088–14587
MACYZ2	7	14588–15087
MAXSTP	1	11
MCHAN	7	142–3641
MECHAN	7	7142–7241
MEXMAT	7	7242–7341
MFAIL	51	86
MFREQA	51	298
MFTZN	51	414–485
MIXR1	7	7542–7841
MIXR2	7	7842–8141
MIXZ1	7	8142–8441
MIXZ2	7	8442–8741
MODEEX	1	55
MPL1	51	59
MPL2	51	60
MPL3	51	61
MPL4	51	62
MPL5	51	63
MPL6	51	64
MPL7	51	65
MPL8	51	66
MPL9	51	67
MREG	7	3642–7141
MSTEP	51	21
MSTPL1	1	109
MSTPL2	1	110
MSTPL3	1	111
MSTPLA	1	107
MSTPLB	1	108
MTACLP	1	53
MTCB	1	81
MTGRD	1	52
MTREAT	51	493
MTRFAC	1	63
MTRFT	1	64
MTRRAC	1	61
MTRRT	1	62
MTTLP	1	54
MULSTR	1	23
MZCHCH	51	491
MZLB	51	28
MZUB	51	27
NANEL	3	1243
NANRVC	3	1282–1287
NAPRX	7	8754
NAPRXZ	7	8755
NAXOP	51	20
NAXYSW	7	8766
NAZSWP	7	8767
NBINOT	3	891
NBYP	3	813
NCCV	3	1153
NCHAN	1	1
NCHCH	51	205
NCICOR	7	14
NCILBL	7	13
NCILPL	7	12
NCILRF	7	11
NCIUBL	7	15
NCIUPL	7	16
NCIURF	7	17
NCIXX1	7	18
NCIXX2	7	19
NCKV	3	472
NCLADM	1	30
NCMRZS	7	8760
NCPLEV	1	38
NCVD	3	3
NCVP	3	1
NCVS	3	2
NCVSSI	3	1379
NDELAY	1	16
NDHX	3	991
NDKGRP	1	17
NDRACS	3	471
NDTSHP	7	9376
NELEMT	3	10
NELHTN	3	1112–1141
NELML	3	325–364
NEXBC	7	141
NEXPFB	3	1008
NEXSO	1	105
NEXZHI	7	7442–7541
NEXZLO	7	7342–7441
NFIAXI	7	20–79
NFIRAD	7	80–139
NFMCMX	7	8756
NFT24	51	501
NFUELD	1	39
NGEOIN	7	2
NGEOUT	7	3
NGRAIN	51	31
NGRDSP	51	18
NIHX	3	470
NIHXBY	3	1171
NINBC	7	140
NIXGRD	7	9377
NIYGRD	7	9378
NLINMX	1	117
NLNDWL	3	1344–1352
NNBUG1	51	48
NNBUG2	51	49
NODSUM	51	156–179
NOEQLE	1	80
NOEQPN	1	50
NOFDBK	1	89
NONEU0	1	21
NOREAC	1	41
NOSTRN	51	35
NOUTMX	7	8742
NOUTSA	7	12587
NOUTSR	7	12586
NOZNOD	7	9340
NPDKST	1	46
NPIN	51	25
NPK	1	10
NPLIN	51	37–44
NPLN	51	4
NPMPBY	3	1182
NPNO	7	17088

Input	Blk	Loc
NPOWDK	1	45
NPREAT	1	18
NPRES	1	19
NPUMP	3	405
NREFB	51	5
NREFT	51	6
NROSMX	7	9331
NROW	3	1398–1401
NRPI	51	70
NRPI1	51	71
NRPI2	51	72
NRPI3	51	73
NRREAC	3	1292
NRRNGS	1	60
NSCRVC	3	1274
NSEGCR	1	78
NSEGGD	3	9
NSEGGP	3	7
NSEGGS	3	8
NSEGLD	3	6
NSEGLP	3	4
NSEGLS	3	5
NSEGMP	51	361
NSGS	3	839
NSHDOM	7	9334
NSKIP	51	51–58
NSLEEX	1	42
NSRMTB	1	43
NSTEP	1	15
NSTRCV	3	1313
NSUBAS	51	26
NSUBTC	1	51
NSUBTR	1	59
NT	51	14
NT0TAB	1	22
NTGPT	3	512
NTHKPW	3	1366
NTLWBY	3	814–821
NTNODE	3	513–612
NULLD3	1	86
NULPT1	51	542
NULST1	51	221
NUMKLT	51	219
NUMWAL	3	1320–1322
NUMZAX	7	9341–9375
NUPMAX	7	8743
NVALVE	3	973
NVNDWL	3	1335–1343
NXTR	7	17089
NXYSWP	7	8757
NZNCOR	7	7
NZNLBL	7	6
NZNLPL	7	5
NZNODE	51	7–13
NZNUBL	7	8
NZNUPL	7	9
NZNURF	7	10
NZONF	51	129–131
NZSWP	7	8758
OLDBDK	12	16–21
OLDBDT	12	28
OLDDKL	12	22–27
ONETIM	16	1120
ORFIN	18	4540
P0GAS	63	27
PCFAIL	65	19
PCVSSI	18	5294–5303
PD	18	3958
PD	18	4018
PD	18	4078
PD	18	4138
PDEC	14	2
PDEC1	14	3
PDEC2	14	4
PERABY	18	2921–2928
PERDBY	18	2929–2936
PERFS	18	4276–4281
PERFSI	18	4432–4437
PERGV	18	4270–4275
PERGVO	18	4426–4431
PERPTD	18	3528–3531
PERPTX	18	3524–3527
PERSFO	18	4438–4443
PERSPD	18	3520–3523
PERSPX	18	3516–3519
PERTID	18	3536–3539
PERTIX	18	3532–3535
PERVAC	18	4252–4257
PERWL2	18	4373–4402
PFIS	64	105–124
PGRMIN	64	183
PHPROF	18	3986–3991
PHPROF	18	4046–4051
PHPROF	18	4106–4111
PHPROF	18	4166–4171
PHPTI	18	3959
PHPTI	18	4019
PHPTI	18	4079
PHPTI	18	4139
PHTIME	18	3980–3985
PHTIME	18	4040–4045
PHTIME	18	4100–4105
PHTIME	18	4160–4165
PINMIN	18	3453
PINSW	18	3945
PINSW	18	4005
PINSW	18	4065
PINSW	18	4125
PITCHA	12	410
PITCHG	12	409
PITCHT	12	411
PLENL	61	53
PLIN	62	45–52
PLUT1	13	1248
PLUT10	13	1257
PLUT2	13	1249
PLUT3	13	1250
PLUT4	13	1251
PLUT5	13	1252
PLUT6	13	1253
PLUT7	13	1254
PLUT8	13	1255
PLUT9	13	1256
PMPEFR	18	1947–1958
PMPEFR	18	1947–1958
PMPEFR	18	1947–1958
PMPFLR	18	1935–1946
PMPFLR	18	1935–1946
PMPFLR	18	1935–1946
PMPHD	18	3657–3719
PMPINR	18	1899–1910
PMPINR	18	1899–1910
PMPSPR	18	1923–1934
PMPSPR	18	1923–1934
PMPTQ	18	3720–3800
POD	18	3944
POD	18	4004
POD	18	4064
POD	18	4124
POROSS	63	90–92
POW	12	1
POWLVL	12	325–364
POWTIM	12	365–404
POWTOT	12	3
PPLCV	18	4723–4760
PREATB	12	29–48
PREATM	12	49–68
PRESG0	18	1461–1498
PRETAB	14	5–24
PRETB2	12	100–179
PRETM2	12	180–259
PRETME	14	25–44
PRFAIL	13	1177
PRFRA1	18	2905–2912
PRFRA2	18	2913–2920
PRSDRC	18	3449–3452
PRSFTN	13	1297
PRSHAP	62	256
PRSIHX	18	3445–3448
PRSMIN	13	605
PRSTY	13	1073–1080
PRTDEL	13	1265
PRTSTR	13	1264
PSCRAM	11	24
PSHAPB	62	319–366
PSHAPC	62	271–318
PSHAPE	62	6–29
PSHAPR	62	30–44
PSHPBT	62	262–266
PSHPBY	18	2801–2856
PSHPTP	62	257–261
PTCHRA	12	450
PTCHRT	12	451
PUBYU	12	405
PUHALF	11	152
PUZRTP	13	1300–1315
PW	18	3936
PW	18	3996
PW	18	4056
PW	18	4116

Input	Blk	Loc
PWLVL2	12	881–920
PWO	18	3946
PWO	18	4006
PWO	18	4066
PWO	18	4126
PWTIM2	12	921–960
PX	14	1
QA1	13	1110
QA2	13	1111
QA3	13	1112
QA4	13	1113
QA5	13	1114
QEMAX	64	196
QETOT	12	961–968
QFACT	18	3954–3955
QFACT	18	4014–4015
QFACT	18	4074–4075
QFACT	18	4134–4135
QKC	13	1274
QLAX	13	1120
QLAX2	13	1121
QPG	13	1089
QPORE	13	1084
QPU	13	1204
QSTAR	13	1202
QSWL	13	1082
QV	13	1091
QV1	13	1093
RAFPLA	13	1158
RAFPSM	13	1159
RAFUZ	61	197–220
RALUDI	13	1284
RALUFZ	13	1285
RBR	61	54–77
RBR0	61	180
RBRPL	61	102
RCALBY	18	2761–2768
RCAUBY	18	2769–2776
RCBARR	12	452
RCBLBY	18	2777–2784
RCBUBY	18	2785–2792
RCDBY	18	2793–2800
RCORE	18	5008
RCSHDR	18	3560–3563
RCSHHX	18	3556–3559
RCTUDR	18	3568–3571
RDEXCF	12	412
RDEXPC	12	78
RDTUHX	18	3564–3567
REAINS	12	417
REAITR	11	8
REAMPT	16	1229
REAMXS	16	1227
REBRK	65	11
REDPTO	18	3966
REDPTO	18	4026
REDPTO	18	4086
REDPTO	18	4146
REFDEN	63	72
REFLAM	64	179
RELAM	64	7
RELAMV	64	193
REORFT	64	191
RER	61	78–101
RER0	61	181
RERPL	61	103
RESMLT	64	166
REYTRV	18	4537
RG	63	59
RGAS	13	1124
RGASC	18	1690
RGASSI	13	1086
RGFV	13	1216
RGSV	13	1217
RHOCD	65	5
RHOCG	63	58
RHOCR	63	51–57
RHOCRD	12	440
RHOCSI	63	37–43
RHOCSO	63	44–50
RHONAR	18	2540–2577
RHOREF	65	24
RHOTAB	13	91–250
RHOTEM	13	251–410
RHOZN	13	1316–1323
RHOZRO	12	470
RHSLBT	13	1198
RHSLTP	13	1199
RHSSLQ	13	1206
RHSSSO	13	1215
RINFP	61	104–127
RITB	18	3801–3804
RIZNC	61	224–247
RIZNM	61	248–271
RLEQ	13	603
RODID	12	429
RODOD	12	430
ROFC	13	1099
ROFF	13	1098
ROGSPI	13	1296
ROTB	18	3805–3808
ROUGHG	18	1833–1860
ROUGHL	18	722–861
ROUTFP	61	128–151
RR1TC	12	427
RR2TC	12	428
RREF	63	63
RST	63	61
RUEQ	13	604
RVHTAB	18	4258–4269
RVHTMP	18	4270–4281
RW5RV	18	4536
SCRTAB	12	80–89
SCRTME	12	90–99
SECLIM	13	1267
SER	61	182–188
SHAMPT	16	1228
SHPMXS	16	1226
SHRDID	12	434–436
SHRDLN	12	431–433
SHRDOD	12	437–439
SIGSTB	18	4535
SLA	18	3964
SLA	18	4024
SLA	18	4084
SLA	18	4144
SLANTD	18	3608–3611
SLANTX	18	3604–3607
SLLMAX	12	408
SLMIN	64	73
SLRVC	18	4450–4455
SPFIN	18	5312–5315
SRFMLE	13	1231
SRFSTZ	61	159–165
SRLEN	18	3825–3828
STCOR	61	176
STEBOL	13	1107
SUFU	13	1157
T0TAB	14	45–64
T0TME	14	65–84
TAIRVC	18	4403
TAUGAS	18	1861–1898
TAUINV	63	104
TAUPEN	18	4977
TAUUP	18	2693
TCLMAX	11	12
TCOSTP	11	9
TCVSSI	18	5284–5293
TDTMIN	11	105–114
TDTSHP	16	1242–1251
TECLMN	13	1184
TECLRL	13	1185
TEFAIL	13	1175
TELIQ	13	813–815
TEMDLT	64	167
TESOL	13	810–812
TEXVF1	16	212–311
TEXVF2	16	312–411
TFIS	64	85–104
TFLIQ	13	794–801
TFSOL	13	786–793
THETA1	64	67
THETA2	64	68
THKWAL	18	4939–4976
THRLIM	13	1268
THT2CV	18	4679
THT2VL	14	96
TIFP	13	1173
TIMAX	11	7
TIMCNS	63	1
TIMDBG	14	92
TIMMIX	14	95
TINSRT	12	416
TIPLMX	13	1167
TIPNMX	13	1278
TIRRFU	65	200
TIXMA2	16	2752–3251
TIXMAC	16	2252–2751
TLIMIT	12	418
TLPEL	12	449

Input	Blk	Loc
TLPRRC	12	413
TMAINS	11	115–149
TMDBP4	18	1
TME	13	899–901
TMF	13	411–418
TMFAIL	64	186–188
TMIDFG	13	1218
TMO	18	3947
TMO	18	4007
TMO	18	4067
TMO	18	4127
TMPMTB	18	3273–3440
TNAO	18	3948
TNAO	18	4008
TNAO	18	4068
TNAO	18	4128
TNAX	18	3937
TNAX	18	3997
TNAX	18	4057
TNAX	18	4117
TNTRY	14	85
TOPLSS	63	147
TPCOEN	11	91
TPCOLE	11	90
TPCOST	11	89
TPDMIN	64	177
TPECHN	16	412–511
TPLCV	18	4685–4722
TPLIN	62	53–60
TPRFCI	11	18
TPWH	18	5244–5283
TPWMC	18	5204–5243
TR	13	419
TREFCV	18	1651–1688
TRFU	18	1692
TRKLSC	18	1959–1970
TRKLSC	18	1959–1970
TSEP1	63	69
TSEP2	63	70
TSNK	63	9
TTRANC	63	81
TTRANM	63	80
TUPL	64	74
TW6RV	18	4528–4533
TWASTI	61	272
TWASTO	61	273
U0CVGS	18	1691
UACH1	64	189
UACH2	64	190
UACHM1	64	197–200
UACHM2	64	201–204
UEMELT	13	816–818
UFMELT	13	802–809
UIVOL	12	77
UMELT	13	902–909
UN1281	13	1281
UN1282	13	1282
UN1283	13	1283
UNFSMC	18	4544
UNGVMC	18	4543
VFC	61	196
VFCRCD	16	1123
VFCRD	12	443
VFCRST	16	1122
VFCRWK	16	1121
VFECH2	16	112–211
VFECHN	16	12–111
VFLREF	61	178
VFNALQ	13	1160
VFNARE	13	1163
VFPLNT	61	177
VFUREF	61	179
VIFI	13	1145
VIFULQ	13	1162
VINL	13	1149
VIPERB	16	3312–3811
VISMC	65	6
VISSC	65	8
VISTR	65	7
VIVG	13	1150
VIXMA2	16	1752–2251
VIXMAC	16	1124–1223
VOIDRA	62	112–159
VOLBLI	18	5183–5185
VOLD	18	3960
VOLD	18	4020
VOLD	18	4080
VOLD	18	4140
VOLLGC	18	1423–1460
VOLMIX	18	2692
VOLSG0	18	3612–3649
VSIHX1	18	5196–5199
VSIHX2	18	5200–5203
VSLEXP	18	4174–4183
W0	64	47
WALLH	18	1283–1422
WALLH2	18	4343–4372
WALLMC	18	1143–1282
WALMC2	18	4313–4342
WALTH2	18	4978–5007
WALTHK	18	4799–4938
WDOPA	62	64–111
WEVI	18	3935
WEVI	18	3995
WEVI	18	4055
WEVI	18	4115
WF0	64	84
WFMIN	64	75
WFMIND	64	172
WFMINS	64	76
WFMNSD	64	173
WFS00	64	77
WPUREF	65	26
WRF	63	62
WST	13	1221
WUREF	65	25
WZRREF	65	27
XCIPL0	63	135
XCIPL1	63	136
XCLDHR	63	107–130
XCMPRS	64	219
XEPSCA	63	138
XEPSFE	63	139
XEPTES	63	140
XEUTHR	63	105
XEVO	18	3938
XEVO	18	3998
XEVO	18	4058
XEVO	18	4118
XEVTES	63	141
XFDVC0	63	133
XFDVC1	63	134
XFPCL1	63	132
XFPLC0	63	131
XGBFRA	63	106
XHTERR	63	137
XIXMAC	16	1252–1751
XKALBY	18	2697–2704
XKAUBY	18	2705–2712
XKBLBY	18	2713–2720
XKBUBY	18	2721–2728
XKDBY	18	2729–2736
XKHXLS	18	3829–3832
XKLAT	64	209–212
XKORGD	64	64
XKORI	64	48–63
XKRF	63	28–34
XKRLS	18	3833–3836
XKSHDR	18	3576–3579
XKSHHX	18	3572–3575
XKSILS	18	3853–3892
XKSITM	18	3893–3932
XKSOLS	18	3837–3840
XKSTIZ	63	11–17
XKSTOZ	63	18–24
XKSWRL	64	214
XKTAB	13	420–579
XKTB	18	3809–3812
XKTEM	13	580–599
XKTUDR	18	3584–3587
XKTUHX	18	3580–3583
XLAIRV	18	4408
XLAORV	18	4411
XLE10	13	1238
XLE4	13	1232
XLE5	13	1233
XLE6	13	1234
XLE7	13	1235
XLE8	13	1236
XLE9	13	1237
XLENEL	18	302–441
XLENGG	18	1693–1720
XLENTR	18	5189–5191
XLEPT1	13	1239
XLEPT2	13	1240
XLEPT3	13	1241
XLEPT4	13	1242
XLEPT5	13	1243
XLEPT6	13	1244
XLEPT7	13	1245

Input	Blk	Loc
XLEPT8	13	1246
XLEPT9	13	1247
XLINRT	64	220
XLOGNA	13	1324–1331
XLP8	13	1190
XLP9	13	1191
XLRVC	18	4246–4251
XLTUBE	18	5316–5319
XLUNRV	18	4541
XMCFMC	63	142
XMCSTW	18	5108–5179
XMCUI	12	407
XMCXAC	12	79
XMINL	64	170
XMXMSI	14	93
XMXMSO	14	94
XPL10	13	1192
XPL11	13	1193
XPL12	13	1194
XPL5	13	1182
XPL6	13	1183
XPL7	13	1189
XPUZR	65	55–198
XRFSHP	62	268
XRNSHP	62	269
XRSSHP	62	270
XSIGMC	13	1332
XSIGMD	13	1334
XSIGMK	13	1333
XTTUBE	18	5320–5323
XVISC	65	9
XXNPIN	61	274
YABOW	12	466
YBBOW	12	467
YCLAD	63	76
YDELT0	12	465
YFUEL	63	75
YKHF	12	456
YKNF	12	455
YKNNA	12	457
YKNSS	12	458
YLCLR	12	460
YLDTAB	13	910–969
YLDTEM	13	970–989
YRCCR	12	462
YRCDOP	12	464
YRCGP	12	463
YRCRR	12	461
YRCUR	12	459
YTCUT	12	469
ZBRVC	18	4404
ZCENTR	18	3105–3272
ZCHOBT	61	221
ZCHOTP	61	222
ZCVL	18	1575–1612
ZFISD	64	145–162
ZFISU	64	125–144
ZIHX	14	89
ZINL	18	42–81
ZINST	18	5180–5182
ZOFFST	61	223
ZONEL	61	152–158
ZOUTEL	18	162–301
ZPLENC	18	4761–4798
ZPLENL	14	87
ZPLENU	14	88
ZSWFAC	13	1228