Westinghouse Non-Proprietary Class 3

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Technical Description Manual for the CENTS Code

Volume 3

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TECHNICAL DESCRIPTION MANUAL FOR THE CENTS CODE

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ABSTRACT

CENTS is an interactive computer code for simulation of the Nuclear Steam Supply System and related systems. It calculates the behavior of a PWR for normal and abnormal conditions including accidents. It is a flexible tool for PWR analysis which gives the user complete control over the simulation through convenient input and output options.

CENTS is an adaptation of design computer codes to provide PWR simulation capabilities. It is based on detailed first-principles models for single and two-phase fluids. Use of nonequilibrium, nonhomogeneous models allows a full range of fluid conditions to be represented, including forced circulation, natural circulation, extensive coolant voiding and lower mode operation. The code provides a comprehensive set of interactions between the analyst, the reactor control systems and the reactor. This allows simulation of multiple failures and the effects of correct and incorrect operator actions. Examples of simulation runs with CENTS are steady state, power change, pump trip, loss of load, loss of feedwater, steam line break, feedwater line break, steam generator tube rupture, anticipated transients without scram, rod ejection, loss of coolant accidents, anticipated operational transients, and malfunctions of components, control systems or portions of control systems.

The CENTS code models most of the nuclear steam supply system and related systems. Core power is computed using a point kinetics model. Boiling curves for forced convection and pool boiling are used in the multi-node core heat transfer model. Primary and secondary thermal-hydraulic behavior is calculated with detailed multi-node and flowpath models. Nonhomogeneous, nonequilibrium conditions are also modeled, as well as the transport of solutes and non-condensible gases. The main control systems for reactivity, level, pressure, and steam flow are simulated. A multi-node and flowpath representation of the feedwater system is provided. Related balance of plant systems for single-phase fluid are represented.

The code features a Generic Control System design that processes system parameters and produces signals to drive the various plant subsystems. The control system is modular in design. It is constructed by the system modeler to simulate a specific plant's control systems, and can be made as simple or as true to the actual controllers as desired. It has an inventory of predefined functional modules, including arithmetic, Boolean, integro-differential and specialized functions. Once the control system structure is established by the modeler, it functions automatically, and its details do not normally concern the CENTS user. However, the user can, at any time during a transient, interactively change setpoints, disable control systems or exercise manual control. The control system designer/analyst, on the other hand, may study the detailed functioning of control modules by tracing their dynamic behavior, experimenting with their parameters and algorithms, or interfering with the lines of communication among the control modules.

The CENTS database provides a complete description of the nuclear plant systems that are modeled. Multiple plant states can be maintained on disk simultaneously as independent "snapshot" files, each of which contains the database plus a complete set of transient information. To initiate a transient from any snapshot, the user effects appropriate changes or perturbations to the plant. A new plant state is obtained by running a simulation to maneuver the plant interactively from a given plant state, or by using the code's self-initialization feature. Any intermediate state during a transient simulation can be saved as a snapshot for later study or to initiate parametric variations on plant behavior.

Use of CENTS is supported by executive software that handles most of the simulation mechanics, and allows the user to interact with CENTS as the transient progresses. This software provides a sophisticated command language that supports basic simulation maneuvers, collection of transient data, as well as complex interactions and probes by the advanced user. The executive software supports changes desired in the course of the transient and facilitates evaluation of the plant behavior details. The user may freeze, resume or backtrack a transient simulation at any time, examine plant parameters, make changes, take manual actions and initiate malfunctions. The user may, at any time, instruct the code to automatically make changes, display parameters or take any interactive action at pre-selected times, or when pre-selected dynamic conditions are satisfied, if desired, without interrupting the simulation.

CENTS may also be driven by a graphical environment in which the user accesses an interactive menu system via mouse-driven controls. Its live system parameter plots and graphical depictions of the plant state are invaluable tools in helping the user gain an understanding of the system behavior. In addition, a combination of standard and user-defined numerical outputs allows the user to explore details of the plant subsystem behavior.

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7.5A	—	*NEW*—C-E PWR
—	7.5b	*DELETED*—Typical 3 Loop Westinghouse PWR
7.5B	—	*NEW*—Westinghouse 3 Loop PWR
—	7.5c	*DELETED*—Typical 4 Loop Westinghouse PWR
7.5C	—	*NEW*—Westinghouse 4 Loop PWR
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7.7	—	*NEW*—Steam Generator Heat Transfer: Typical Nodalization
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—	8.1	*DELETED*—Four Pump Coastdown Volumetric Flow Fraction
—	8.2	*DELETED*—Overcooling Transient Steam generator Secondary Pressure
—	8.3	*DELETED*—Overcooling Transient Pressurizer Pressure
—	8.4	*DELETED*—Overcooling Transient Steam Generator Secondary Level
—	8.5	*DELETED*—Overcooling Transient Pressurizer Level
—	8.6	*DELETED*—Overcooling Transient Primary System Temperatures
—	8.7	*DELETED*—Upper Head Voiding Transient Pressure
—	8.8	*DELETED*—Upper Head Voiding Transient Pressurizer Pressure
—	8.9	*DELETED*—Upper Head Voiding Transient Loop Temperatures
—	8.10	*DELETED*—Upper Head Voiding Transient Upper Head Level
—	8.11	*DELETED*—Primary Pressure for Small Break LOCA
—	8.12	*DELETED*—Inner Vessel Level for Small Break LOCA
—	8.13	*DELETED*—Core Exit Steam Temperature for Small Break LOCA
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APPENDIX A INPUT VARIABLES

This appendix lists input variables for the CENTS code. The variables are divided into two categories: base inputs and auxiliary inputs.

Table C.1 lists the "Base Input" variables needed to describe a plant and to initialize it at steady state conditions. These variables describe the primary and secondary side geometry and interconnection of the components (nodalization). They are grouped into categories based on related PWR components. The last group, "Universal", contains variables that are largely the same for most plants. However, some transients or plant designs may require application-specific data.

Table C-2 lists the "Auxiliary Input" variables, grouped by system or component. The table lists variables that provide additional detail of subsystems that play a role in balancing the NSSS, initiating transients or mitigating their effects, e.g., leaks and ECCS devices. The table also lists variables that are used to initiate accidents and component malfunctions. The systems necessary for a particular transient are determined by the control systems. A complete set of data for the systems present in a plant is necessary to run a broad range of transients.

It must be noted that this appendix does not list input variables that define the plant controllers, or which specify their auto/manual states, setpoints, delays, time constants, etc. Definition of controllers is explained in Appendix C. The controller setpoint inputs are presented in detail in Sections 6 and 7. Also, variables for any accident-specific variables are not discussed here.

Table A.1
Base Inputs

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** GENERAL *****				
TIME_SCALE	RE		Overall calculational time step size	Second
CTL_OUTPUT_INTERVAL	IN		Output frequency for line output – every N time steps	Counts
***** CORE *****				
POW_USER_POWZ	RE		Nominal steady-state power	Megawatts
CORE_HT_AREA	RE		Core heat transfer area, clad/coolant	Ft^2
AREA_CORE	RE		Active core flow area	Ft^2
CORE_HYD_DIA	RE		Core hydraulic diameter	Feet
CORE_RAD_OUT	RE	10	Outer radii of radial regions, CHT mesh	Feet
CORE_BOT	RE		Active core bottom elevation (relative to node bottom)	Feet
CORE_TOP	RE		Active core top elevation (relative to node bottom)	Feet
CHT_NUM_NODE	IN		Number of axial core nodes, max 20	Counts
CHT_NREGIONS_RAD	IN		Number of radial regions in heat transfer mesh	Counts
FUEL_DENSITY	RE		Density of uranium fuel	Lbm/ft^3
CHT_GAP_COND	RE	20	Fuel-clad gap thermal cond.	Btu/sec-ft-degF
MATTYP	IN	10	Radial fuel rod region material (1/2/3=Fuel/Clad/Gap).	Pointer
CHT_USE_NEW_ENTHALPY_OPTION	RE		1.0 => Use new (Sect. 3.3.5) CHT enthalpy calculation	Dimensionless
KSHAPIN	RE	50	Axial power shape input	Fraction
ZSHAPIN	RE	50	Fraction of core height for KSHAPIN	Fraction
AXPD_INPUT_OPT	IN		AXPD Input option: 0=node average, 1=node ends	Dimensionless
AXPD_NUM_POINTS	IN		Number of points in AXPD (AXPD_INPUT_OPT=1 only)	Dimensionless
***** REACTOR VESSEL *****				
N_SECTIONS	IN	50	Sections in node (node 1 max 22, rest 1)	Counts
N_AREA_SECT	RE	1,22	Cross sectional area of section (node,section)	Ft^2
N_HEIGHT_SECT	RE	1,22	Height of section (node,section)	Feet

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RCS_ANNUL_NSECT	IN		Number of sections in annulus lower plenum	Pointer
RCS_ANNUL_ASECT	RE	3	Annulus cross-sectional areas	Ft^2
RCS_ANNUL_HSECT	RE	3	Annulus section heights	Feet
N_TOP_UPLEN	RE		Top elevation of Upper Plenum part of inner vessel node	Feet
N_BOT_UPLEN	RE		Bottom elevation of Upper Plenum part of IV node	Feet
KLOSS_UPLEN_POS	RE		Upper Plenum geometric form loss coef, positive flow	Dimensionless
KLOSS_UPLEN_NEG	RE		Upper Plenum geometric form loss coef, negative flow	Dimensionless
RCS_CEAIN_KTERM	RE		CEA fully inserted - k factor multiplier	Dimensionless
HA_CEA_CORE	RE		CEA to IV wall heat transfer coefficient (hA)	Btu/sec-degF
HA_UHEAD_CORE	RE		Upper head to IV heat transfer coefficient (hA)	Btu/sec-degF
PATH_CEA_LOW	IN		Inlet path, Upper Plenum to CEA guide tubes	Pointer
PATH_CEA_UP	IN		Exit path, CEA to upper head	Pointer
CTL_CEA_MAX	RE		Maximum CEA withdrawal position	Steps
CTL_CEA_MIN	RE		Minimum CEA withdrawal position	Steps
CTL_CEA_STEP	RE		Step size of control rod motion	Inches
CEAS_DIST	RE		Traveling distance of CEAs	Feet
RTRV_BYPASS	RE		Fraction of vessel flow bypassing core	Fraction
RCS_KWEIGHT_HTILT	RE	4,4	Coefficient for cold leg to hot leg mixing	Fraction
RTRV_MIX_INLET	RE	2	Core-in mixg factor: (1) low flow, (2) high flow	Fraction
RTRV_MIX_OUTLET	RE	2	Core-out mixg factor: (1) low flow, (2) high flow	Fraction
***** NODES *****				
NUM_NODES	IN		Total number of nodes (50 max)	Counts
NUM_SG_NODES	IN		Number of SG nodes (2 or 4 per SG, 16 max)	Counts
NUM_HL_NODES	IN		Number of hot leg nodes	Counts
NUM_SL_NODES	IN		Number of suction leg nodes	Counts
NUM_CL_NODES	IN		Number of cold leg nodes	Counts
NODE_HL1	IN		Hot leg 1 node number	Pointer
NODE_HL2	IN		Hot leg 2 node number	Pointer
NODE_HL3	IN		Hot leg 3 node number	Pointer
NODE_HL4	IN		Hot leg 4 node number	Pointer
NODE_SG	IN	16	Steam Generator node numbers (in any order)	Pointer

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
NODE_CL1	IN		Cold leg node number, loop 1	Pointer
NODE_CL2	IN		Cold leg node number, loop 2	Pointer
NODE_CL3	IN		Cold leg node number, loop 3	Pointer
NODE_CL4	IN		Cold leg node number, loop 4	Pointer
NODE_SG1P	IN		SG outlet plenum and suction leg node loop 1	Pointer
NODE_SG2P	IN		SG outlet plenum and suction leg node loop 2	Pointer
NODE_SG3P	IN		SG outlet plenum and suction leg node loop 3	Pointer
NODE_SG4P	IN		SG outlet plenum and suction leg node loop 4	Pointer
NODE_CORE	IN		Core node number	Pointer
NODE_PRZR	IN		Pressurizer node number	Pointer
NODE_UHEAD	IN		Upper head node number	Pointer
NODE_ANNUL	IN		Annulus node number	Pointer
NODE_CEASH	IN		CEA shroud node number	Pointer
NODE_AREA	RE	50	Node cross sectional area	Ft^2
NODE_HEIGHT	RE	50	Node height	Feet
N_BOT	RE	50	Node bottom elevation	Feet
N_GEOM	IN	50	Node geometry indicator	Pointer
N_HEAT_XFER_LIQ	RE	50	Node wall-to-liquid overall heat transfer coefficients	Btu/sec-degF
N_HEAT_XFER_STM	RE	50	Node wall-to-steam overall heat transfer coefficients	Btu/sec-degF
N_HEAT_XFER_CONT	RE	50	Node wall-to-containment overall heat transfer coeffs	Btu/sec-degF
N_HEAT_XFER_BOT	RE	50	Node bottom wall-to-fluid heat transfer coefficients	Btu/secft^2degF
N_HEAT_CAP	RE	50	Node wall heat capacity	Btu/degF
NE_CANDIDATE	IN	50	Non-equilibrium state possible in node	Pointer
TEMP_CONT	RE	50	RCS Node containment temperatures.	Degree F
***** PATHS *****				
NUM_PATHS_MOM	IN		Number of momentum paths	Counts
NUM_PATHS_HL	IN		Number of hot leg flowpaths (4 max)	Counts
NUM_PATHS_CL	IN		Number of cold leg flowpaths (8 max)	Counts
RCS_NUMIN_CHGS	IN		Number of RCS-Charging connections (4 max)	Counts
RCS_NUMOUT_LDNS	IN		Number of RCS-Letdown connections (4 max)	Counts
RCS_NUMOUT_RCWDRAINS	IN		Number of RCS-RCW Drain connects (1 max)	Counts

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RCS_NUMOUT_SDC	IN		Number of RCS-Shutdown Cooling connections (2 max)	Counts
RCS_NUMIN_SIS	IN		Number of RCS-Safety Injection connections (8 max)	Counts
PATH_SURGE	IN		Surge line path number	Pointer
PATH_ANNUL_CORE	IN		Annulus-to-inner vessel path number	Pointer
PATH_CORE_UHEAD	IN		Upper head-to-inner vessel path number	Pointer
PATH_SPRAY	IN		Pressurizer spray path number	Pointer
PATH_LB_LOCA	IN		Large break LOCA path number	Pointer
PATH_PUMP	IN	4	RCP paths numbers	Pointer
PATH_HL	IN	8	Inner vessel to hot leg path numbers	Pointer
PATH_CL	IN	8	Cold leg to annulus path numbers	Pointer
PATH_SG	IN	4	Top of SG tube bundle path numbers	Pointer
PATH_UCEA	IN		CEA to upper head path number	Pointer
P_NODE_INLET	IN	150	Path inlet node number (all paths)	Pointer
P_NODE_EXIT	IN	100	Path exit node number (momentum paths)	Pointer
P_ELEV_INLET	RE	150	Path inlet elevation (at circle center)	Feet
P_ELEV_EXIT	RE	100	Path exit elevation (at circle center)	Feet
P_GEOM	IN	100	Path end geom 0,1,2,3=point,circle,upper/lower semicirc	Pointer
P_RADIUS	RE	100	Path radii at end (not related to P_AREA)	Feet
PATH_TLOA	RE	100	Combined inertia length/area (dMom/dt)	Composite
PATH_KLOSS_POS	RE	100	Geometric forward k-factor	Dimensionless
PATH_KLOSS_NEG	RE	100	Geometric reverse flow k-factor	Dimensionless
P_AREA	RE	100	Path flow area	Ft^2
PATH_LEN_DIAM	RE	100	Path length-to-diameter ratio	Dimensionless
P_DIAM_HYD	RE	100	Path hydraulic diameter	Feet
***** PRESSURIZER *****				
RCS_PRZR_NSECT	IN		Number of area sections in pressurizer	Pointer
RCS_PRZR_ASECT	RE	3	Pressurizer cross-sectional areas	Ft^2
RCS_PRZR_HSECT	RE	3	Pressurizer section heights	Feet
RCS_PRZR_HWALLF_MULT	RE		Multiplier for pressurizer wall condensation	Dimensionless

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** RCP *****				
NUM_PUMPS	IN		Number of main coolant pumps (4 max)	Counts
FRAC_TABL	RE	11	Independent variables for RCP homologous curves	Dimensionless
BAN	RE	11	RCP torque homologous curve (normal +f,+s)	Dimensionless
BVN	RE	11	RCP torque homologous curve (normal +f,+s)	Dimensionless
BAD	RE	11	RCP torque homologous curve (energy dissipation -f,+s)	Dimensionless
BVD	RE	11	RCP torque homologous curve (energy dissipation -f,+s)	Dimensionless
BAT	RE	11	RCP torque homologous curve (turbine -f,-s)	Dimensionless
BVT	RE	11	RCP torque homologous curve (turbine -f,-s)	Dimensionless
BAR	RE	11	RCP torque homologous curve (abnormal +f,-s)	Dimensionless
BVR	RE	11	RCP torque homologous curve (abnormal +f,-s)	Dimensionless
HAN	RE	11	RCP head homologous curve (normal +f,+s)	Dimensionless
HVN	RE	11	RCP head homologous curve (normal +f,+s)	Dimensionless
HAD	RE	11	RCP head homologous curve (energy dissipation -f,+s)	Dimensionless
HVD	RE	11	RCP head homologous curve (energy dissipation -f,+s)	Dimensionless
HAT	RE	11	RCP head homologous curve (turbine -f,-s)	Dimensionless
HVT	RE	11	RCP head homologous curve (turbine -f,-s)	Dimensionless
HAR	RE	11	RCP head homologous curve (abnormal +f,-s)	Dimensionless
HVR	RE	11	RCP head homologous curve (abnormal +f,-s)	Dimensionless
HANC	RE	11	RCP difference head homologous curve (normal +f,+s)	Dimensionless
HVNC	RE	11	RCP difference head homologous curve (normal +f,+s)	Dimensionless
HADC	RE	11	RCP difference head homol curve (energy dissip -f,+s)	Dimensionless
HVDC	RE	11	RCP difference head homol curve (energy dissip -f,+s)	Dimensionless
HATC	RE	11	RCP difference head homologous curve (turbine -f,-s)	Dimensionless
HVTC	RE	11	RCP difference head homologous curve (turbine -f,-s)	Dimensionless
HARC	RE	11	RCP difference head homologous curve (abnormal +f,-s)	Dimensionless
HVRC	RE	11	RCP difference head homologous curve (abnormal +f,-s)	Dimensionless
FRAC_HD_TABL	RE	11	RCP head degradation void frac (independent variables)	Dimensionless
HD_DEG_TABL	RE	11	RCP head degradation multiplier	Dimensionless
RATED_PUMP_SPEED	RE	4	Rated pump speed	Shaft RPM
RATED_VOL_FLOW	RE	4	Rated pump volumetric flow	Ft^3/sec
RATED_PUMP_DENS	RE	4	Rated pump density	Lbm/ft^3

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RATED_PUMP_HD	RE	4	Rated pump head	Feet
RATED_PUMP_TORQ	RE	4	Rated pump torque	Ft-lbf
RATED_PUMP_SYNCH	RE	4	Pump synchronous speed at rated frequency	Shaft RPM
NUM_POLES	IN		Number of poles per pump	Counts
WIND_TORQ_MULT	RE		Windage/friction torque constant	Ft-lbf
NPTS_TAB	IN		Number of points in Torque(slip) table	Counts
SLIP_TAB	RE	22	Electrical slip table (independent variable)	Dimensionless
TORQ_TAB	RE	22	Electrical torque multiplier table (dependent variable)	Dimensionless
RCP_VOLT_RATED	RE		RCP rated voltage	Volts
RCP_FREQ_RATED	RE		RCP rated frequency	Hertz
RCP_MOM_INERTIA	RE	4	Reactor coolant pump rotor/flywheel interia	Composite
RCP_HEAT_MULT	RE		Reactor coolant pump heat rate multiplier	Dimensionless
RCP_FR_SP_RUB_RATCH	RE		RCP fractional speed at which the pawls rub on ratchet	Fraction
RCP_TORQ_RUB_RATCH	RE		RCP torque when the pawls rub on ratchet	Ft-lbf
RCP_FRIC_COEFF	RE		RCP windage and friction coefficient	Composite
***** STEAMLINES *****				
NUM_SL	IN		Number of steamlines per steam generator	Counts
ASL_MAX	RE	2,2	Steamline flow area (design,line)	Ft^2
ASL_MIN	RE	2,2	Steamline restrictor min area upstream of MSIV or break	Ft^2
VOL_MSLH	RE		Header and steamline volume from MSIV to turbine stop	Ft^3
SLI_FLOW_COEFF	RE	8	Flow coefficient, steam nozzle to MSIV, at 100%	Composite
SLO_FLOW_COEFF	RE	8	Flow coefficient, MSIV to header, at 100%	Composite
SLI_DP100	RE	8	Pressure drop, steam nozzle to MSIV, at 100%	Psid
SLO_DP100	RE	8	Pressure drop, MSIV to header, at 100%	Psid
MSLH_MSIV_AMAX	RE	2,2	MSIV full-open flow area (design,line)	Ft^2
MSLH_MSIV_BYPASS_AMAX	RE	2,2	MSI Bypass Valve full-open flow area (design,line)	Ft^2
MSLH_VALVE_AMAX	RE	50	Steamline external valves full open flow areas	Ft^2
MSLH_VALVE_INLET	IN	50	Steamline external valves upstream regions	Pointer
MSLH_VALVE_EXIT	IN	50	Steamline external valves downstream regions	Pointer
MSLH_VALVE_NUM	IN		# of steamline external valves <50-NUM_SG*NUM_SL	Counts
SLI_CHECK_VALVE	LO	2,2	Steamline check valve (design,line)	True False

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
VEL100	RE	8	Steamline velocity at 100% flow	Ft/sec
HA_WALLI_MSLH	RE		Inside MSLH wall heat transfer coefficient hA	Btu/sec-degF
HA_WALLO_MSLH	RE		Outside MSLH wall heat transfer coefficient hA	Btu/sec-degF
MCP_WALL_MSLH	RE		Total heat capacity of MSLH pipe wall	Btu/degF
CTL_ATM_DUMP_NUM	IN		Number of steamline atmospheric dump valves	Counts
CTL_ATM_DUMP_PATH	IN	10	Path number for steamline atmospheric dump valve	Pointer
CTL_TAV_NUM	IN		Number of tubine admission valves	Counts
CTL_TAV_PATH	IN	5	Path number for turbine admission valve	Pointer
CTL_TURB_BYPASS_NUM	IN		Number of turbine bypass valves	Counts
CTL_TURB_BYPASS_PATH	IN	5	Path number for turbine bypass valve	Pointer
NUM_MSLH	IN		Number of Main Steamline Header nodes (1 or 2)	Counts
MSLH_AFRSL	RE	8	Steamline restrictor minimum flow area dnstrm	Ft^2
MSLH_ACROSS	RE		Steamline header cross tie flow area with TSV shut	Ft^2
MSLH_ACROSST	RE		Steamline header cross tie flow area with TSV open	Ft^2
MSLH_FKCROSS	RE		Steamline header cross tie flow resistance with TSV shut	Composite
MSLH_FKCROSST	RE		MSLH cross tie flow resistance with TSV open	Composite
MSLH_NO_MOISTURE_CARRY	RE		If 1 => No moisture carryover	Dimensionless
***** STEAM GENERATOR *****				
NUM_SG	IN		Number of steam generators	Counts
SG_DESIGN	IN	4	Type of steam generator design (1 or 2)	Pointer
SG_ECONOMIZER	LO		SG economizer: T=exist, F=none	True False
ASP_TBL	RE	15,2	Table: cross-sectional area of evaporator region	Ft^2
HSP_TBL	RE	15,2	Table: height in evaporator region	Feet
VST_TBL	RE	15,2	Table: volume in evaporator region	Ft^3
TBL2_NUM	IN	2	No. of entries in evaporator geometry table	Counts
HT3_TBL	RE	15,2	Table: height in SG downcomer	Feet
V3_TBL	RE	15,2	Table: volume in SG downcomer	Ft^3
TBL3_NUM	IN	2	No. of entries in downcomer geometry table	Counts
ASEP_SG	RE	4	Steam separation area at can deck, 100% steady state	Ft^2
EVAP_SS_ALPHA	RE	4	SG evaporator void fraction at 100% steady state	Fraction
PERIM	RE	2	Perimeter of tube shroud in lower SG	Feet

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
SG_V2_ACTIVE	RE	2	Volume in region 2 to cover tubes	Ft^3
VOLSGS	RE	2	SG volume to main steam isolation valve	Ft^3
W32_FLOW_COEFF	RE	4	Downcomer to tube bundle flow coefficient, 100% ss	Composite
TAURC1	RE		Time constant on recirculation flow W23	Seconds
SG_REF_NUM	IN	2	Number of level instrumentation reference legs	Counts
SG_REF_BOT	RE	2,3	Lower tap height above tubesheet (design, leg#)	Feet
SG_REF_TOP	RE	2,3	Upper tap height above tubesheet (design, leg#)	Feet
ELEV_TUBE_SHEET	RE	4	Tubesheet elevation above common reference	Feet
WALL_AREA	RE	2	SG surface area for heat loss to containment	Ft^2
WALL_MCP	RE	2	SG wall heat capacity	Btu/degF
SG_TUBE_AREA	RE	2	SG tube internal flow area, one tube	Ft^2
ATUBES_MAX_CS	RE	2	Primary flow area through tubes	Ft^2
ATUBES_MAX_HT	RE	2	SG tubes heat transfer area	Ft^2
QSG100	RE	4	Tube heat transfer to each SG at 100% power	Btu/sec
SGS_AREA_DOWNCOMER	RE	4	Area of downcomer for bubble rise calculation.	Ft^2
RTUBES	RE	2	Thermal resistance of SG tubes	Sec-ft^{2}degF/Btu
SGMTCP	RE	2	Total heat capacity of tubes	Btu/degF
SGT_HYD_DIAM	RE	2	Hydraulic diameter of SG tubes primary side	Feet
SGT_HTCRTC	RE	4	SG cold side heat transfer resistance tuning factor	Composite
SGT_HTCRTH	RE	4	SG hot side heat transfer resistance tuning factor	Composite
NUM_SG_SECT	IN	16	Number of sections in SG node (request)	Counts
RCS_SG_SECT_DH	RE		Tolerance for SG node saturation hysteresis	Btu/lbm
RCS_SG_SECT_DW	RE		Tolerance for SG node flow hysteresis	Lbm/sec
RCS_SG_SECT_TOPT	IN		Primary temp model for heat transfer: 0=T_{EXIT} , 1=T_{LMTD}	Pointer
***** UNIVERSAL *****				
RCS_CONT_HEAT_MULT	RE		Multiplier on containment heat transfer rates	Dimensionless
N_XFER_INJ	RE	50	Node liquid injection condensation multiplier	Dimensionless
XFER_SURF_POFF	RE	50	Node surface condensation coefficient (pump off)	Btu/secft^2degF
XFER_SURF_PON	RE	50	Node surface condensation coefficient (pump on)	Btu/secft^2degF
AREA_INJ_MULT	RE	50	Interfacial condensation area multiplier	Dimensionless
RCS_DROP_COND_MULT	RE	50	Multiplier on droplet condensation	Dimensionless

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RCS_COND_SURF_MULT	RE	50	Surface condensation multiplier	Dimensionless
RCS_KLOSS_MULT	RE	100	Geometric losses multipliers	Dimensionless
CONC_RATIO_STM_LIQ	RE	20	Ratio of concentrations in steam/liquid: Cs/(Cs+Cl)	Fraction
RCS_SUPERCRIT_FLOW_MULT	RE		Multiplier on critical flux at supercritical pressure	Dimensionless
RCS_SUBCRIT_FLOW_MULT	RE		Multiplier on critical flux at subcritical pressure	Dimensionless
RCS_PRZR_DH_SPRAY_EQ	RE		Pressurizer spray delta-enthalpy for equil.	Btu/lbm
RCS_PRZR_SPRAY_EQ	LO		Pressurizer spray delta-enthalpy equilibrium flag	True False
RCS_PRZR_DT_SUBH	RE		Pressurizer delta-temperature for boiling at the heaters	Degree F
RCS_PRZR_TAU_DTSUB	RE		Pressurizer time constant delta-temp subcooled	Seconds
RCS_PRZR_L_BOIL	RE	2	Boiling degradation parameters	Feet
RCS_CRIT_FLOW_CHECK	LO		Momentum paths critical flow check on	True False
RCS_PRZR_MSPRAY_TAU	RE		Main spray flow time constant	Seconds
RCS_PRZR_HAX_WALL	RE		Pressurizer walls axial overall heat transfer coefficient	Composite
RCS_PRZR_LVLDT_SUBC	RE	2	Pressurizer levels for boiling	Feet
CHT_GAP_HCAP	RE		Fuel-clad gap thermal heat capacity	Btu/ft^3-degF
CHT_PRESS_SUPERCRIT	RE		Pressure for supercritical DNB calculation	Psia
CHT_CHF_MULT	RE		Multiplier on calculated critical heat flux	Dimensionless
CHT_CONST_LEV	RE		Time constant for level calculation in the core.	Fraction
POW_KIN_TSS	RE		Maximum kinetics time step	Seconds
POW_DKHT_TIMDHT	RE	40	Time for ANS decay heat vs time table	Seconds
POW_DKHT_ANSDHC	RE	40	Decay heat fraction for decay heat vs time table	Fraction
POW_DKHT_NDHC	IN		No. of pairs in decay heat vs time table	Counts
POW_DKHT_DHCBEG	RE		Power fraction for switch to decay heat	Fraction
POW_DKHT_DHCFCT	RE		Multiplier on tabular decay heat	Dimensionless
POW_ZRH2O_NYZIR	LO		Option: calculate zirconium-water oxidation	True False
POW_ZRH2O_FZBJ	RE		Multiplier on Baker-Just generated heat	Dimensionless
RCS_NUM_MUKPR_P	IN		Number steps for mu-k-Pr calc.	Counts
RCS_NUM_FLOWLIM_P	IN		Number steps for critical flow checks	Counts
RCS_PRZR_CONT_HEAT_MULT	RE		Multiplier on pressurizer wall heat to containment	Dimensionless
RCS_UHEAD_CONT_HEAT_MULT	RE		Multiplier on upper head heat loss to containment	Dimensionless
RCS_SPRAY_EFF_MULT	RE		Spray efficiency multiplier	Dimensionless
RCS_L_EFF_SPR	RE	2	Levels for spray efficiency calculation	Feet
RCS_PRZR_TREF_TAU	RE	2	Pressurizer reference leg time constants	Seconds

Table A.1

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
CONT_PRES	RE		Containment pressure	Psia
CONT_SG_TEMP	RE	4	Containment temperature at steam generators	Degree F
P_CONDENSER	RE		Condenser pressure	Psia
P_ATMOSPHERE	RE		Atmospheric pressure	Psia
SF_CONC_IO	RE		Stripping factor for SG iodine nuclides concentration	Dimensionless
SG_U12	RE		Heat transfer coefficient between SG regions 1 & 2	Btu/secft^2degF
SG_U23	RE		Heat transfer coefficient between SG regions 2 & 3	Btu/secft^2degF
TAU_REFLG_DN	RE	2	Time constant, level instrum ref leg during cooldown	Seconds
TAU_REFLG_UP	RE	2	Time constant, level instrum ref leg during heatup	Seconds
SG_HCONV	RE		Convective heat transfer coefficient outside SG wall	Btu/secft^2degF
SG_RWALL	RE	2	Thermal resistance of SG wall	Sec-ft^{2}degF/Btu
MSLH_TATM	RE		Atmospheric temperature at steamline header	Degree F
SGS_ASEP_TUNE	RE		SG steam separator area tuning factor	Dimensionless
SGS_FK3_TUNE	RE		SG downcomer flow coefficient tuning factor	Dimensionless
SGS_PCNVRG	RE		Pressure convergence criterion	Psia
SGS_RECIRC_DELVOL	RE		Delta volume for adjusting recirculation flow	Ft^3
SGS_RECIRC_MIN	RE		Minimum recirculation for crossflow	Dimensionless
SGS_TAURC1_TUNE	RE		SGS recirculation flow time constant tuning factor	Dimensionless
SGS_TAURC2_MAX	RE		SGS downcomer flow maximum time constant	Seconds
SGS_USTM_MIN	RE		Minimum steam separation velocity	Ft/sec
SGS_VCNVRG	RE		SG volume convergence criterion	Fraction
SGT_HTCSCW	RE		Tube reverse heat transfer coeff, if liquid or two-phase	Btu/secft^2degF
SGT_HTCSTM	RE		Tube heat transfer coefficient if tube is in steam	Btu/secft^2degF
SGT_Q_MULT	RE	4	Multiplier on SG tube heat transfer area	Dimensionless
SGS_VF_REF	RE		Liquid specific volume for level instrument calibration	Ft^3/lbm
SGS_VG_REF	RE		Steam specific volume for level instrument calibration	Ft^3/lbm
SGS_VLEG_REF	RE		Ref-leg specific volume for level instrument calibration	Ft^3/lbm
SGS_UADROP_PERIM	RE		Perimeter of the feedring	Feet
SGS_UADROP_WFDMIN	RE		Minimum feedflow below which condens efficiency = 1.	Lbm/sec
SGS_DELTV	RE	4	Multiplier on steam velocity. Normally set to 1.0	Dimensionless
SGS_VEL31_MULT	RE	4	Downcomer multiplier on Wilson velocity.	Dimensionless

Table A.2

Auxiliary Inputs

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** FEEDWATER *****				
FW_COEFF	RE	4	FW flow coefficient at 100%. Used for #pumps=0 only	Composite
FWS_FLOW100	RE	4	Feedwater flow at 100% power, each SG	Lbm/sec
HTNOZ	RE	2	Height of downcomer feedwater nozzle above tubesheet	Feet
HTNOZ_ECON	RE	2	Height of economizer feedwater nozzle above tubesheet	Feet
HTNOZ_EFW	RE	2	Height of auxiliary feedwater nozzle above tubesheet	Feet
NUM_FWS_PUMPS	IN		No. of MFW pumps (max 4). >0 turns on detailed model	Counts
FWS_HTABLE_ENTH	RE	20	Table: MFW norm. enthpy, (h-H1)/(H2-H1) (#pumps=0)	Dimensionless
FWS_HTABLE_LOAD	RE	20	Table: turbine normalized load, W/Wrated (#pumps=0)	Dimensionless
FWS_HTABLE_NUM	IN		Table: number of entries. Used for #pumps=0 only	Counts
CTL_FWS_H	RE	2	Steady state FW enthalpy: 1 at CST, 2 at SGS	Btu/lbm
CTL_FWS_H_MAX	RE		Maximum feedwater enthalpy. Used for #pumps=0 only	Btu/lbm
CTL_FWS_H_TC	RE		FW enthalpy time constant. Used for #pumps=0 only	Seconds
NUM_AFW_PUMPS	IN		Number of AFW pumps (max 4)	Counts
FWS_VOL	RE	4	FW line volume after downcomer valve.	Ft^3
FWS_ECON_VOL	RE	4	FW line volume after economizer valve.	Ft^3
FWS_DPEL	RE	50	FWS model: flowpath elevation gain, external path	Feet
FWS_CV	RE	50	FWS model: flowpath flow coefficient	Composite
FWS_NDIN	IN	50	FWS model: flowpath input node ID	Pointer
FWS_NDOUT	IN	50	FWS model: flowpath output node ID	Pointer
FWS_NDEXT	IN	50	FWS model: flowpath external node ID	Pointer
FWS_NCPUMP	IN	50	FWS model: flowpath pump ID	Pointer
FWS_ICK	IN	50	FWS model: flowpath check valve flag	Pointer
FWS_NFLO	IN		FWS model: network number of paths	Counts
FWS_PEXTN	RE	20	FWS model: external node pressure	Psia
FWS_HEXTN	RE	20	FWS model: external node enthalpy	Btu/lbm
FWS_AEXTF	RE	30	FWS model: node external leak flow area	Ft^2
FWS_NNOD	IN		FWS model: network number of nodes	Counts

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
FWS_NEXTN	IN		FWS model: network number of ext. nodes	Counts
FWS_NPSGMFW	IN	4	FWS model: SG main feedwater path ID	Pointer
FWS_NPSGECO	IN	4	FWS model: SG economizer feedwater path ID	Pointer
FWS_NPSGAFW	IN	4	FWS model: SG emergency/aux feedwater path ID	Pointer
FWS_NPFWLB	IN	4	FWS model: MFWLB path ID	Pointer
FWS_TOPN	RE	30	FWS model: valve stroke open time	Seconds
FWS_TCLOS	RE	30	FWS model: valve stroke close time	Seconds
FWS_TLAG	RE	30	FWS model: valve actuator lag	Seconds
FWS_CVP	RE	200	FWS model: valve CV vs Position	Composite
FWS_STP	RE	200	FWS model: valve position vs. CV	Fraction
FWS_NPATH	IN	30	FWS model: valve path location ID	Pointer
FWS_NTABLE	IN	30	FWS model: valve CV table ID	Pointer
FWS_NPTV	IN	10	FWS model: valve CV table number of points	Counts
FWS_NVMFV	IN	4	FWS model: Main Feed Valve ID	Pointer
FWS_NVBFV	IN	4	FWS model: Bypass Feed Valve ID	Pointer
FWS_NVAL	IN		FWS model: number of valves	Counts
FWS_NHDV	IN		FWS model: number of Heater Drain valves	Counts
FWS_NVHDV	IN	3	FWS model: heater drain valve ID	Pointer
FWS_NAFWVT	IN		FWS model: total number of AFW valves	Counts
FWS_NVAFW1	IN		FWS model: AFW valve 1 ID	Pointer
FWS_NTABFV	IN		FWS model: number of feedwater valve tables	Counts
FWS_TAUON	RE	20	FWS model: pump speed lag (increasing)	Seconds
FWS_TAUOFF	RE	20	FWS model: pump speed lag (decreasing)	Seconds
FWS_HT	RE	200	FWS model: pump head vs flow tables	Feet
FWS_WT	RE	200	FWS model: pump flow vs head tables	Gal/min
FWS_NPMPTH	IN	20	FWS model: pump path ID	Pointer
FWS_NTABP	IN	20	FWS model: pump performance table ID	Pointer
FWS_NPTP	IN	10	FWS model: pump table number of points	Counts
FWS_NPMPMFW	IN	4	FWS model: pump MFP ID	Pointer
FWS_NPMPEFW	IN	4	FWS model: pump AFW/EFW pump ID	Pointer
FWS_NPUM	IN		FWS model: number of pumps	Counts
FWS_NTABFP	IN		FWS model: number of feedwater pump tables	Counts
FWS_NMFWP	IN		FWS model: number of MFW pumps	Counts

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
FWS_NEFWP	IN		FWS model: number of EFW pumps	Counts
FWS_TQLAG	RE	9	FWS model: feedwater heater heat transfer tau	Seconds
FWS_HTRHOV	RE	9	FWS model: feedwater heater thermal mass	Lbm
FWS_PWRTBL	RE	90	FWS model: feedwater heater turbine power vs Q	Percent
FWS_QPTBL	RE	90	FWS model: feedwater heater Q vs turbine power	Btu/sec
FWS_HTRHMX	RE	90	FWS model: feedwater heater maximum enthalpy	Btu/lbm
FWS_TPOWR	RE	10	FWS model: feedwater heater drain turb pwr table	Percent
FWS_TWHDP	RE	10	FWS model: feedwater heater drain flow vs turb power	Lbm/sec
FWS_TENHDP	RE	10	FWS model: feedwater heater drain enth vs turb power	Btu/lbm
FWS_MAXTAU	RE	9	FWS model: feedwater heater maximum tau	Seconds
FWS_HFWBIAS	RE		FWS model: delta enthalpy bias to tune fw enthalpy	Btu/lbm
FWS_NPHEAT	IN	9	FWS model: feedwater heater path location ID	Pointer
FWS_NHTBL	IN	9	FWS model: feedwater heater table number of points	Counts
FWS_NHT	IN		FWS model: number of feedwater heaters	Counts
FWS_NHDPTBL	IN		FWS model: feedwater heater drain table no. of points	Counts
FWS_NRCIRC	IN		FWS model: number of recirculation flow control valves	Counts
FWS_FWRCPB	RE	20	FWS model: recirc pump control proportional band	Percent
FWS_FWRCRE	RE	20	FWS model: recirculation pump control reset	Seconds
FWS_FWRCSP	RE	20	FWS model: recirculation pump control setpoint	Gal/min
FWS_FWRCIR	RE	20	FWS model: recirculation pump control instrum range	Gallons
FWS_NPTHRC	IN	20	FWS model: recirculation pump control path ID	Pointer
FWS_NVALRC	IN	20	FWS model: recirculation pump control valve ID	Pointer
FWS_NPMPRC	IN	20	FWS model: recirculation pump control pump ID	Pointer
***** INITIALIZATION *****				
TGAPIN	RE		Initial core gap conductance	Btu/hr-ft2-degF
KFRAIN	RE		Initial core power fraction	Fraction
RPINIT	RE		Initial pressurizer pressure	Psia
RLINIT	RE		Initial pressurizer level	Feet
RWINIT	RE		Initial total loop flowrate	Lbm/sec
RTCLIN	RE		Initial cold leg temperature	Degree F
RBINIT	RE		Initial boron concentration	Parts/million

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
SGT_INIT_OPTION	RE		0 => Adjust area to get SPINIT. 1 => Calc. SG pressure	Dimensionless
SPINIT	RE		Initial SG pressure (input if option=0)	Psia
SLINIT	RE		Initial SG secondary side mixture level	Feet
RCS_DOSE_INIT_IOD	RE		Initial RCS Iodine Concentration	Microcurie/lbm
INIT_OFF_RCS	LO		Initialization of RCS: off flag	True False
INIT_OFF_CHT	LO		Initialization of CHT: off flag	True False
INIT_OFF_POW	LO		Initialization of POW: off flag	True False
INIT_OFF_SGS	LO		Initialization of SGS: off flag	True False
INIT_OFF_CON	LO		Initialization of CONT: off flag	True False
INIT_ITER	IN		Number of initialization passes	Counts
***** CORE POWER *****				
CHT_FRAC_HT_GEN	RE	11	Heat generated in fuel (1-8), gap, clad, coolant	Fraction
POW_USER_IFUPOW	LO		User option for using power table	True False
POW_USER_NPOWT	IN		No. of pairs in power vs time table	Counts
POW_USER_POWT	RE	20	Power values for power vs time table	Fraction
POW_USER_TPOWT	RE	20	Time values for power vs time table	Seconds
POW_KIN_ALPHA	RE	11	Fission products disintegration energies	Fraction
POW_KIN_DLAM	RE	11	Decay constants for fission products	1/seconds
POW_KIN_BETA	RE	6	Delayed neutron fractions	Fraction
POW_KIN_PLAM	RE	6	Decay constants for delayed neutrons	1/seconds
POW_KIN_STARL	RE		Prompt neutron lifetime	Seconds
POW_KIN_NDKCON	IN		No. of pairs, reactivity vs boric acid concentration table	Counts
POW_KIN_DKCON	RE	30	Table of boric acid reactivities, vs concentrations	Reactivity
POW_KIN_TDKCON	RE	30	Table of boric acid concentrations, vs reactivites	Parts/million
POW_KIN_NDKCTM	IN		Number of pairs, reactivity vs moderator temp table	Counts
POW_KIN_DKCTM	RE	30	Table of moderator temperature reactivities, vs temps	Reactivity
POW_KIN_TDKCTM	RE	30	Table of moderator temperatures, vs reactivites	Degree F
POW_KIN_NDKDEN	IN		Number of pairs, reactivity vs moderator density table	Counts
POW_KIN_DKDEN	RE	30	Table of moderator density reactivities, vs densities	Reactivity
POW_KIN_TDKDEN	RE	30	Table of moderator densities, vs reactivities	Lbm/ft^3
POW_KIN_NDKTMP	IN		Number of pairs, Doppler reactivity vs fuel temp table	Counts

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
POW_KIN_DKTMP	RE	30	Table of Doppler reactivities, vs fuel temperatures	Reactivity
POW_KIN_TDKTMP	RE	30	Table of fuel temperatures, vs Doppler reactivities	Degree F
POW_KIN_NQDK	IN		Number of pairs, reactivity vs time table	Counts
POW_KIN_QDK	RE	30	Table of reactivities, vs times	Reactivity
POW_KIN_TQDK	RE	30	Table of times, vs reactivities	Seconds
POW_KIN_NDKINS	IN		Number of pairs in worth vs position table	Counts
POW_KIN_DKINS	RE	100	Table of CEA reactivities, vs CEA positions	Reactivity
POW_KIN_TDKINS	RE	100	Table of CEA positions, va reactivities	Steps
POW_KIN_NCUTBACK	IN		No. of points in Reactor Power Cutback reactivity table	Counts
POW_KIN_CUTBACK	RE	10	Table of RPC reactivities, vs times	Reactivity
POW_KIN_TCUTBACK	RE	10	Table of times, vs RPC reactivities	Seconds
POW_KIN_SOURCE	RE		Kinetics source term	Neutron/sec
POW_KIN_SCRAM_ROD_OPTION	LO		Scram control rod reactivity option	Active Inactive
POW_KIN_REG_ROD_OPTION	LO		Regulating rod reactivity option	Active Inactive
POW_KIN_CUT_ROD_OPTION	LO		Reactor Power Cutback control rod reactivity option	Active Inactive
POW_KIN_DOPPLER_FB_OPTION	LO		Doppler reactivity option	Active Inactive
POW_KIN_BORON_FB_OPTION	LO		Moderator boric acid reactivity option	Active Inactive
POW_KIN_MOD_TEMP_FB_OPTION	LO		Moderator temperature reactivity option	Active Inactive
POW_KIN_MOD_DENSITY_FB_OPTION	LO		Moderator density reactivity option	Active Inactive
CORE_N16_MULT	RE		Production constant for N-16, μC/power-fraction	Composite
***** CESEC EMULATION *****				
POW_KIN_MOD_DENSITY_OPTION	LO		Flag for moderator react. by cold edge moderator density	True False
POW_KIN_HERM_CREDIT_OPTION	LO		Flag for Hermite 3-D reactivity feedback credit	Active Inactive
POW_KIN_HERM_TD	RE		Time delay after Scram for taking Hermite 3D credit	Seconds
POW_KIN_HERM_MULT	RE		Fraction of Hermite 3D credit taken	Fraction
POW_KIN_TEMP_TILT_MIN	RE		Temperature tilt (negative) below which it is set to zero	Degree F
POW_KIN_POWTOFLOW_MIN	RE		Minimum power to flow ratio (3D feedback)	Dimensionless
POW_KIN_FLOWFRAC_MIN	RE		Min flow fraction for which the Hermite tables are valid	Fraction
POW_KIN_TEMP_TILT_MAX	RE		Max temp tilt for which the Hermite tables are valid	Degree F
POW_KIN_POWTOFLOW_MAX	RE		Max power/flow ratio for which Hermite tables are valid	Dimensionless
POW_KIN_HERM_POW_REF	RE		Power for normalizing powers in the Hermite credit data	Megawatts

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
POW_KIN_HERM_FLOW_REF	RE		Flow for normalizing flows in the Hermite credit data	Lbm/sec
POW_KIN_HERM_N_FLOWFR	IN		No. of flow fracs in POW_KIN_CORE_W_FRACTAB	Counts
POW_KIN_CORE_W_FRACTAB	RE	8	Core flow fractions for the Hermite 3-D credit tables	Fraction
POW_KIN_HERM_CREDITTAB	RE	350	Hermite reactivity credit trivariant table (3D feedback)	Composite
POW_KIN_EDGE_WEIGHT	RE		Edge temperature geometric weight (3D feedback)	Fraction
POW_KIN_DH_FACTOR	RE		Core enthalpy rise adjustment fraction (3D feedback)	Fraction
SGS_TUBE_AREA_OPTION	LO		Option to degrade secondary tube area	True False
SGS_MASS_FULL_TUBE_AREA	RE		Minimum mass for full secondary-side tube area	Lbm
SGS_MASS_ZERO_TUBE_AREA	RE		Mass for zero secondary-side tube area	Lbm
***** UPPER HEAD *****				
RCS_ORING_PNODEIN	IN		RCS O-ring seal inlet node	Pointer
RCS_ORING_PELEVIN	RE		RCS O-ring seal inlet elevation	Feet
PRES_ATWS_MIN	RE		ATWS minimum head seal leakage pressure	Psia
P_AREA_ATWS_MIN	RE		ATWS minimum head seal leak area	Ft^2
PRES_ATWS_MAX	RE		ATWS maximum head seal leakage pressure	Psia
P_AREA_ATWS_MAX	RE		ATWS maximum head seal leak area	Ft^2
RCS_UHEAD_RING_SEAL_MULT	RE		Multiplier on upper head ring seal area	Dimensionless
RTRV_HEAD_SEAL_MULT	RE		Multiplier on head seal pressure	Dimensionless
RCS_P_ORING_FAIL	RE		Pressure for vessel O-ring failure	Psia
RCS_UHEAD_RELIEF_PNODEIN	IN		Upper head relief valves inlet node	Pointer
RCS_UHEAD_RELIEF_PELEVIN	RE		Upper head relief valves inlet elevation	Feet
RTRV_VENT_MULT	RE		Multiplier on head vent valve flows	Dimensionless
PLT_VLVAREA_UHEAD_CONT	RE		Area of vent valve from upper head to containment	Ft^2
PLT_VLVAREA_UHEAD_QT	RE	2	Area vents valves upper head to quench tank	Ft^2
MAL_VLV_UHEAD_CONT	RE		Upper head to containment valve position (malfunction)	Fraction
MAL_VLV_UHEAD_QT	RE	2	Upper head to quench tank valve position (malfunction)	Fraction
P_AREA_RODEJ	RE		CEA ejection leak area	Ft^2
RCS_Q_CEA_CORE_MULT	RE		Multiplier on heat transfer CEA to core	Dimensionless

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** PRESSURIZER *****				
NUM_PROP_HEATERS	IN		Number of proportional heaters (Prop + Backup ≤ 6)	Counts
NUM_BACK_HEATERS	IN		Number of backup heaters (Prop + Backup ≤ 6)	Counts
HCAP_HEATER	RE	6	Heater gross heat capacity	Btu/degF
XFER_HEATER	RE	6	Heater overall heat transfer coefficient	Btu/sec-degF
RESI_HEATER	RE	6	Heater electrical resistance	Ohms
TOP_HEATERS	RE		Top elevation of pressurizer heaters	Feet
PRZR_HEATER_MULT	RE		Multiplier on total pressurizer heat	Dimensionless
RCS_HEATER_VOLT_BUS	RE	6	Heater bus voltages	Volts
RCS_NUM_MSPRAYVLVS	IN		Number of pressurizer main spray valves	Counts
RCS_SPRAY_PNODEIN	IN		RCS pressurizer spray inlet node	Pointer
RCS_SPRAY_PELEVIN	RE		RCS pressurizer spray inlet elevation	Feet
RCS_SPRAYBLEED_PNODEIN	IN	2	RCS pressurizer spray bleed inlet node	Pointer
RCS_SPRAYBLEED_PELEVIN	RE	2	RCS pressurizer spray bleed inlet elevation	Feet
RCS_PRZR_RELIEF_PNODEIN	IN		Pressurizer relief valves inlet node	Pointer
RCS_PRZR_RELIEF_PELEVIN	RE		Pressurizer relief valves inlet elevation	Feet
PLT_VLVAREA_PRZR_MSPRAY	RE	2	Area main spray control valves	Ft^2
AREA_BLEED_MIN	RE		Pressurizer spray bleed line minimum area	Ft^2
PRZR_SPRAY_MULT	RE		Multiplier on main pressurizer spray	Dimensionless
MAL_VLV_PRZR_MSPRAY	RE	2	Main spray control valves positions (malfunction)	Fraction
RCS_NUM_PORVS	IN		Number of pressurizer PORVs	Counts
PLT_VLVAREA_PRZR_PORV	RE	4	Area pressurizer PORVs	Ft^2
PLT_VLVAREA_PRZR_MOV	RE	4	Area pressurizer MOVs (in series with PORVs)	Ft^2
PRZR_PORV_MULT	RE		Multiplier on PORV relief flowrates	Dimensionless
MAL_VLV_PRZR_PORV	RE	4	Pressurizer PORV positions (malfunction)	Fraction
MAL_VLV_PRZR_MOV	RE	4	Pressurizer MOV positions (malfunction)	Fraction
VLV_PRZR_KLOSS_UP	RE		Loss coefficient, pressurizer to pressurizer-relief-valves	Composite
VLV_PRZR_KLOSS_DOWN	RE		Loss coefficient, pressurizer-relief-valves to quench tank	Composite
RCS_NUM_SAFETYVLVS	IN		Number of pressurizer safety valves	Counts
PLT_VLVAREA_PRZR_SAFETY	RE	4	Areas of pressurizer safety valves	Ft^2
PRZR_SAFETY_MULT	RE		Multiplier on safety valve flowrates	Dimensionless
MAL_VLV_PRZR_SAFETY	RE	4	Pressurizer safety valves positions (malfunction)	Fraction

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
VLV_PRZR_QUAL_DF	RE		Upper quality limit for using VLV_PRZR_FLOW_OPTION	Fraction
VLV_PRZR_FLOW_OPTION	IN		PSV option: 1=choked, 2=Bernouli*cd(subc), 3=flux(P)	Pointer
VLV_PRZR_NPOINTS_TAB	IN		No. points in discharge table (..._FLOW_OPTION=2,3)	Counts
VLV_PRZR_FLOW_TABLE	RE	15	Discharge table: dependent var, 2=subcooling, 3=press	Undefined
VLV_PRZR_PROP_TABLE	RE	15	Discharge table: independent variable, 2=Cd, 3=flux	Undefined
PLT_VLVAREA_PRZR_CONT	RE		Area vent pressurizer to containment	Ft^2
PLT_VLVAREA_PRZR_QT	RE	2	Area vents pressurizer to quench tank (in series)	Ft^2
MAL_VLV_PRZR_CONT	RE		Vent valve pos, pressurizer to containment (malfunction)	Fraction
MAL_VLV_PRZR_QT	RE	2	Vent valve pos, pressurizer to quench tank (malfunction)	Fraction
PRZR_VENT_MULT	RE		Multiplier on pressurizer vent valve flows	Dimensionless
LEVL_REF_BOT	RE		Bottom level of pressurizer reference leg	Feet
LEVL_REF_TOP	RE		Top level of pressurizer reference leg	Feet
CTL_PRZR_LIQ_SPVOL_REF	RE		Pressurizer instrum. reference liquid specific-volume	Ft^3/lbm
CTL_PRZR_STM_SPVOL_REF	RE		Pressurizer instrum. reference steam specific-volume	Ft^3/lbm
LEVL_PRZR_RTD	RE		Level of pressurizer RTD	Feet
***** QUENCH TANK *****				
VOLU_QT	RE		Quench Tank total volume	Ft^3
HEIGHT_QT	RE		Quench Tank height assuming circular cross section	Feet
MASS_QT_MAX	RE		Quench Tank maximum mass of water	Lbm
QT_RUPTURE_SPOINT	RE		Quench Tank rupture disk setpoint pressure	Psia
QT_N2_MULT	RE		Multiplier on nitrogen supply flow	Dimensionless
QT_VENT_MULT	RE		Multiplier on Quench Tank vent flow	Dimensionless
PRES_N2	RE		Quench Tank nitrogen supply pressure	Psia
PLT_VLVAREA_QT_GWS	RE		Quench Tank to GWS vent valve area	Ft^2
PLT_VLVAREA_QT_CONT	RE		Quench Tank to containment vent valve area	Ft^2
PLT_VLVAREA_QT_NSUPPLY	RE		Valve area nitrogen supply to containment	Ft^2
MAL_VLV_QT_GWS	RE		Quench Tank to GWS vent valve position (malfunction)	Fraction
MAL_VLV_QT_CONT	RE		Quench Tank to containment vent valve position (malf)	Fraction
MAL_VLV_QT_NSUPPLY	RE		Nitrogen supply to Quench Tank valve position (malf)	Fraction

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VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** CVCS *****				
NUM_CHGS_PUMPS	IN		Number of charging pumps	Counts
RCS_CHGS_PNODEIN	IN	4	Charging inlet node	Pointer
RCS_CHGS_PELEVIN	RE	4	Charging inlet elevation	Feet
RCS_LDNS_PNODEIN	IN	4	RCS- letdown inlet node	Pointer
RCS_LDNS_PELEVIN	RE	4	RCS- letdown inlet elevation	Feet
CTL_CH_PUMP_W_RATED	RE	4	Charging pump rated flow	Lbm/sec
CTL_HA_REG_HEAT_X	RE		Regenerative heat exchanger overall heat transfer coeff	Btu/sec-degF
CTL_CH_H(1)	RE	2	Charging enthalpy at RHEX inlet	Btu/lbm
CTL_CH_T(1)	RE	2	Charging temperature at RHEX inlet	Degree F
CTL_CHV_RAREA	RE	5	Charging valve relative flow area	Dimensionless
CTL_CHV_FRAC	RE	5	Fractional opening of charging valves	Fraction
CHGS_RCS_BORON	RE		Charging system boron concentration (input to RCS)	Parts/million
CHGS_RCS_IOD	RE		Charging system iodine concentration (input to RCS)	Microcurie/lbm
***** STEAMLINE BREAK *****				
MSLB_AREA	RE		Area of main steamline breaks	Ft^2
MSLH_FKBRK	RE	8	Steamline K factor from SG to MSLB	Composite
MAL_MSLB_OUT	IN		Steamline break in MSLH: 0=>no 1=>yes	Flag
MAL_MSLB_IN	IN	8	SLB in stmln 0=No, 1-3=various locations	Flag
***** RCS LEAKS *****				
RCS_SBLOCA_PNODEIN	IN	4	RCS small break LOCA inlet node	Pointer
RCS_SBLOCA_PELEVIN	RE	4	RCS small break LOCA inlet elevation	Feet
MAL_SB_LOCA	RE	4	Small break LOCA areas	Ft^2
CONV_GPM_AREA(1)	RE	3	GPM-to-area conversion at RCP seals at nominal state	Ft^2/gpm
CORE_IOD_REL	RE		Core iodine release	Microcurie/sec
CORE_PART_REL	RE		Core particulate (cesium) release	Microcurie/sec
CORE_XEN_REL	RE		Core xenon release	Microcurie/sec
RCS_CRIT_MODEL	IN		Liquid/2-phase choked flow model: 0=HEM, 1=H/F	Pointer

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RCS_SGTR_PNODEIN	IN	8	RCS SG tube rupture inlet node	Pointer
RCS_SGTR_PELEVIN	RE	8	RCS SG tube rupture inlet elevation	Feet
MAL_SGTR	RE	8	SG tube rupture leaks (number of tubes)	Pointer
RCS_SGTR_FLOWMULT	RE		SG tube rupture flow area multiplier	Dimensionless
SGTR_TUBE_LENGTH	RE	8	SGTR tube length. 2 values/SG	Feet
SGTR_TUBE_ENTRANCE_K	RE	8	SGTR entrance K factor. Use 0.5 - 2 values/SG	Dimensionless
SGTR_BREAK_ELEV	RE	4	SGTR elevation above tube sheet - 1 value/SG	Feet
SGTR_SLOT_BREAK_OPT	LO	4	SGTR option for slot break flow calculation	True False
SGTR_SLOT_BREAK_AREA	RE	4	SGTR slot area per tube for slot break option	Ft^2
SB_PIPE_AREA	RE	4	SBLOCA pipe flow area	Ft^2
SB_PIPE_LOD	RE	4	SBLOCA pipe length/diameter	Dimensionless
SB_PIPE_KGEOM	RE	4	SB pipe geometric k-factor, excluding entrance loss	Dimensionless
SB_PIPE_KENT	RE	4	SBLOCA pipe entrance loss k-factor	Dimensionless
SB_DELTA_ELEV	RE	4	SB break elevation above RCS connection	Feet
LDN_PIPE_AREA	RE	2	Letdown line flow area (pre/post RHX)	Ft^2
LDN_PIPE_LOD	RE	2	Letdown line length/diameter (pre/post RHX)	Dimensionless
LDN_PIPE_KGEOM	RE	2	Letdown line geom k-factor, excl entrance loss (pre/post)	Dimensionless
LDN_PIPE_KENT	RE	2	Letdown line entrance loss k-factor (at RCS, at RHX)	Dimensionless
LDN_PIPE_DELTA_ELEV	RE	2	Letdown line elev above RCS connection (pre/post RHX)	Feet
MAL_LDN_BREAK	RE		Letdown line break area (<0: before RHX. >0: post RHX)	Ft^2
***** ECCS *****				
RCS_SIS_PNODEIN	IN	8	RCS safety injection inlet node	Pointer
RCS_SIS_PELEVIN	RE	8	RCS safety injection inlet elevation	Feet
CTL_HPSI_NPOINTS_TAB	IN		Number of pairs in HPSI flow vs pressure table	Counts
CTL_HPSI_FLOW_TABLE	RE	45	Flows for HPSI flow-vs-pressure table	Gal/min
CTL_HPSI_PRES_TABLE	RE	15	Back pressures for HPSI flow-vs-pressure table	Psia
CTL_HPSI_PUMP_NUM	IN		Number of operating HPSI pumps	Counts
CTL_HPSI_SPLIT	RE	8	HPSI flow split to injection points	Fraction
CTL_LPSI_NPOINTS_TAB	IN		Number of pairs in LPSI flow vs pressure table	Counts
CTL_LPSI_FLOW_TABLE	RE	45	Flows for LPSI flow-vs-pressure table	Gal/min
CTL_LPSI_PRES_TABLE	RE	15	Back pressures for LPSI flow-vs-pressure table	Psia

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
CTL_LPSI_PUMP_NUM	IN		Number of operating LPSI pumps	Counts
CTL_LPSI_SPLIT	RE	8	LPSI flow split to injection points	Fraction
CTL_SIS_HLPSI_BC	RE		HPSI/LPSI flow boron concentration	Parts/million
CTL_SIS_HLPSI_H	RE		HPSI/LPSI flow enthalpy	Btu/lbm
CTL_SIT_NUM	IN		Number of SI tanks	Dimensionless
CTL_SIT_ELEV_PRES	RE	4	SI tank elevation heads	Psid
CTL_SIT_FLOW_COEFF	RE	4	SI tank flow coefficients	Composite
CTL_SIT_GAS_CONST	RE		SI tank gas constant	Dimensionless
CTL_SIT_GAS_PRES	RE	4	SI tank gas pressures	Psia
CTL_SIT_GAS_VOLUME	RE	4	SI tank gas volumes	Ft^3
CTL_SIT_ISO_VALVE	LO	4	SI tank isolation valves	Open Closed
CTL_SIT_LIQ_SPVOL	RE	4	SI tank liquid specific volumes	Ft^3/lbm
CTL_SIT_LIQ_VOLUME	RE	4	SI tank liquid volumes	Ft^3
CTL_SIS_SIT_BC	RE		SI tank flow boron concentration	Parts/million
CTL_SIS_SIT_H	RE		SI tank flow enthalpy	Btu/lbm
CTL_SDC_DH	RE		Shutdown Cooling enthalpy drop	Btu/lbm
CTL_SDC_H_MIN	RE		Shutdown Cooling minimum return enthalpy	Btu/lbm
CTL_SDC_SPLIT	RE	4	SDC flow split to injection points	Fraction
SDC_RCS_FLOW	RE	2	Shutdown cooling out-flow (RCS connection).	Lbm/sec
***** FEEDWATER LINE BREAK *****				
FWLB_AREA	RE		Standard area for feedwater line breaks	Ft^2
MAL_FWLB_IN	RE	4	Feedline break inside check valve, downcomer line	Fraction
MAL_FWLB_ECON_IN	RE	4	Feedline break inside check valve, economizer line	Fraction
MAL_FWLB_OUT	RE	4	Feedline brk outside check valve, downcomer line	Fraction
MAL_FWLB_ECON_OUT	RE	4	Feedline brk outside check valve, economizer line	Fraction
FWLB_F	RE	4	Feedline break location, downcomer line	Fraction
FWLB_ECON_F	RE	4	Feedline break location, economizer line	Fraction
SGS_CRIT_MODEL	IN		Liquid/2-phase choked flow model: 0=HEM, 1=H/F	Pointer

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** RCP *****				
RCS_RCPLEAK_PNODEIN	IN	4	RCP leak inlet node	Pointer
RCS_RCPLEAK_PELEVIN	RE	4	RCP leak inlet elevation	Feet
RCP_SEALS_LEAK	RE	4	RCP seals leakage at rated conditions	Gal/min
RCPI_VOLT_FRAC	RE	4	RCP voltage (fraction)	Fraction
RCPI_FREQ_FRAC	RE	4	RCP electric motor frequency (fraction)	Fraction
RCP_MOM_INERTIA_SPLIT	RE		Frac. of inertia staying with motor when sheared shaft	Fraction
MAL_RCP_SHAFTBREAK	LO	4	RCP shaft break malfunction	True False
MAL_RCP_LOCKED	LO	4	RCP locked rotor malfunction	True False
***** SGBD *****				
SGBD_ACROSS	RE		Cross section area of SGBD tank	Ft^2
MCP_WALL_SGBD	RE		Total heat capacity of SGBD tank wall	Btu/degF
SGBD_VOL	RE		SGBD tank volume	Ft^3
SGBD_SURF_COEFF	RE	4	Flow coefficients, surface blowdown nozzles	Composite
SGBD_BOT_COEFF	RE	4	Flow coefficients, bottom blowdown nozzles	Composite
SGBD_SURF_HTNOZ	RE	2	Height of SG surface blowdown nozzle	Feet
SGBD_BOT_HTNOZ	RE	2	Height of SG bottom blowdown nozzle	Feet
SGBD_OUT_HTNOZ	RE	2	Heights above bottom, 2 BD tank outlet nozzles	Feet
SGBD_OUT_COEFF	RE	2	Flow coefficients, 2 BD tank outlet nozzles	Composite
SGBD_RELIEF_AMAX	RE		BD tank relief valve full-open flow area	Ft^2
HA_WALLI_SGBD	RE		Inside SGBD tank overall heat transfer hA	Btu/sec-degF
HA_WALLO_SGBD	RE		Outside SGBD tank overall heat transfer hA	Btu/sec-degF
***** ROD DROP/EJECTION *****				
RCS_RODEJ_PNODEIN	IN		RCS rod ejection small break inlet node	Pointer
RCS_RODEJ_PELEVIN	RE		RCS rod ejection small break inlet eleva	Feet
MAL_ROD_EJECT	RE		Rod ejection plus CEDM rupture (fraction)	Fraction

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
***** NON-CONDENSIBLES AND SOLUTES *****				
RCS_GAS_PNODEIN	IN	2	RCS gas injection inlet node	Pointer
RCS_GAS_PELEVIN	RE	2	RCS gas injection inlet elevation	Feet
NUM_SOLUTES	IN		No. dissolved solutes excl. nonc, $N_{SOLUTES} + N_{NONC} \leq 20$	Counts
NUM_NONC	IN		No. of noncondensible species, $N_{NONC} \leq 5$	Counts
HALF_LIFE_SOLUTES	RE	20	Decay half-lives of dissolved species	Seconds
CONC_MAX	RE	20	Maximum concentrations of species (lbm/lbm, PPM,...)	Composite
ID_TYPE_BORON	IN		Identifying pointer for boron	Pointer
ID_TYPE_N16	IN		Identifying pointer for N-16	Pointer
ID_TYPE_IODINE	IN		Identifying pointer for iodine	Pointer
ID_TYPE_XENON	IN		Identifying pointer for xenon	Pointer
ID_TYPE_PART	IN		Identifying pointer for particulates	Pointer
ID_TYPE_HYD	IN		Identifying pointer for hydrogen	Pointer
ID_TYPE_NIT	IN		Identifying pointer for nitrogen	Pointer
ID_TYPE_AIR	IN		Identifying pointer for air	Pointer
NONC_K_DISSOLVE	RE	5	Noncondensibles dissolution constant, lb/sec-ft2-Δconc	Composite
NONC_MW	RE	5	Molecular weights of noncondensibles	Composite
COND_NONC_FRAC	RE	2	Noncond fraction for (1) full condensation, (2) no cond	Fraction
COND_NONC_DEG_MULT	RE	50	Condensation degradation at initial inflow of nonconds	Dimensionless
RCS_PRZR_SPR_GAS_ENTR	RE		Constant for gas entrainment in sprays	Dimensionless
RCS_PRZR_Q_EFF	RE		Pressurizer condensation efficiency when n/c present	Fraction
SIS_RCS_NONC	RE	6,5	Noncondensibles inflow via SI lines	Lbm/sec
GS_VES_NONC	RE		Noncondensibles inflow to vessel via Gas System	Lbm/sec
GS_PRZR_NONC	RE		Noncondensibles inflow to pressurizer via Gas System	Lbm/sec
GS_SPECIES	IN		Species of Gas System gas (from ID_TYPE_...)	Pointer
CORE_RELE_SOLU	RE	20	Solute release rate in the core due to fuel failure	Composite
***** DOSE *****				
RCS_DOSE_INIT_IOD	RE		Initial RCS Iodine Concentration	Microcurie/lbm
RCS_DOSE_FLASH	RE		Dose model flashing factor flag	Dimensionless

Table A.2

VARIABLE NAME	TYPE	DIM	DEFINITION	UNITS
RCS_DOSE_BF	RE		Dose model breathing factor	Ft^3 /sec
RCS_DOSE_CF	RE		Dose model conversion factor	Rem/Curie
RCS_DOSE_XOQ2	RE		Dose model 2-hour site dispersion factor	sec/ft^3
RCS_DOSE_XOQ8	RE		Dose model 8-hour site dispersion factor	sec/ft^3
RCS_DOSE_CONT_LEAK	RE		Dose model containment leak rate	Frac./day
RCS_DOSE_COND_DF	RE		Turbine & condenser decontamination factor	Dimensionless
***** CETOP LINK *****				
CETOP_IN_FR_USER_MULT	RE		CETOP in: User input multiplier on the CETOP Fr	Fraction
CETOP_PRESS_OPT	LO		CETOP link: Constant pressure option	True False
CETOP_FR_DERIV	RE		CETOP link: Fr vs temperature derivative	1/Del-DegF
CETOP_FR_PATH1	IN		CETOP link: Path number for Temp1	Pointer
CETOP_FR_PATH2	IN		CETOP link: Path number for Temp2	Pointer
CETOP_FR_TEMP1	RE		CETOP link: Temp1 for DT calculation (if PATH1=0)	Degree F
CETOP_FR_TEMP2	RE		CETOP link: Temp2 for DT calculation (if PATH2=0)	Degree F

APPENDIX B CRITICAL FLOW TABLES

For choked flow of liquid or two-phase, CENTS provides a choice of one of two critical flow models. They are the homogeneous equilibrium (HEM) correlation and the Henry-Fauske (H-F) correlation. See Sections 4.7 and 5.2.6. CENTS finds the HEM critical flow from the data in Tables B.1 and B.2 using bi-variant interpolations on pressure and enthalpy. Similarly, it finds the H-F critical flow from Tables B.3 and B.4.

In the following tables, pressure and throat pressure are expressed in psia, enthalpy is in Btu/lbm, and the units of mass flux are lbm/sec-ft^2.

B.1 References

B.1 Moody, F.J., "Maximum Discharge Rate of Liquid-Vapor Mixtures from Vessels," ASME Winter Annual Meeting, November 1975.

B.2 R. E. Henry and H. K. Fauske, "The Two-Phase Critical Flow of One-Component Mixture in Nozzles, Orifices and Short Tubes," Journal of Heat Transfer, May 1971.

Table B.1

HEM Tables. Mass Flux as a Function of Pressure and Enthalpy

Pressure	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux
10.0	127.971 1723.749	137.983 1501.987	148.006 1181.103	158.038 607.653	161.261 151.564	167.154 123.084	180.903 99.308	210.365 77.371
	220.186 72.932	259.470 60.844	357.678 46.069	455.887 38.620	554.096 33.919	652.305 30.605	848.722 26.134	1143.348 22.040
50.0	208.502 3702.818	218.633 3316.603	228.787 2812.067	238.966 2097.026	249.174 655.801	250.212 571.607	255.755 501.807	268.690 423.603
	305.645 325.329	342.600 276.601	434.988 213.904	527.376 181.015	619.765 159.842	712.153 144.728	896.929 124.116	1174.093 105.033
100.0	208.608 6410.551	239.066 5603.164	269.775 4188.359	280.078 3436.425	290.420 2333.636	298.539 989.455	303.870 897.414	316.311 776.931
	351.856 612.185	387.401 526.359	476.264 412.361	565.127 351.062	653.990 311.089	742.852 282.328	920.578 242.815	1187.166 205.965
200.0	208.820 9790.477	269.959 8408.488	311.391 6528.570	332.377 4911.988	342.949 3688.190	355.506 1685.384	360.563 1573.526	372.363 1402.104
	406.076 1140.016	439.789 994.153	524.072 792.037	608.354 679.714	692.637 605.195	776.920 550.991	945.485 475.771	1198.334 404.896
400.0	209.243 14329.500	280.617 13053.380	322.169 11708.310	375.266 8740.656	407.962 5252.215	424.168 2818.495	428.850 2694.821	439.776 2476.103
	470.993 2092.076	502.210 1858.251	580.252 1514.386	658.295 1314.225	736.337 1178.118	814.379 1077.547	970.464 935.914	1204.591 800.417
600.0	209.667 17741.710	298.977 16614.920	332.970 15146.710	386.291 12671.930	430.322 9252.980	471.697 3768.992	476.089 3644.763	486.336 3408.740
	515.615 2955.504	544.893 2660.682	618.089 2206.239	691.285 1931.696	764.481 1741.217	837.677 1598.627	984.069 1395.333	1203.657 1198.326
800.0	210.092 20594.720	312.367 18821.590	354.379 17497.950	419.311 14261.110	464.479 10498.470	509.812 4606.211	513.949 4485.508	523.603 4245.773
	551.186 3754.471	578.769 3417.408	647.727 2876.148	716.684 2538.149	785.642 2299.316	854.599 2118.374	992.514 1857.431	1199.387 1601.483
1000.0	210.517 23097.040	333.572 20846.150	397.548 18460.430	464.487 14298.540	511.794 9246.176	542.551 5360.902	546.453 5245.680	555.559 5009.688
	581.574 4501.098	607.589 4136.188	672.628 3528.065	737.666 3136.416	802.705 2854.799	867.743 2638.963	997.821 2324.198	1192.936 2011.759
1200.0	221.027 25242.270	344.373 22876.680	408.632 20471.970	476.035 16443.740	523.846 11929.060	571.853 6049.910	575.531 5941.258	584.112 5713.594
	608.631 5202.613	633.149 4821.496	694.445 4164.141	755.741 3728.105	817.037 3409.157	878.333 3161.884	1000.925 2797.197	1184.813 2430.801

Table B.1 (continued)

HEM Tables. Mass Flux as a Function of Pressure and Enthalpy

Pressure	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux
1400.0	221.445 27311.300	344.664 25003.610	408.811 22735.450	499.447 17359.110	548.677 12551.510	598.830 6683.371	602.288 6581.961	610.359 6365.664
	633.418 5863.516	656.477 5475.953	714.125 4785.445	771.773 4314.086	829.420 3963.346	887.068 3688.239	1002.364 3277.791	1175.307 2860.220
1600.0	221.864 29233.450	344.957 26962.530	408.994 24792.360	523.368 17972.270	574.355 12764.980	624.202 7267.660	627.444 7173.922	635.009 6971.113
	656.622 6486.551	678.235 6100.922	732.268 5392.320	786.300 4894.734	840.333 4518.004	894.366 4218.938	1002.431 3767.341	1164.530 3301.789
1800.0	222.283 31036.020	345.253 28787.660	409.181 26690.690	523.157 20329.760	601.123 12579.660	648.490 7806.832	651.513 7721.074	658.567 7533.320
	678.720 7073.414	698.874 6697.105	749.258 5984.809	799.642 5470.367	850.027 5073.867	900.411 4755.141	1001.179 4267.664	1152.332 3757.933
2000.0	222.702 32738.620	409.372 28462.120	476.028 25375.030	547.557 20586.680	629.345 11965.990	672.111 8303.238	674.909 8225.727	681.436 8054.324
	700.085 7625.125	718.734 7264.863	765.356 6563.016	811.979 6041.578	858.601 5632.180	905.224 5298.684	998.468 4781.527	1138.336 4232.297
2200.0	223.122 34356.400	409.567 30129.090	499.111 25858.070	572.671 20603.370	659.615 10853.930	695.462 8757.281	698.022 8688.324	703.996 8534.484
	721.064 8141.535	738.132 7803.730	780.802 7126.688	823.471 6608.961	866.141 6194.457	908.811 5851.926	994.150 5312.656	1122.159 4729.914
2400.0	223.543 35900.710	409.766 31708.020	522.627 26153.430	598.675 20376.650	657.717 14164.290	718.953 9077.238	721.261 9020.883	726.648 8893.668
	742.039 8559.883	757.431 8263.457	795.909 7645.703	834.387 7154.316	872.866 6750.324	911.344 6409.973	988.300 5863.156	1103.735 5258.488
2600.0	223.964 37380.620	409.968 33211.570	546.656 26262.830	625.813 19894.620	690.036 12766.030	744.475 9408.918	746.500 9361.852	751.226 9254.914
	764.729 8969.762	778.232 8711.047	811.988 8155.797	845.745 7699.270	879.502 7314.586	913.259 6984.250	980.772 6442.141	1082.043 5827.277
2800.0	224.385 38803.520	410.174 34649.520	571.299 26184.230	654.440 19137.050	727.621 11214.610	770.686 9700.238	772.396 9662.594	776.389 9576.551
	787.794 9343.570	799.200 9127.766	827.715 8650.637	856.230 8244.438	884.745 7892.750	913.260 7584.102	970.289 7064.777	1055.834 6457.391
3000.0	225.000 40000.000	421.150 35641.940	583.644 26886.760	668.593 19712.350	745.797 11705.470	801.845 9874.754	803.155 9848.203	806.213 9787.117
	814.950 9619.000	823.687 9459.719	845.529 9095.344	867.371 8771.859	889.213 8481.965	911.055 8220.082	954.740 7763.887	1020.266 7206.020

Table B.2

HEM Tables. Throat Pressure as a Function of Pressure and Enthalpy

Pressure	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr
10.0	68.023 0.949	127.971 4.743	158.038 9.340	161.261 9.650	171.082 8.154	259.470 6.496	1143.348 5.790
50.0	128.067 4.793	208.502 24.957	249.174 49.198	250.212 46.405	259.451 41.407	342.600 33.248	1174.093 28.844
100.0	162.486 10.000	249.271 49.151	290.420 89.624	298.539 90.503	307.425 82.876	387.401 67.329	1187.166 57.647
200.0	198.716 20.714	300.970 102.834	353.581 180.702	355.506 175.406	363.934 164.681	439.789 136.489	1198.334 115.377
400.0	239.663 41.575	353.844 194.794	419.039 361.388	424.168 337.392	431.972 323.863	502.210 276.702	1204.591 231.530
600.0	260.457 56.940	397.165 306.477	464.481 528.647	471.697 492.631	479.017 478.077	544.893 417.923	1203.657 348.679
800.0	281.339 76.538	430.431 418.138	499.841 698.838	509.812 643.036	516.707 628.302	578.769 559.344	1199.387 466.866
1000.0	302.324 101.125	453.051 507.372	524.116 881.412	542.551 789.565	549.055 775.094	607.589 700.640	1192.936 586.163
1200.0	313.025 115.303	476.035 610.293	549.106 1038.770	571.853 932.808	577.983 918.803	633.149 841.493	1184.813 706.699
1400.0	323.746 130.969	499.447 728.206	574.999 1217.119	598.830 1072.961	604.594 1059.817	656.477 981.714	1175.307 828.583
1600.0	344.957 167.859	511.259 790.525	602.067 1351.223	624.202 1210.452	629.605 1198.185	678.235 1121.109	1164.530 951.904
1800.0	355.758 188.681	535.411 932.757	615.582 1521.275	648.490 1345.381	653.528 1334.041	698.874 1259.537	1152.332 1076.741
2000.0	366.585 211.387	547.557 1006.848	629.345 1628.333	672.111 1477.914	676.774 1467.597	718.734 1396.955	1138.336 1203.341
2200.0	366.854 210.436	559.812 1084.806	659.615 1839.125	695.462 1608.183	699.729 1599.026	738.132 1533.568	1122.159 1332.213
2400.0	377.694 235.013	572.182 1166.653	674.611 2005.405	718.953 1720.205	722.800 1713.230	757.431 1659.926	1103.735 1464.788
2600.0	388.561 261.657	584.678 1252.359	690.036 2134.147	744.475 1842.720	747.850 1837.008	778.232 1791.561	1082.043 1601.543
2800.0	399.457 290.488	610.837 1448.209	705.942 2266.912	770.686 1962.770	773.537 1958.214	799.200 1921.627	1055.834 1744.450
3000.0	410.353 319.319	636.996 1644.059	721.848 2399.677	801.845 2075.315	804.029 2072.253	823.687 2046.246	1020.266 1896.673

Table B.3

H-F Tables. Mass Flux as a Function of Pressure and Enthalpy

Pressure	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux
10.0	161.261 757.339	164.207 337.690	167.154 258.262	170.100 217.886	190.724 126.259	210.365 98.988	259.470 70.779	357.678 51.095
	455.887 42.087	554.096 36.596	652.305 32.810	750.513 30.001	848.722 27.811	946.931 26.043	1045.140 24.575	1143.348 23.327
50.0	208.502 3739.189	228.787 2975.727	238.966 2506.849	244.070 2271.742	249.174 2036.635	250.212 1993.246	287.167 502.699	342.600 328.075
	434.988 240.319	527.376 198.880	619.765 173.250	712.153 155.460	804.541 142.208	896.929 131.851	989.317 123.471	1174.093 110.584
100.0	208.608 6418.713	228.888 5941.358	249.271 5290.286	269.775 4415.844	290.420 3361.282	298.539 2971.010	334.084 954.246	387.401 630.974
	476.264 467.517	566.127 388.274	653.990 338.711	742.852 304.129	831.715 278.292	920.578 258.063	1009.440 241.674	1187.166 216.452
200.0	208.820 9796.246	249.465 9017.179	269.959 8444.994	290.594 7706.236	332.377 5627.812	355.506 4369.078	372.363 2323.364	439.789 1206.237
	524.072 909.562	608.354 759.471	692.637 663.980	776.920 596.804	861.203 546.381	945.485 506.790	1029.768 474.654	1198.334 425.146
400.0	209.243 14342.426	249.855 13741.844	290.942 12802.820	332.672 11360.451	396.980 7899.647	424.168 6312.357	447.580 3611.381	502.210 2283.790
	580.252 1771.320	658.295 1491.964	736.337 1309.183	814.379 1178.818	892.421 1080.222	970.464 1002.457	1048.506 939.167	1204.591 841.526
600.0	209.667 17765.658	250.245 17223.262	291.291 16409.572	354.111 14409.974	397.165 12321.509	471.697 7737.958	500.976 4581.633	544.893 3292.623
	618.089 2618.017	691.285 2222.326	764.481 1956.854	837.677 1765.051	910.873 1618.957	984.069 1503.257	1057.265 1408.878	1203.657 1263.102
800.0	210.092 20632.350	250.636 20115.563	291.642 19363.199	333.270 18279.240	397.355 15749.392	509.812 8873.789	530.499 6218.193	578.769 4245.921
	647.727 3457.081	716.684 2956.541	785.642 2612.089	854.599 2360.042	923.557 2166.728	992.514 2013.043	1061.472 1887.415	1199.387 1693.191
1000.0	210.517 23150.109	312.695 21464.008	375.963 19501.020	419.455 17554.799	487.791 13379.993	542.551 9810.510	568.566 6813.215	607.589 5176.532
	672.628 4291.912	737.666 3696.905	802.705 3277.440	867.743 2966.484	932.782 2726.280	997.821 2534.563	1062.859 2377.522	1192.936 2134.516
1200.0	210.942 25422.775	292.347 24226.150	354.924 22646.668	419.604 20123.576	511.599 14591.389	571.853 10593.408	590.242 8254.198	633.149 6084.725
	694.445 5126.006	755.741 4447.579	817.037 3956.356	878.333 3587.274	939.629 3300.133	1000.925 3070.088	1062.221 2881.309	1184.813 2589.030

Table B.3 (continued)

H-F Tables. Mass Flux as a Function of Pressure and Enthalpy

Pressure	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux	Enthalpy Mass Flux
1400.0	211.368	313.356	376.443	441.928	511.421	598.830	621.889	656.477
	27511.141	25896.986	24123.764	21362.811	17199.482	11248.473	8621.405	6968.760
	714.125	771.773	829.420	887.068	944.716	1002.364	1060.011	1175.307
	5960.580	5209.245	4650.486	4224.657	3890.854	3622.370	3401.639	3059.737
1600.0	211.794	355.478	442.030	511.259	561.146	624.202	651.218	678.235
	29454.408	26796.936	23507.426	19562.717	16046.978	11791.727	8986.325	7832.780
	732.268	786.300	840.333	894.366	948.399	1002.431	1056.464	1164.530
	6798.636	5985.068	5362.414	4880.821	4500.405	4193.284	3940.360	3548.552
1800.0	212.221	355.758	442.139	511.113	587.214	648.490	673.682	698.874
	31279.619	28653.932	25483.775	21722.568	16361.599	12234.239	9679.584	8683.805
	749.258	799.642	850.027	900.411	950.795	1001.179	1051.564	1152.332
	7644.791	6779.140	6096.361	5559.987	5132.906	4786.762	4501.316	4059.358
2000.0	212.648	356.041	420.247	510.981	586.513	672.111	700.085	718.734
	33006.332	30401.457	28253.064	23717.533	18525.521	12584.719	9982.929	9533.384
	765.356	811.979	858.601	905.224	951.846	998.468	1045.091	1138.336
	8506.508	7597.539	6857.501	6266.759	5792.672	5407.093	5088.825	4596.680
2200.0	213.075	356.326	442.374	559.812	643.381	695.462	712.530	738.132
	34649.285	32057.303	29058.920	22439.350	16218.618	12844.819	11170.948	10410.529
	780.802	823.471	866.141	908.811	951.480	994.150	1036.820	1122.159
	9392.525	8446.301	7650.360	7004.818	6482.920	6057.265	5705.857	5163.890
2400.0	213.503	356.613	510.760	612.528	674.611	718.953	738.192	757.431
	36219.816	33634.914	27326.537	20464.371	15746.939	12996.687	11694.003	11316.755
	795.909	834.387	872.866	911.344	949.822	988.300	1026.779	1103.735
	10324.857	9327.321	8474.087	7771.945	7200.848	6734.362	6349.683	5759.240
2600.0	213.931	356.901	510.668	611.653	672.385	744.475	778.232	811.988
	37726.980	35144.758	28981.230	22343.668	17651.865	12971.041	12303.079	11320.592
	845.745	879.502	913.259	947.016	980.772	1014.529	1048.286	1082.043
	10260.879	9336.557	8571.472	7947.303	7437.981	7019.448	6672.513	6382.501
2800.0	214.360	357.192	510.589	639.301	753.572	770.686	799.200	827.715
	39178.105	36595.180	30555.600	21977.088	13661.039	13752.790	13427.841	12384.717
	856.230	884.745	913.260	941.774	970.289	998.804	1027.319	1055.834
	11228.914	10211.377	9369.284	8684.192	8128.177	7674.654	7302.198	6994.401

Table B.4

H-F Tables. Throat Pressure as a Function of Pressure and Enthalpy

Pressure	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr	Enthalpy Throat Pr
10.0	148.006 7.293	161.261 8.973	357.678 6.339	750.513 5.816	1143.348 5.455
50.0	208.502 24.463	250.212 42.594	434.988 32.365	804.541 29.073	1174.093 27.323
100.0	269.775 63.277	298.539 83.101	476.264 65.496	831.715 58.119	1187.166 54.707
200.0	311.391 111.746	355.506 162.121	524.072 132.794	861.203 116.117	1198.334 109.561
400.0	375.266 229.188	424.168 316.845	580.252 269.698	892.421 231.739	1204.591 219.367
600.0	419.172 348.647	471.697 469.914	618.089 408.356	910.873 346.812	1203.657 329.070
800.0	464.479 502.606	509.812 622.651	647.727 547.856	923.557 461.192	1199.387 438.531
1000.0	487.791 606.647	542.551 775.737	672.628 687.590	932.782 574.635	1192.936 547.429
1200.0	511.599 721.891	571.853 929.692	694.445 826.844	939.629 686.711	1184.813 655.506
1400.0	536.004 849.921	598.830 1084.948	714.125 965.055	944.716 796.772	1175.307 762.017
1600.0	587.967 1113.827	624.202 1241.877	732.268 1101.362	948.399 904.271	1164.530 866.560
1800.0	560.670 1009.525	648.490 1400.740	749.258 1234.560	950.795 1007.961	1152.332 968.059
2000.0	614.485 1321.506	672.111 1561.615	765.356 1362.659	951.846 1106.096	1138.336 1064.784
2200.0	643.381 1511.262	695.462 1724.726	780.802 1482.440	951.480 1195.686	1122.159 1153.867
2400.0	641.903 1538.618	718.953 1891.445	795.909 1585.643	949.822 1271.893	1103.735 1230.471
2600.0	640.548 1553.431	744.475 2066.513	811.988 1661.749	947.016 1323.917	1082.043 1283.685
2800.0	670.394 1770.429	770.686 2160.248	827.715 1690.066	941.774 1331.433	1055.834 1291.599

APPENDIX C CENTS GENERIC CONTROL SYSTEMS

C.1 Introduction

CENTS features a Generic Control System design (Reference C.1) that defines the individual control systems (e.g., a pressurizer main spray controller) in a totally generic manner. Database input, supplied by the system modeler, defines the structure, operation and interdependence of control systems for the core, primary system, secondary system and selected balance-of-plant systems.

The design is flexible and modular. The overall system, consisting of all the individual control systems, is driven by a CENTS model, which provides interfaces for the process models, control models and the user. Each control model is assembled using generic modules as building blocks, in a manner determined by the database input. This input is constructed and supplied by the system modeler.

The system modeler has the flexibility to create control systems of any design, as simple or as sophisticated as needed. The flexible capability to model plant-specific characteristics of control systems is also available. For the system modeler, the control modules and the rules for assembling them constitute a kind of programming language, with decision making and branching capabilities.

The CENTS user, on the other hand, interacts with the control systems at a more superficial level. The control systems normally perform their functions and drive their associated physical systems automatically. However, as described in Chapter 6, the user may change setpoints, switch selected control systems to manual control mode, and exercise manual control via the interface variables. The setpoint variables eliminate the need for constants to be hard-coded into the control system definitions, giving the CENTS user easy access to the system setpoints and time-constants.

C.2 Control System Structure

The CENTS control system design uses a modular approach to model controllers and control systems, and to construct the detailed logic within the controllers.

C.2.1 Functional Elements

The basic building block available to the control system modeler is the functional element. It is a generic module, designed to perform the following three functions.

a. Input - The element may receive information from selected CENTS variables (pressure, flow, setpoints, etc.), from other functional elements, or from constant parameters built into the control system.

b. Processing - The element processes the input data according to its specific design. CENTS provides thirty functional element types, performing simple arithmetic and logical operations, differential and integral transfer functions, block branching, simulated valve characteristics, and specialized functions.

c. Output - The element generates a single numerical result, which is available as input to other elements, or as the final output of the control group.

C.2.2 Control Groups

A control group consists of up to 250 functional elements, grouped together to perform a desired operation. The control group is held together as a unit, and the relationship among its functional elements is defined, by the exchange of information between elements. Up to 1000 control groups may be defined.

The elements of a control group are executed sequentially, in the order specified by the system modeler. However, their logical order is defined by the lines of communication between them.

Figure C.1 demonstrates the structures of two control groups. Control Group I consists of six elements, while J contains 2 elements. Elements 4 and 5 must execute before element 6 in order to achieve a logical flow of information. Element outputs are available for input to other elements only during execution of their control group, and become undefined after the final element has been processed. Therefore, as seen in Figure C.1, the output of an element is readable only by elements of the same control group, or by the control group's output.

The output of a control group is defined as the output of the last element that executes within the control group and is not a Branch. In the example, the outputs of element 6 of Group I and element 2 of Group J are the control group outputs of I and J. The control group output is automatically stored in a Global Common array, GROUT(1:1000), immediately after the execution of the group's final element. Since GROUT is in Global Common, it is available at all times as input to elements of other control groups. Thus, in the example of Figure C.1, element 2 of control group J reads the output of group I, although it could not read the output of element 6 directly.

No restriction is made on the order of execution of groups I and J. That is, an element may read the output of any control group that precedes it in the execution sequence (backward reference) or that follows it in the sequence (forward reference), as well as its own control group's output (self-reference). In the latter two cases, the information would necessarily arrive lagged by one time step.

C.2.3 <u>Control Systems</u>

A control system is an association of one or more control groups, which produces a desired output to drive (control) a particular physical system or signal generator.

CENTS requires a control system for each of the physical systems listed in Table C.1. More specifically, it expects to find the driving quantities, with which to drive each physical system, in the output slots (GROUT) of the control groups. The association of a particular device driven by the control system to a specific control group is made via database input (Table C.1). For example, if the database contains

CTL_HEATER_CONTROLLERS(1) = 51

then control group 51 should be constructed to generate a fractional voltage signal for the pressurizer's proportional heaters, per Table C.1. CENTS obtains this signal from GROUT(51) and drives the proportional heaters with it.

In the above example, control group 51 may constitute the entire proportional heater control system. More likely, however, it is merely the final control group in a multi-group control system. In that case, CENTS uses GROUT(51) for its intended purpose, and ignores the outputs of the other groups in that control system. To illustrate, suppose that the two control groups in Figure C.1 constitute the proportional heater control system, with J=51. Control group 50 (I) generates a processed pressurizer pressure signal, while group 51 converts the pressure signal into a fractional voltage signal. Although the two control groups could have been defined as a single, eight-element group, they were split as shown in order to make the processed pressure signal, GROUT(50), available to other control systems – backup heaters, main pressurizer spray valves, PORV. Thus, the four control systems overlap, sharing control group 50 as the common initial group.

Tables C.1 and C.2 list the controllers required for driving particular signals or physical systems, the variables for the component model interfaces, and the number of controllers required for each. The controllers drive the variables listed under "Interface Variable." In addition, some control systems that drive valves have two interface variables associated with each – the valve modulating signal calculated by the control system (under "Signal to Handler" in Table C.2), and the valve's position in response to the signal ("Interface Variable" in Table C.2).

C.2.4 Sequence of Control Group Execution

Control groups may be input and consequently numbered, in any convenient order. However, there may be a logical need for them to be executed in some other order. Therefore, CENTS drives the execution of control groups in the order indicated by a database input array, SEQNCE(1:1000).

C.2.5 Entry of Control System Information

The information that determines the structure, logic and data flow of the controllers and control systems is entered into the plant-specific database. The information is stored in several Control System arrays. Entering this information can be done in one of two methods:

1. Non-modular. Each of the Control System arrays is entered separately in its entirety, with each array addressing different aspects of all the control groups. Thus, all of ELEMS is entered (number of elements in each controller), followed by all of ELTYPE (Type ID of each element, Table C.3), then all of ELIN (inputs to the elements, Table C.3) with the CENTS variables referenced via numeric pointers, and all of SEQNCE (execution sequence).

2. Modular. The complete set of input describing each controller is entered together, followed by the complete set of input for the next controller, etc.. CENTS variables are referenced using their alphanumeric names [e.g. TEMP_LIQ(5)]. Element types are referenced by their Type Names (e.g., MULT; see Table C.3). This information is converted internally into numeric pointers similar to those entered directly in method 1, and is loaded into the control system arrays.

C.3 Description of Functional Elements

CENTS provides thirty functional element types, performing a variety of functions. Each element type has associated with it a required number of inputs and a required number of saved "last values". The last values, if required, are stored values of input, output or status variables that are saved from one time step to the next.

Table C.3 lists the functional elements and their functions, along with the number of inputs and last values required by each. The following nomenclature applies:

x, x_1, x_2	Input quantity	K, K_1, K_2	Constants
y	Output quantity	τ, τ_1, τ_2	Time constants (sec)
$( )_t$	Quantity at the current time	s	Laplace differential operator
$( )_{t-1}$	Quantity at previous time step	I	Integrated quantity
Δt	Current time step size (sec)		

C.4 References

C.1 CE-CES-59-P, Rev. 004, "Modeler's Manual for the CENTS Generic Control Systems," December 2002.

Table C.1: Controller Designations

	Required Controller Designation	Quantity	Magnitude	Units	Description
1.	CTL_CORE_TRIP_CONTROLLER	1	0 or 1	Trip signal (1)	Reactor scram
2.	CTL_RPS_CONTROLLERS	20	0 or 1	Trip signal (1)	Reactor protection system channels
3.	CTL_POWER_CUTBACK_CONTROLLER	1	0 or 1	Trip signal (1)	Reactor Power Cutback signal
4.	CTL_TURB_SETBACK_CONTROLLER	1	0 or 1	Trip signal (1)	Turbine Setback signal
5.	CTL_TURB_RUNBACK_CONTROLLER	1	0 or 1	Trip signal (1)	Turbine Runback signal
6.	CTL_CEA_CONTROLLER	1	(2)	Steps/minute	Control rod speed
7.	CTL_LETDOWN_CONTROLLERS	4	0.0 - 1.0	Fraction	Letdown valve position
8.	CTL_CHGS_CONTROLLERS	4	0.0 - 1.0	Fraction	Charging pump flows
9.	CTL_HEATER_CONTROLLERS	2	0.0 - 1.0	Fraction	Heater voltages
10.	CTL_SPRAY_CONTROLLERS	2	0.0 - 1.0	Fraction	Main spray valve positions
11.	CTL_PORV_CONTROLLERS	4	0.0 - 1.0	Fraction	Pressurizer PORV valve positions
12.	CTL_PSV_CONTROLLERS	4	0.0 - 1.0	Fraction	Pressurizer safety valve positions
13.	CTL_SIAS_TRIP_CONTROLLER	1	0 or 1	Trip signal (1)	SIAS: Safety Injection Actuation Signal
14.	CTL_TURB_TRIP_CONTROLLERS(1)	1	0 or 1	Trip signal (1)	Turbine trip signal
15.	CTL_TURB_TRIP_CONTROLLERS(2)	1	0.0 - 1.0	Fraction	Turb. admission valve position after trip
16.	CTL_MSIS_TRIP_CONTROLLER	1	0 or 1	Trip signal (1)	MSIS: Main Steamline Isolation Signal
17.	CTL_MSIV_CONTROLLERS	8	0.0 - 1.0	Fraction	MSIV valve positions
18.	CTL_MSLH_CONTROLLERS	50	0.0 - 1.0	Fraction	MSLH external valve positions
19.	CTL_PRZR_LVL_ERR_CONTROLLER	1	Defined by controller		Pressurizer level error
20.	CTL_PRZR_PROG_LVL_CONTROLLER	1	Defined by controller		Programmed pressurizer level
21.	CTL_T_AVG_CONTROLLER	1	(2)	°F	RCS average coolant temperature
22.	CTL_T_REF_CONTROLLER	1	(2)	°F	RCS reference coolant temperature
23.	CTL_FWS_TRIP_CONTROLLER	1	0 or 1	Trip signal (1)	Main feedwater (FW) trip signal
	➢ *NUM_FWS_PUMPS = 0:*				
24.	CTL_FWS_CONTROLLERS	4	(2)	Lbm/sec	Main FW to downcomer: flowrates
25.	CTL_FWS_ECON_CONTROLLERS (3)	4	(2)	Lbm/sec	Main FW to economizer: flowrates
	➢ *NUM_FWS_PUMPS > 0:*				
26.	CTL_FWS_CONTROLLERS	4	0.0 - 1.0	Fraction	Main FW to downcomer: valve signals
27.	CTL_FWS_ECON_CONTROLLERS (3)	4	0.0 - 1.0	Fraction	Main FW to economizer: valve signals
28.	CTL_FWS_BYPS_CONTROLLERS (4)	4	0.0 - 1.0	Fraction	FW System bypass valves demand signals
29.	CTL_FWS_PUMP_CONTROLLERS	4	0.0 - 1.0	Fraction	Main FW pumps speed signals
30.	CTL_FWS_ISOL_CONTROLLERS	4	0.0 - 1.0	Fraction	FW System isolation valves demand signals
	➢ *NUM_FWS_PUMPS = 0 or NUM_AFW_PUMPS = 0:*				
31.	CTL_AFWS_CONTROLLERS	4	(2)	Lbm/sec	Auxiliary feedwater flowrates
32.	➢ *NUM_FWS_PUMPS > 0 and NUM_AFW_PUMPS > 0:*				
32.	CTL_AFWS_CONTROLLERS	4	0.0 - 1.0	Fraction	Auxiliary feedwater pumps speed signals
33.	CTL_AFWS_VALVE_CONTROLLERS	14	0.0 - 1.0	Fraction	Auxiliary FW System valves demand signals

(1) 0 0 = False (no trip), 1.0 = True (trip). (2) Physically realistic. (3) If SG_ECONOMIZER = T . (4) If SG_ECONOMIZER = F

Table C.2: Controller Interface Variables

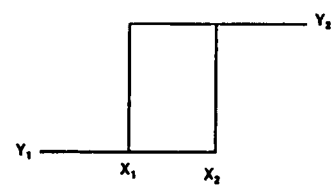
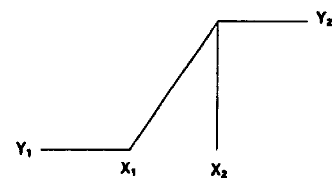
	Description	Interface Variables	Required Number	Signal to Handler
1.	Reactor scram	CTL_CORE_TRIP	1	
2.	Reactor protection system channels	CTL_CORE_TRIP_SIG( )	CTL_NUM_RPS	
3.	Reactor Power Cutback signal	CTL_RPCS_TRIP	1	
4.	Turbine Setback signal	CTL_TURB_SETBACK_TRIP	1	
5.	Turbine Runback signal	CTL_TURB_RUNBACK	1	
6.	Control rod speed	CTL_CEA_SPEED	1	
7.	Letdown valve position	CTL_LETDOWN_FRAC( )	RCS_NUMOUT_LDNS	
8.	Charging pump flows	CTL_CH_PUMP_FRAC( )	NUM_CHGS_PUMPS	
9.	Heater voltages	PRSI_HEATER_VOLT_FRAC( )	2 (Proportional & Backup)	
10.	Main spray valve positions	VLV_PRZR_MSPRAY( )	RCS_NUM_MSPRAYVLVS	VLV_PRZR_MSPRAY_SIG( )
11.	Pressurizer PORV valve positions	VLV_PRZR_PORV( )	RCS_NUM_PORVS	VLV_PRZR_PORV_SIG( )
12.	Pressurizer safety valve positions	VLV_PRZR_SAFETY( )	RCS_NUM_SAFETYVLVS	
13.	SIAS: Safety Injection Actuation Signal	CTL_SIAS_TRIP	1	
14.	Turbine trip signal	CTL_TURB_TRIP	1	
15.	Turb. admission valve position after trip	MSLH_VALVE_POS( )	1	MSLH_VALVE_SIG( )
16.	MSIS: Main Steamline Isolation Signal	CTL_MSIS_TRIP	1	
17.	MSIV valve positions	MSLH_MSIV_POS( )	NUM_SG * NUM_SL	MSLH_MSIV_SIG( )
18.	MSLH external valve positions	MSLH_VALVE_POS( )	MSLH_VALVE_NUM	MSLH_VALVE_SIG( )
19.	Pressurizer level error	CTL_PRZR_LEVEL_ERROR	Optional	
20.	Programmed pressurizer level	CTL_PRZR_PROG_LEVEL	Optional	
21.	RCS average coolant temperature	CTL_T_AVG	Optional	
22.	RCS reference coolant temperature	CTL_T_REF	Optional	
23.	Main feedwater (FW) trip signal	CTL_FWS_TRIP	1	
	➢ *NUM_FWS_PUMPS = 0:*			
24.	Main FW to downcomer: flowrates	FWS_FLOW( )	NUM_SG	
25.	Main FW to economizer: flowrates	FWS_ECON_FLOW( )	NUM_SG (1)	
	➢ *NUM_FWS_PUMPS > 0:*			
26.	Main FW to downcomer: valve signals	CTL_FWS_SIG( )	NUM_SG	
27.	Main FW to economizer: valve signals	CTL_FWS_ECON_SIG( )	NUM_SG (1)	
28.	FWS bypass valves demand signals	CTL_FWS_BYP_SIG( )	NUM_SG (2)	
29.	Main FW pumps speed signals	CTL_FWS_SPEED_SIG( )	NUM_FWS_PUMPS	
30.	FW System isolation valves demand signals	CTL_FWS_ISO_POS( )	NUM_SG	
	➢ *NUM_FWS_PUMPS = 0 or NUM_AFW_PUMPS = 0:*			
31.	Auxiliary feedwater flowrates	AFWS_FLOW( )	NUM_SG	
32.	➢ *NUM_FWS_PUMPS > 0 and NUM_AFW_PUMPS > 0:*			
32.	Auxiliary feedwater pumps speed signals	CTL_AFWS_SPEED_SIG( )	NUM_AFW_PUMPS	
33.	Auxiliary FW System valves demand signals	FWS_STROKE( )	FWS_NAFWVT	

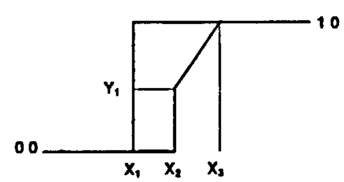
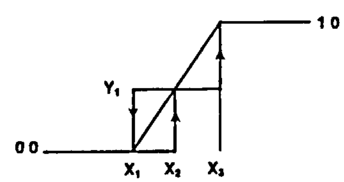
(1) If SG_ECONOMIZER = T (2) If SG_ECONOMIZER = F

Table C.3

FUNCTIONAL ELEMENT DESCRIPTIONS

Type ID	Type Name	Description	Definition	Inputs No.	Inputs Values	Last Values No.	Last Values Values
1	PASS	Pass Value	$y = x$	1	x	0	---
2	ADD	Add	$y = x_1 + x_2$	2	x_1, x_2	0	---
3	WSUM	Weighted Add	$y = K_1 x_1 + K_2 x_2$	4	x_1, x_2, K_1, K_2	0	---
4	MULT	Multiply	$y = x_1 * x_2$	2	x_1, x_2	0	---
5	DIV	Divide	$y = x_1 / x_2$	2	x_1, x_2	0	---
6	COMP	Compare	$y = 1.0$, if $x_1 > x_2$ $y = 0.0$, if $x_1 \leq x_2$	2	x_1, x_2	0	---
7	MIN	Minimum	$y =$ Minimum (x_1, x_2)	2	x_1, x_2	0	---
8	MAX	Maximum	$y =$ Maximum (x_1, x_2)	2	x_1, x_2	0	---
9	LIM	Limit	$y = x_1$, Subject to $x_2 \leq y \leq x_3$	3	x_1, x_2, x_3	0	---
10	SUB	Subtract	$y = x_1 - x_2$	2	x_1 , x_2	0	---
11	PI	Proportional–Integral (PI)	$\frac{y}{x} = K + \frac{1}{\tau s}$	5	$x_i , K, \tau ,$ K_{min}, K_{max}	2	x_{i-1} I_{i-1}
12	PID	Proportional–Integral–Differential (PID)	$\frac{y}{x} = K + \tau_1 s + \frac{1}{\tau_2 s}$	6	x_i $K, \tau_1,$ τ_2, K_{min}, K_{max}	2	x_{i-1} I_{i-1}

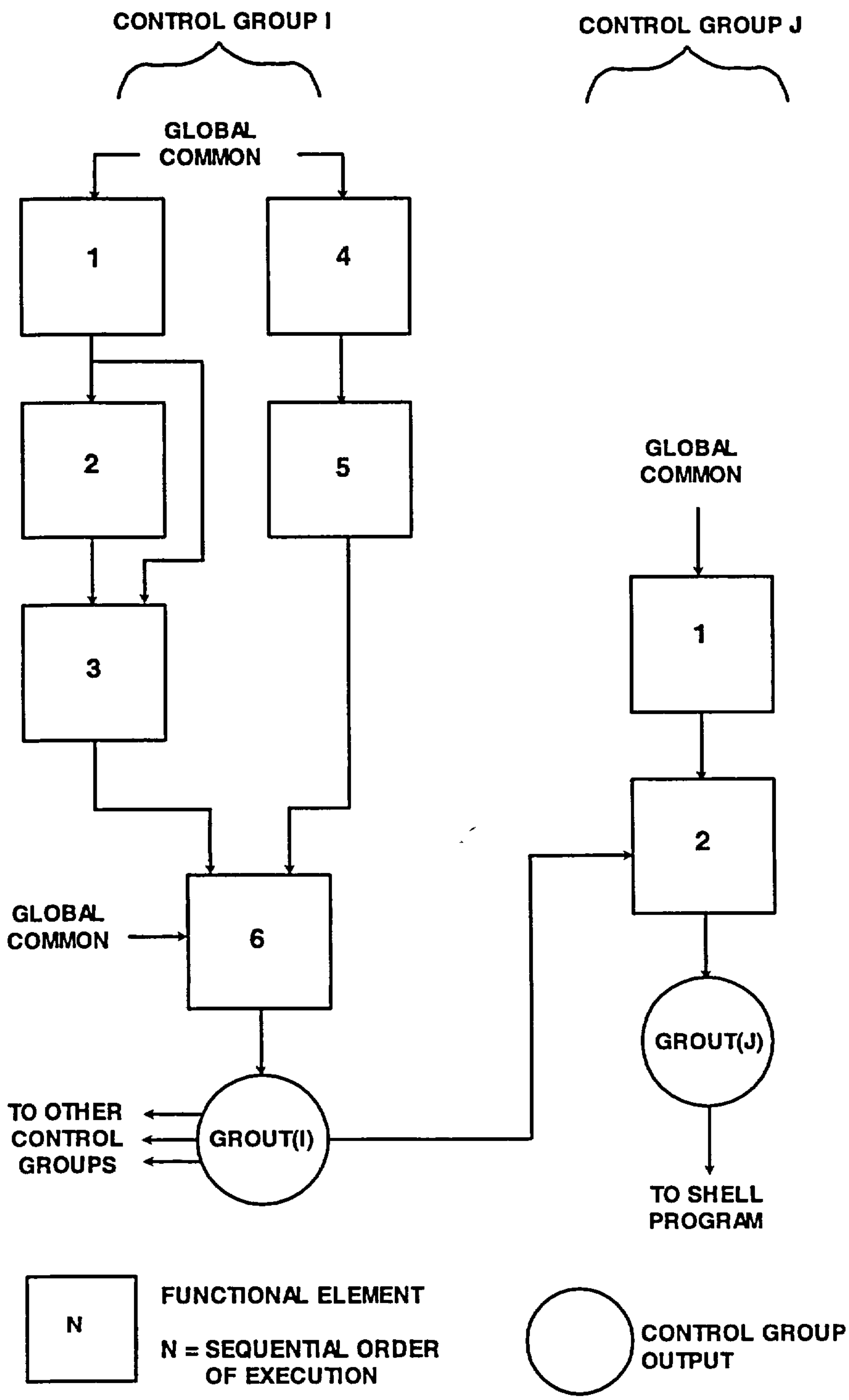
Type ID	Type Name	Description	Definition	Inputs No.	Inputs Values	Last Values No.	Last Values Values
13	DERIV	Filtered Derivative (Impulse)	$\frac{y}{x} = \frac{\tau_1 s}{1+\tau_2 s}$	3	x_i, τ_1, τ_2	2	x_{i-1}, y_{i-1}
14	LAG	Lag (Filter)	$\frac{y}{x} = \frac{1}{1+\tau s}$	2	x_i, τ	2	x_{i-1}, y_{i-1}
15	LLAG	Lead-Lag	$\frac{y}{x} = \frac{1+\tau_1 s}{1+\tau_2 s}$	3	x_i, τ_1, τ_2	2	x_{i-1}, y_{i-1}
16	STEP	Step with Hysteresis (or Bistable)		5	x, X_1, X_2, Y_1, Y_2	1	Z_{i-1}
17	RAMP (or CHOICE)	Ramp (or Bistable)		5	x, X_1, X_2, Y_1, Y_2	0	---
18	FUNC	User Defined Function	y = F(x) where F(x) is defined by Table No. M, and y is found by interpolation	2	x, M	0	---
19	DELAY	Signal Delay	Delay an input On/Off signal by a given length of time	6	x, ΔT_{IN1}, ΔT_{IN0}, ΔT_{OUT1}, ΔT_{OUT0}, Opt	3	$T_{X,i-1}$, $T_{Z,i-1}$, y_{i-1}

Type ID	Type Name	Description	Definition	Inputs No.	Inputs Values	Last Values No.	Last Values Values
20	BRANCH	Branch (Block If)	$x_1 > x_2$ Execute 1st block $x_1 \leq x_2$ Execute 2nd block	4	x_1, x_2, K_1, K_2	0	---
21	AND	Boolean AND	$y = x_1$ .AND. x_2	2	x_1, x_2	0	---
22	OR	Boolean OR	$y = x_1$ .OR. x_2	2	x_1, x_2	0	---
23	XOR	Boolean XOR	$y = x_1$ .XOR. x_2	2	x_1, x_2	0	---
24	NOT	Boolean NOT	y = .NOT. x	1	x	0	---
25	VDIR	Valve Handler: Constant Rate, Direction Signal	Modulate valve at rate K x = -1, close x = 0, no action x = 1, open	2	x, K	1	y_{i-1}
26	VPOS	Valve Handler: Rate Limited, Position Signal	Modulate toward x rate = K_1, opening rate = K_2, closing	3	x, K_1, K_2	1	y_{i-1}
27	SV1	Valve Handler Accumulation and Blowdown		5	x, X_1, X_2, X_3, Y_1	1	z_{i-1}
28	SV2	Valve Handler Step Open, Ramp Closed		5	x, X_1, X_2, X_3, Y_1	1	z_{i-1}

Type ID	Type Name	Description	Definition	Inputs No.	Inputs Values	Last Values No.	Last Values Values
29	VLAG	Valve Handler: Lag Compensation	Valve position (y) approaches x exponentially with time constant τ. $y_1 = x_1$, if $\lvert y_1 - x_1 \rvert < Y_1$	3	x_1, τ, Y_1	2	x_{i-1}, y_{i-1}
30	SVGEN	Valve Handler: Generic Safety Valve	Valve opening and closing curves are described by up to 4 points each.	14	$x, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, Y_2, Y_3, Y_6, Y_7, \Delta P_{TOL}$	4	$x_{i-1}, y_{i-1}, z_{i-1}, p_{i-1}$

* Boolean inut is 0.0 (false) or 1.0 (true).

Figure C.1
SCHEMATIC STRUCTURE OF CONTROL GROUPS



APPENDIX D CENTS INITIALIZATION

This appendix describes a procedure of initializing CENTS. This initialization procedue brings CENTS to a steady state whose parameters are defined by a set of user-specified inputs.

D.1 Initialization Routines

This section describes the CENTS initialization routines, with emphasis on the assumptions and limitations. One has to pay attention to these limitations in order to utilize this procedure.

D.1.1 INITIAL

This program is the initialization driver, called in response to the INITIAL command. It calls the other initialization programs that are described below, followed by the transient process models, and repeats this cycle INIT_ITER times (typically 30-80 cycles) without updating the transient time.

When done, this program resets the transient time to TIME = 0, and displays an Initialization Summary Report on the initial mass and energy balances in the primary and secondary systems. The following is an example of the Initialization Summary Report:

```
NSSS initializing with the following parameters:
   Total core power (Kfrain)          1.0000      Fraction
   Pressurizer pressure (Rpinit)      2250.0      PSIA
   Pressurizer level (Rlinit)         17.400      Feet
   Total vessel flow (Rwinit)         41111.      Lbm/sec
   Cold leg temperature (Rtclin)      553.00      Deg F
   Boron concentration (Rbinit)       0.0000      PPM
   SG pressure option (Sgt_init_option)  1.0  =>  Do not adjust area
   =>  SG pressure (Spinit)           Calculated based SG area
   Steam generator level (Slinit)     36.550      Feet
   Fuel Gap conductance (Tgapin)      6527.0      Btu/hr-ft2-degF
   Fission Source Term (Pow_kin_source) 1.00000E-09
   Feedwater enthalpy (Fhinit)        425.80      Btu/lbm
   =>  Calculated as (1.0-Kfrain)*Ctl_fws_h(1) + Kfrain*Ctl_fws_h(2)
Initializing:   RCS  CHT  POW  SGS  CTL
Exercise models and iterate to a steady state. Init_iter =  30

   RCS loop energy balance        -61.88               Btu/sec
   RCS loop mass balance            0.36               Lbm/sec
   Przr energy balance             -8.01               Btu/sec
   SG mass balance                  0.00        0.00   Lbm/sec
   SG energy balance             -117.63     -289.53   Btu/sec
   SG global balance (Q/dh-W)       0.27        0.27   Lbm/sec
   SG pressure                    907.59      907.59   PSIA
```

The first portion of the Initialization Summary Report consists of:

a. Confirmation of the initialization parameters, which are discussed below in Section D.1.2 - D.1.6.

b. Confirmation of the models being initialized. Normally, all five models indicated in the above example are initialized. Flags to activate/deactivate the initialization of specific models are listed in Appendix C, Table C.2, under "Initialization".

c. Confirmation of the number of initialization cycles.

The second section of the Initialization Summary Report consists of relevant mass and energy balances, and the calculated initial steam generator (secondary) pressure. The displayed information is described below.[

]

d. RCS loop energy balance:

[ ]

e. RCS loop mass balance:

[ ]

f. Pressurizer energy balance:

[ ]

g. SG mass balance, separately for each steam generator:

[ ]

h. SG energy balance.

[ ]

i. SG global balance.

j. Steam generator pressure.

D.1.2 RCSINI

This program is called by INITIAL to initialize RCS conditions. The user inputs for this program are

RPINIT : initial pressurizer pressure (psia)

RLINIT : initial pressurizer level (feet)

RWINIT : initial total loop flowrate (lbm/sec)

RTCLIN : initial cold leg temperature (°F)

RBINIT : initial boron concentration (ppm)

RCS_DOSE_INIT_IOD : Initial iodine concentrations (μCi/lbm)

The overall assumptions used for this procedure are

1. The loop conditions are symmetric.
2. Single-phase water flows in the loops. Only the pressurizer has a steam phase.
3. The RCP's are running at speed RATED_PUMP_SPEED (RPM).

The loop flows are initialized using RWINIT with the assumption that all flowrate ratios to the total loop flowrate in the system stay the same. The flowrate in the pressurizer surge line is set to the pressurizer spray flow. No assumptions are made for the flow direction from the upper plenum to CEA and upper head.

The loop enthalpies are calculated first, with the temperatures in the pump discharge cold legs set to RTCLIN. The pump heat and heat transfer rates in the steam generators are considered in the enthalpy balances. The pressurizer liquid enthalpy is set to saturation at the RPINIT conditions.

The node pressure calculation starts at the pressurizer, whose pressure is RPINIT. Pressure drops by both friction and head losses are accounted for following both directions from the hot leg. The main coolant pump head rise is calculated using the homologous curve. The ratio between the calculated pressure drop across the pump and the pump head rise is defined as an RCP efficiency factor (RKPUMP). This factor multiplies the RCP head in subsequent transient calculation.

The liquid and steam masses are calculated by dividing the node volume by appropriate specific volumes, and the steam masses are set to zero except in the pressurizer. The liquid and steam masses in the pressurizer are calculated using RLINIT, state and geometric information. Iodine concentrations, if input, are set to RCS_DOSE_INIT_IOD.

The wall temperatures are the steady state temperatures that result from setting the right hand side to zero in Equation (4.10.1). For the pressurizer, the lower and upper wall temperatures are set to the steady state temperatures that result from setting the right hand sides to zero in Equations (4.10.2). The pressurizer heater temperatures are set to the steady state temperatures that result from setting the right hand side to zero in Equation (4.13.1). The boron concentration is set to RBINIT.

D.1.3 CHTINI

This program is called by INITIAL to initialize the core heat transfer rate. This routine uses the following user inputs:

KFRAIN :	initial core power fraction (fraction)
TGAPIN :	initial core gap conductance (Btu/hr-ft^2-°F)
KSHAPIN(1:50) :	power shape (fraction; see Section 7.1.1.)

The axial power shape and distribution are calculated using the reference power POW_USER_POWZ and the inputs of KSHAPIN and KFRAIN. The gap conductivity is also calculated with the gap width and TGAPIN. The conductivity is assumed to be a constant along the fuel rod.

The core fluid conditions are obtained by mass and energy balances. The fuel rod temperatures are calculated by enforcing a steady state heat transfer balance. It is assumed that the core heat transfer is in a forced convection mode.

D.1.4 POWINI

This program is called by INITIAL to initialize the power generation rate. The user inputs for this program are:

KFRAIN :	initial core power fraction (fraction)
RBINIT :	initial boron concentration (ppm)
POW_KIN_SOURCE :	fission source term (fraction)

The core power fraction and RCS boron concentrations are set to KFRAIN and RBINIT, respectively. The average fuel temperature, core coolant temperature and specific volume are calculated in CHTINI. These values are used to calculate reference boron, Doppler, moderator temperature and density feedbacks. The reference control rod reactivity feedback is calculated at the input initial rod position. No reactivity feedbacks from cutback and scram are included in this initialization.

The decay heat, prompt power and temporary prompt power fractions are calculated by assuming that they are proportional to the power level. The normalized concentrations of the fission products and delayed neutrons are also calculated in the same way. The fission source term is included, although it is only significant for initially subcritical conditions.

D.1.5 SGSINI

This program is called by INITIAL to initialize the steam generators (SGs). The user specified variables for this program are:

SGT_INIT_OPTION :	Option flag for SG pressure calculation (see below)
SPINIT :	if option=0, initial steam generator pressure (psia)
SLINIT :	initial SG downcomer water level (feet)
CTL_FWS_H(1:2) :	limits for initial feedwater enthalpy (Btu/lbm)

The tube heat transfer rate is initialized by employing a steady state energy balance on the primary system. The tube heat rate is the sum of heat input from the core and RCPs, heat losses to containment (excluding the pressurizer), and energy flows due to charging, letdown and RCP seals leakage.

The steam generator dome pressure is determined based on the input option flag:

- If SGT_INIT_OPTION = 0.0, then CENTS sets the pressure to the input SPINIT, and adjusts the effective tube heat transfer area to achieve the primary-to-secondary heat balance necessary to attain the desired pressure.

- If SGT_INIT_OPTION = 1.0, then CENTS calculates SPINIT as the steam generator dome pressure that provides the best steady-state heat balance for the given initial conditions. The SG tube heat transfer areas remain at their input value.

The coolant temperature in the evaporator is the saturation temperature for the pressure SPINIT. Heat transfer coefficients are calculated on the primary and secondary sides of the tubes, as described in Sections 5.3.4 and 5.3.5. The tube metal temperatures on the cold and hot sides of the bundle are then determined from a steady state heat balance that results from setting the right hand side to zero in Equation (5.25).

The initial feedwater enthalpy (FHINIT) is determined as a function of the initial core power fraction KFRAIN (Sections D.1.3-4), based on the input CTL_FWS_H(1:2). This array of two elements represents the feedwater enthalpy at zero power and full power, respectively, with linear interpolation for intermediate initial power levels.

The required feedwater flowrate is found from a steady state energy balance on the steam generator, with steam flow set equal to the feedwater flowrate.

Downcomer water level is set to the input SLINIT. The evaporator level is set equal to the can deck height. The average void fraction in the evaporator is found as the void fraction for which the Wilson correlation (Section 5.2.2) will produce the required steam flow.

The circulation and recirculation flows are determined based on the calculated downcomer-to-evaporator driving head. The average downcomer enthalpy (subcooled) is the result of imposing a steady state energy balance on the downcomer.

With all levels, pressures, void fractions and temperatures (or enthalpies) known, the procedure calculates the masses and total energies, utilizing the liquid and steam property routines.

D.1.6 CONINI

This program is called by INITIAL to initialize the control systems. ELLAST and GROUT arrays are set to proper initial conditions. The setpoints are not changed. Valve states and error signals after this initialization are based on the setpoints and the initial conditions. Therefore, the user may need to change setpoints to bring the valve states and error signals to those expected for specific applications.

D.2 Initialization Procedure

The guidelines for this initialization procedure are as follows:

1. Input initial conditions. The variables for the initial conditions are discussed in Section D.1, and are summarized below.

RPINIT :	Initial pressurizer pressure (psia)
RLINIT :	Initial pressurizer level (feet)
RWINIT :	Initial total loop flowrate (lbm/sec)
RTCLIN :	Initial pump-discharge cold leg temperature (°F)
KFRAIN :	Initial core power fraction (fraction)
TGAPIN :	Initial core gap conductance (Btu/hr-ft^2-°F)
KSHAPIN(1:50) :	Power shape (fraction)
RBINIT :	Initial boron concentration (ppm)
SLINIT :	Initial steam generator downcomer water level (feet)
SGT_INIT_OPTION :	Option flag for SG pressure calculation (Section D.1.5)
SPINIT :	If option=0, initial steam generator pressure (psia)
CTL_FWS_H(1:2) :	Limits for initial feedwater enthalpy (Btu/lbm; Sect. D.1.5)
RCS_DOSE_INIT_IOD :	Initial iodine concentrations (μCi/lbm, Section 5.8.2)

2. Issue the command INITIAL.
3. Examine the Initialization Summary Report, Section D.1.1. Confirm that:
   - The echoed initialization parameters are as input.
   - If SGT_INIT_OPTION = 1.0, the steam generator pressure is as expected.
   - The mass and energy balances (items d. through i. in Section D.1.1) are acceptably small. If not, the number of initialization cycles, INIT_ITER, may be increased. Alternatively, system parameters, boundary conditions or control setpoints may have to be changed.
4. Check the values of RKPUMP(1:4) (RCP head efficiency factors, Section D.1.2), which normally should be near 1.0. If SGT_INIT_OPTION = 0.0, then check the value of SGT_Q_MULT(1:4), which normally should be near 1.0. If these values are much different from 1.0, the resultant initial condition is still valid, but the user should understand the reasons – e.g., boundary conditions are not realistic.
5. Proceed with the transient simulation, or use the SNAP command to save the new initial conditions for later use.

APPENDIX E CESEC EMULATION

CENTS incorporates some of the features of CESEC (Reference E.1), to support licensing applications with the conservatism of CESEC for certain accident scenarios. These features are:

1. Temperature Tilt in the Core
2. Cold-Edge Moderator Density Reactivity Feedback
3. Hermite Reactivity Credit
4. Steam Generator Heat Transfer Degradation

The following sections discuss these features and their implementation within CENTS.

E.1 Temperature Tilt in the Core

In reality, there are three dimensional temperature distributions in the core. CESEC uses the coldest temperature in the core in calculating the moderator density. The implementation of the CESEC temperature tilt feature within CENTS is based on the following guidelines:

1. The implementation uses the CENTS calculated cold leg temperatures, core flowrates and reactivities.
2. The implementation provides flexibility for users in calculating and adjusting the mixing in the lower plenum.
3. The implementation follows the CESEC input arrangements as much as possible.

These guidelines mean that the implementation of the CESEC feature within CENTS retains the essential feature of CESEC, but does not emulate the CESEC calculation exactly.

CENTS employs a reactor vessel mixing model to calculate core mixing and the core-exit/hot-legs enthalpy tilt that results from non-symmetric operation of the steam generators. Section 7.2.5 provides details for this model.

CENTS calculates the temperature tilt in the core, as part of the CESEC model emulation, in order to support the Cold-Edge Moderator Density Reactivity Feedback model emulation (Section E.2) and/or the Hermite Reactivity Credit model emulation (Section E.3). That is, the core temperature tilt is calculated if either of these flags is True:

POW_KIN_MOD_DENSITY_OPTION

POW_KIN_HERM_CREDIT_OPTION

The cold-edge enthalpy (h_{ec}) and hot-edge enthalpy (h_{eh}) are calculated as:

$$h_{ec} = K_e \, \Delta h_c + h_{path\,1} + F_{DH} \, \Delta h_{core}$$

$$h_{eh} = K_e \, \Delta h_h + h_{path\,1} + F_{DH} \, \Delta h_{core}$$

where

$h_{path\,1}$ = specific enthalpy of the flow in the core inlet flowpath

F_{DH} = input core enthalpy rise adjustment factor, POW_KIN_DH_FACTOR

Δh_{core} = core enthalpy rise

K_e = input weight factor for edge enthalpies, POW_KIN_EDGE_WEIGHT

Δh_c = cold side enthalpy defect, $h_{min} - h_{ave}$, passed through a lag with time constant = (annulus mass) / (total cold legs flowrate into annulus)

Δh_h = hot side enthalpy excess, $h_{max} - h_{ave}$, lagged as above

h_{min} = minimum cold leg path enthalpy

h_{max} = maximum cold leg path enthalpy

h_{ave} = flow-averaged cold leg enthalpy = $\Sigma(W \cdot h) / \Sigma(W)$

The edge temperatures (T_{ec} and T_{eh}) are calculated by a CENTS property function, evaluated at the core pressure, and h_{ec} and h_{eh}. That is,

$$T_{ec} = T_{sub}(P_{core}, h_{ec})$$

$$T_{eh} = T_{sub}(P_{core}, h_{eh})$$

The input variables for this option are listed in table E.1. The temperature tilt is defined as

$$\Delta T_{TILT} = T_{eh} - T_{ec}$$

E.2 Moderator Density Calculation

The moderator density and the corresponding moderator reactivity feedback is computed by the CENTS when the flag POW_KIN_MOD_DENSITY_FB_OPTION is True. CENTS calculates the moderator density for use in the reactivity versus density tables, as described in Section 7.1 and in Tables 7.4 and 7.5. Normally, this is the bulk density in the core.

However, if the flag POW_KIN_MOD_DENSITY_OPTION is True, then CENTS uses the CESEC emulation model to calculate the moderator density from a property function, evaluated at the core pressure and the cold-edge enthalpy (Section E.1):

$$\rho_{mod} = \text{POW\_KIN\_DENCOR} = 1 / v_{sub}(P_{core}, h_{ec})$$

The input variables for this option are listed in table E.1.

E.3 Hermite Reactivity Credit

CENTS and CESEC employ a point kinetics model to calculate power in the core. However, the CESEC method of calculating the reactivity based on the coldest temperature (Section E.2) is overly conservative. Therefore, the Hermite credit, which accounts for the effect of three dimensional power distribution, is available in CENTS. The Hermite credit is calculated if the flag POW_KIN_HERM_CREDIT_OPTION is True, and then only after POW_KIN_HERM_TD seconds (input) past the Scram.

The implementation of the Hermite credit follows very closely the method in CESEC. The temperature tilt (ΔT_{TILT}) and the moderator density (ρ_{mod}) are calculated as outlined in Sections E.1 and E.2. The flow fraction is

$$F_W = W_{CORE} / W_{REF}$$

where W_{CORE} is the CENTS calculated core flow, and W_{REF} is the input reference flow POW_KIN_HERM_FLOW_REF. The fission power fraction is

$$F_{MW} = \Pi_{CORE} / \Pi_{REF}$$

where Π_{CORE} is the CENTS calculated fission power, and Π_{REF} is the input reference power POW_KIN_HERM_POW_REF. The power-to-flow ratio is

$$R_{PF} = F_{MW} / F_W \geq \text{POW\_KIN\_POWTOFLOW\_MIN (input minimum).}$$

The 3-D Hermite reactivity credit (POW_KIN_DKHERMC) is calculated at each time step, based on the current temperature tilt (ΔT_{TILT}) and power-to-flow ratio (R_{PF}), and using the input tables POW_KIN_HERM_CREDITTAB(1:350) and POW_KIN_CORE_W_FRACTAB(1:8). Table E.1 describes these inputs.

The final resulting 3-D Hermite reactivity credit, POW_KIN_DKHERMC, is multiplied by the input fraction of Hermite credit to be taken, POW_KIN_HERM_MULT, and the result is added to the total reactivity.

E.4 Inputs for CESEC Reactivity Model Emulation

The input variables are listed in Table E.1. The CESEC input vector numbers, where applicable, are shown for comparison. It must be noted the CESEC vectors A(5550)-A(5553) are a subset of the CENTS array POW_KIN_HERM_CREDITTAB. All the relevant CESEC vectors are represented in CENTS.

E.5 Steam Generator Heat Transfer Degradation

Normally, CENTS calculates the degradation of heat transfer as a function of the void fraction in the steam generator evaporator region. However, CENTS also provides for optional emulation of the CESEC model, in which the steam generator heat transfer is degraded as the secondary mass inventory decreases.

The CESEC emulation is activated via the flag SGS_TUBE_AREA_OPTION. If this flag is True, then the alternate, CESEC emulation model computes the degradation as a function of the total liquid mass in the steam generator. For steam generator i:

- When the total mass < SGS_MASS_ZERO_TUBE_AREA(i), then the heat transfer is completely degraded to zero.

- When the total mass > SGS_MASS_FULL_TUBE_AREA(i), there is no degradation.

- When the total mass is between these two masses, the degradation is linearly interpolated.

This model should not be used in realistic calculations, but only when it is required to match the CESEC methodology.

E.6 References

E.1 LD-82-001-P, Enclosure 1-P, "CESEC, Digital Simulation of a Combustion Engineering Nuclear Steam Supply System," January 6, 1982.

TABLE E.1
INPUTS FOR CESEC EMULATION

Variable Names (dimension) Short	Long	CESEC Vector	Definition
***** MODERATOR DENSITY CALCULATION *****			
KFLDEN	POW_KIN_MOD_DENSITY_OPTION		Flag for moderator reactivity by cold edge moderator density
KFDH	POW_KIN_DH_FACTOR		Core enthalpy rise adjustment factor
KWEDGE	POW_KIN_EDGE_WEIGHT		Weight factor for edge temperatures and enthalpies
***** HERMITE CREDIT CALCULATION *****			
KOPHER	POW_KIN_HERM_CREDIT_OPTION		Flag for Hermite 3-D reactivity feedback credit
KTDHER	POW_KIN_HERM_TD	A(5500)	Time delay after Scram for taking Hermite credit
KMLHER	POW_KIN_HERM_MULT	A(5501)	Fraction of Hermite credit taken
KTLTMN	POW_KIN_TEMP_TILT_MIN	A(5502)	Temperature tilt (negative) below which ΔT_{TILT} is set to zero
KPTWMN	POW_KIN_POWTOFLOW_MIN	A(5503)	Minimum power to flow ratio
KWFRMN	POW_KIN_FLOWFRAC_MIN	A(5504)	Minimum flow fraction for which the Hermite credit tables are valid
KTLTMX	POW_KIN_TEMP_TILT_MAX	A(5505)	Maximum temperature tilt for which the Hermite credit tables are valid
KPTWMX	POW_KIN_POWTOFLOW_MAX	A(5506)	Maximum power to flow ratio for which Hermite credit tables are valid
KPHER	POW_KIN_HERM_POW_REF	A(5508)	Power to which powers are normalized in the Hermite credit data
KWHER	POW_KIN_HERM_FLOW_REF	A(5509)	Flow to which flows are normalized in the Hermite credit data
KNWFR	POW_KIN_HERM_N_FLOWFR	A(5510)	Number of flow fractions in the POW_KIN_CORE_W_FRACTAB array
KWFHET	POW_KIN_CORE_W_FRACTAB (1.8)	A(5511-8)	Core flow fractions for the Hermite 3-D reactivity credit tables
KRHER	POW_KIN_HERM_CREDITTAB (1:350)		Hermite 3-D reactivity credit tables. *See description on next page.*

Structure of the array POW_KIN_HERM_CREDITTAB(1:350)

The array POW_KIN_HERM_CREDITTAB has several different variables as its elements which follow exactly the CESEC structures. The elements are:

- ***Begin repeat block for first flow fraction***

Element (1) : Table number (=1) of reactivity vs. temperature tilt and vs. power to flow ratio, for the first flow, POW_KIN_CORE_W_FRACTAB(1).
Element (2) : Degree of Lagrangian interpolation.
Element (3) : Number of table entries for temperature tilt (NX).
Element (4) : Number of table entries for power to flow ratio (NY).
Elements (5),...,(4+NX) : Temperature tilt entries.
Elements (5+NX),...,(4+NX+NY) : Power to flow ratio entries.

Elements (5+NX+NY),...,(4+NX+NY+NY) : Reactivity feedback entries for the first flow fraction, POW_KIN_CORE_W_FRACTAB(1), and the first temperature tilt, POW_KIN_HERM_CREDITTAB(5), for all NY power to flow ratios.

Elements (5+NX+NY+NY),...,(4+NX+NY+2*NY) : Reactivity feedback entries for the first flow fraction, POW_KIN_CORE_W_FRACTAB(1), and the second temperature tilt, POW_KIN_HERM_CREDITTAB(6), for all NY power to flow ratios.

•
•
•

Elements (5+NX+NY+(NX-1)*NY),...,(4+NX+NY+NX*NY) : Reactivity feedback entries for the first flow fraction, POW_KIN_CORE_W_FRACTAB(1), and the NX'th temperature tilt, POW_KIN_HERM_CREDITTAB(4+NX), for all NY power to flow ratios.

- ***End repeat block for first flow fraction***

- ***Begin repeat block for second flow fraction***

Element (5+NX+NY+NX*NY) : Table number (=2) of reactivity vs. temperature tilt and vs. power to flow ratio, for the second flow, POW_KIN_CORE_W_FRACTAB(2).

•
•
•

The pattern of the first table repeats for each of the POW_KIN_HERM_N_FLOWFR entries in POW_KIN_CORE_W_FRACTAB().

APPENDIX F CETOP LINK

CETOP is a quick-running program to compute DNBR (Reference F.1). It has been approved for use on C-E designed plants.

CENTS provides a link to the CETOP program to calculate DNBR based on the RCS system response calculated by CENTS. The link is done directly through the computer memory, and affects neither the CENTS nor the CETOP calculation. This link eliminates the need for utility codes to manipulate the CENTS output into CETOP input format. When this link is activated:

- CETOP is called periodically from within CENTS;
- CETOP receives its thermal-hydraulic input from the CENTS calculation;
- CETOP sends its output to CENTS for processing by the user.

The CENTS/CETOP link is controlled by the "CETOP" command, which is described below. The data passed between CENTS and CETOP is contained in the data partition CETOP_LINK. The variables within that partition are described in detail below.

The CETOP base deck is a separate file that is not a part of the CENTS data base and is not saved as part of the SNAPshot. The CETOP command must be used to read the CETOP base deck for every CENTS run.

F.1 The CETOP Command

Syntax: CETOP {INPUT = (*in-filespec*) }
{OUTPUT = (*out-filespec* {,REPLACE})}
{TAPE8 = (*tape8-filespec* {,REPLACE})}
{DT = *interval*}
{On | Off}

CETOP CLEAR

CETOP

Description:

- INPUT = (*in-filespec*)
  - Open the CETOP base deck file for reading only.
  - Call CETOP to execute this file.
  - Basedeck values from this file are used for subsequent CETOP execution, except for the parameters which are over-written by CENTS calculated values, as described below.
  - If INPUT includes stacked cases, all of the cases are executed. The calculation will use the last set of basedeck values.
- OUTPUT = (*out-filespec*)
  - Open an output file with the given name for the standard (long) CETOP output. If *out-filespec* does not include an extension, the extension ".out" is appended.
  - If "OUTPUT = (*out-filespec*)" is not provided, CENTS will select a file name *cetpnnn.out*.

- TAPE8 = (*tape8-filespec*)
  - Open an output file with the given name for the standard (short) CETOP output. If *tape8-filespec* does not include an extension, the extension ".tp8" is appended.
  - If "TAPE8 = (*tape8-filespec*)" is not provided, CENTS will select a file name *cetpnnn.tp8*.
- DT = *interval*
  - Set the time interval (seconds) for executing CETOP.
- ON / OFF
  - Activate / suspend the execution of CETOP.
  - "ON" causes the execution to proceed normally.
  - "OFF" causes the CENTS-CETOP link to be inactive. CETOP is not called, and the data exchange between CENTS and CETOP does not take place. However, file definitions, CETOP basedeck values, time step size, etc, remain defined.
- CLEAR
  - CETOP files are closed. No further CETOP calculations are performed. File definitions, CETOP basedeck values, time step size, etc, become undefined.
- (NO FUNCTION GIVEN)
  - Display a summary of the current CETOP control setup. The summary lists the names of the current input and output files, the time interval for executing CETOP, and the settings of the two flags which define the way the Fr and pressure to CETOP is determined.

F.2 Associated CENTS Variables

The CENTS partition CETOP_LINK contains the data that passes back and forth between CETOP and CENTS. It has three sub-partitions, for the outputs from CETOP, the inputs passed by CENTS to CETOP, and the parameters used by CENTS to calculate certain inputs to CETOP.

Outputs from CETOP

Output values are passed from CETOP to CENTS. These are the standard CETOP summary information. The CETOP output are stored in the subpartition CETOP_OUT which consists of the following variables:

CETOP_OUT_CASE	CETOP out: Case number	Fraction
CETOP_OUT_QDBL	CETOP out: Heat flux	MegBtu/hr-ft^2
CETOP_OUT_POLR	CETOP out: Power operating limit	Fraction
CETOP_OUT_TIN	CETOP out: Inlet temperature	Degree F
CETOP_OUT_PIN	CETOP out: Pressure	Psia
CETOP_OUT_GAVG	CETOP out: Core average mass velocity	10^6 lbm/hr-ft^2
CETOP_OUT_ASI	CETOP out: Axial shape index	Ratio
CETOP_OUT_NRAD	CETOP out: Peripheral axial shape index	Fraction
CETOP_OUT_P1MAX	CETOP out: Max radial avg peaking factor	Fraction
CETOP_OUT_DNB-N	CETOP out: Min DNBR at final iteration	Fraction
CETOP_OUT_X-N	CETOP out: Quality at final iteration	Fraction
CETOP_OUT_DNB-1	CETOP out: Min DNBR at first iteration	Fraction
CETOP_OUT_X-1	CETOP out: Quality at first iteration	Fraction
CETOP_OUT_QUIX	CETOP out: QUIX file case number	Fraction
CETOP_OUT_ITER	CETOP out: Number of iterations	Fraction
CETOP_OUT_IEND	CETOP out: Iter code: 1 => DNBR conv'd	Fraction
CETOP_OUT_ATR	CETOP out: Avg enthalpy transport coeff	Composite Units
CETOP_OUT_HCH	CETOP out: Min DNBR hot channel number	Pointer
CETOP_OUT_MNOD	CETOP out: Min DNBR node location	Pointer

Inputs to CETOP

The data that is passed from CENTS to CETOP is stored in the subpartition CETOP_IN which consists of the following variables:

CETOP_IN_TIME	CENTS simulation time. Equals CENTS variable TIME. Replaces CETOP vector #93.	Seconds
CETOP_IN_FLOW_FRAC	Core inlet flow normalized by the initial core inlet flow. Equals CENTS variable CTL_CORE_FLOW_FRAC. The CETOP mass flow specified by CETOP vector #1 is multiplied by this factor.	Fraction
CETOP_IN_INLET_TEMP	Core inlet temperature. Equals CENTS variable CHT_TEMP_COOL(1). Replaces CETOP vector #3.	Degree F
CETOP_IN_CORE_PRESSURE	Core pressure. Replaces CETOP vector #4. If CETOP_PRESS_OPT=F: Equals CENTS variable PRESS(NODE_CORE). If CETOP_PRESS_OPT=T: A constant *input* pressure.	Psia
CETOP_IN_HEAT_FLUX_FRAC	Core average heat flux normalized by the heat flux at full power. Equals CENTS variable CTL_HEAT_FLUX_FRAC. The CETOP heat flux specified in CETOP vectors 2 and 102 are multiplied by this factor	Fraction
CETOP_IN_FR_USER_MULT	User specified multiplier (first of two multipliers) on the CETOP radial peak Fr given by CETOP input vector #58. The user sets (or RAMPs) this multiplier to account for radial effects such as the increase in Fr due to a dropped CEA. This variable should normally be set to 1.0.	Fraction
CETOP_IN_FR_TEMP_MULT	Temperature driven multiplier (second of two multipliers) on the CETOP radial peak Fr given by CETOP input vector #58. This factor accounts for the increase in core peaking due to changes in core inlet temperature. It is calculated by CENTS based on current path temperatures (see Case Control variables, below): = 1.0 + CETOP_FR_DERIV * | CETOP_FR_DEL_TEMP |	Fraction

Case Control

A few CENTS variables control the way CENTS transient data is processed before being passed to CETOP:

CETOP_PRESS_OPT	User input option flag to use constant pressure in the DNBR calculation. The default is False, so that CETOP receives the current value of core pressure. When True, the user must assign the constant pressure value to the variable CETOP_IN_CORE_PRESSURE.	True/False
CETOP_FR_DERIV	User input derivative of Fr with respect to temperature. See CETOP_IN_FR_TEMP_MULT, above. A typical value is 0.005 /degF. To disable the Fr temperature correction, set CETOP_FR_DERIV to 0.0 so that CETOP_IN_FR_TEMP_MULT will always be 1.0.	1 / DegF
CETOP_FR_PATH1	Path number for CETOP_FR_TEMP1.	Pointer
CETOP_FR_PATH2	Path number for CETOP_FR_TEMP2.	Pointer
CETOP_FR_TEMP1	If CETOP_FR_PATH1 > 0: Temperature in that path, set be CENTS. If CETOP_FR_PATH1 ≤ 0: Constant temperature, assigned by user. This enables the user to calculate the temperature correction based on the difference of a path temperature and a reference value. See CETOP_FR_DEL_TEMP and CETOP_IN_FR_TEMP_MULT.	Degree F
CETOP_FR_TEMP2	If CETOP_FR_PATH2 > 0: Temperature in that path, set be CENTS. If CETOP_FR_PATH2 ≤ 0: Constant temperature, assigned by user. This enables the user to calculate the temperature correction based on the difference of a path temperature and a reference value. See CETOP_FR_DEL_TEMP and CETOP_IN_FR_TEMP_MULT.	Degree F
CETOP_FR_DEL_TEMP	Temp difference for the Fr correction = CETOP_FR_TEMP2 - CETOP_FR_TEMP1	Degree F

Example

```
rest (snapshot_file)

CETOP Input  = (plant1_cetop_basedeck.inp) \
      Output = (case1_cetop_output.out)    \
      Tape8  = (case1_cetop_summary.out)   \
      DT = 0.5
!
! New variables must be set
!
CETOP_PRESS_OPT      = F        ! CETOP uses calculated core pressure
CETOP_FR_DERIV       = 0.005    ! Fr increases 0.5% per degree F
CETOP_FR_PATH1       = 1        ! CETOP_FR_TEMP1 based on core inlet path
CETOP_FR_PATH2       = 0        ! Don't update CETOP_FR_TEMP2 = user
specified
CETOP_FR_TEMP2       = (RTCLIN) ! DT is Current temp - Initial temp
CETOP_IN_FR_USER_MULT = 1.0
!
go
```

F.3 Reference

F.1 "CETOP: Thermal Margin Model Development," CE-NPSD-150-P, Rev 03, May, 2002.

APPENDIX G CENTS VARIABLE DICTIONARY

This appendix lists the elements (variables, arrays and partitions) of the CENTS data dictionary, along with a detailed description of each one and a general description of the structure of the data dictionary. For simplicity, the following discussion refers to variables, arrays and partitions as "variable".

Each variable in the CENTS data dictionary is identified by either of two names, which are completely synonymous. The Short Name is conveniently short, with a length of six characters or less. The Long Name is more descriptive, and may be up to 32 characters long. Both names are displayed in this appendix. All references in the body of this report, outside of this appendix, are to the variables' Long Names.

The variables of the CENTS variables dictionary are listed in five tables. Table G.1 lists the variables that are used by CENTS, with Long Names and full definitions. Table G.2 displays the entire dictionary (used and unused variables) in tree-structure format, with both Long and Short Names, and abbreviated definitions. Table G.3 is an alphabetized index of the variables' Long Names with corresponding index numbers, to facilitate access to Tables G.1 and G.2. Likewise, Table G.4 is an alphabetized index of the variables' Short Names with corresponding index numbers.

G.1 Variables Dictionary With Full Definitions

Table G.1 lists the variables of the CENTS variables dictionary, with full definitions.

This table lists only variables that are actually used by CENTS, and their container partitions (see "Partition" below). Unused variables are omitted from this table. Hence, the Index No. column displays gaps in the number sequence.

The information in Table G.1 is organized in eleven columns, as described below.

1. Index No. .... The index numbers uniquely identify each of the variables.
2. Long Variable Name. Descriptive variable name, up to 32 characters long. Each variable also has a Short Name, which is synonymous and is up to 6 characters long. The Short Names are not shown in this table, due to space limitations. The short names are listed in Sections G.3 and G.5.
3. Input / Output .... Indicates the Input/Output status of each variable:

   Input .... The variable is used by CENTS, but is not calculated. Therefore, an input value is expected.

   Output.................. The variable is calculated by CENTS. The variable may also be used by CENTS, or it may be strictly for output. Since the variable is calculated, input is generally not accepted.

   I/O........................ The variable may serve as input or output, depending on status. Typically, the status is determined by an input controlling flag. The variable is calculated (output) by CENTS when the flag is in one state, but is not calculated (input or constant) when the flag is in the opposite state. Example 1: For some valve control signals, the I/O status is determined by a Auto/Manual control flag (e.g., see Section 6.4.1). Example 2: The initialization parameter SPINIT is either the input steam generator pressure or the calculated pressure, depending on the input value of the flag SGT_INIT_OPTION (Section D.1.5).

   Input / Init............ The variable is calculated by CENTS during INITIALization. Thereafter, it remains constant, unless changed by the user during a transient.

   Output / Init .... The variable is an input for system initialization. Thereafter, it is calculated as an output.

Partition .... Arrays that contain other variables. Partitions are normally organized by subject matter. E.g., CTL_FWS_CONTROL is a partition that contains feedwater setpoints, control flags, and other FW related partitions.

Segment .... The top-level partitions, representing the major plant systems. E.g., RCS_COMMON for the primary system dynamics, SGS_COMMON for the secondary system dynamics.

Input Partition...... A partition containing input variables, which may be accessed either by reference to the variables, or by reference to an element of the partition which is treated as an array. E.g., RCS_SGTR_PNODEIN(1) is also accessible as RCS_P_NODE_INLET_NONM(26) or as P_NODE_INLET(126).

Output Partition... A partition containing output variables, which may be accessed either by reference to the variables, or by reference to an element of the partition which is treated as an array. E.g., RCS_SGTR_FLOW(1) is also accessible as RCS_P_FLOW_NONM(26) or as P_FLOW(126).

Constant............... Input parameters that are treated as hard constants, e.g., 1.0, 2.0.

4. System .... Major system to which the variable belongs. E.g., RCS.

5. System Alt. 1 .... Second system to which the variable belongs. E.g., pressurizer.

6. System Alt. 2 .... Third system to which the variable belongs. E.g., spray.

7. Variable's Function ... Categorizes the nature of the variable. E.g., plant design (number of charging pumps), model design (number of RCS nodes), flag (control system Auto/Manual).

8. Type .... Real (RE), integer (IN), logical (LO) or character (CH).

9. Dimensions................ Length of an array. For two-dimensional arrays, both dimensions appear. For single variables, the entry is blank.

10. Definition .... An explanation of the variable's function, use, method of calculations, limits, references, and more as necessary. These definitions are more detailed than the dictionary definitions listed in Table G.2 and which CENTS displays in response to interactive queries.

11. Units .... Dimensional units. E.g., ft, ft^2, lbm/sec.

G.2 Variables Dictionary in Tree Structure

Table G.2 displays the entire CENTS variables dictionary (used and unused variables) in tree-structure format, with both Long and Short Names, and abbreviated definitions.

The variables are listed in tree format, showing a multi-level equivalencing scheme. In this scheme, a variable can be designated as an element of one or more arrays that are hierarchically equivalenced to each other.

There are ten arrays in the first level of equivalencing (Section 7.6.2), labeled "Segment" in the Units column. These are subdivided into multiple levels of lower-level arrays, which are labeled "Partition". Since the partitions are organized by subject matter at their various levels, the partitioning scheme provides a convenient means of accessing groups of variables. Thus, a query of the value of a variable or of a lowest-level array yields the value(s) of that variable or array only, whereas a query for a partition yields the values of all variables and arrays (and other partition) within that partition.

Each variable in the CENTS data dictionary is identified by either of two names, which are completely synonymous. The Short Name is conveniently short, with a length of six characters or less. The Long Name is more descriptive, and may be up to 32 characters long. Both names are displayed in Table G.2. All references in the body of this report, outside of this appendix, are to the variables' Long Names.

The information in Table G.2 is organized in eight columns, as described below.

1. Index No............................ The index numbers uniquely identify each of the variables.
2. Tree-structure hierarchy..... (No title) The level of each variable in the tree structure is indicated by indentation filled with periods.
3. Variable Name: Short......... Short variable name, up to 6 characters long. The Short Names are indexed in Section G.5.
4. Variable Name: Long......... Descriptive variable name, up to 32 characters long. The Long Names are indexed in Section G.4.
5. Type.................................. Real (RE), integer (IN), logical (LO) or character (CH).
6. Dimensions......................... Length of an array. For two-dimensional arrays, both dimensions appear. For single variables, the entry is blank.
7. Definition .... An abbreviated explanation of the variable's function. These definitions are identical to the one-line definitions that CENTS displays in response to interactive queries. They are more concise than the detailed definitions given in Table G.1.
8. Units.................................. Dimensional units. E.g., ft, ft^2, lbm/sec.

G.3 Alphabetized Index of Long Variable Names

Table G.3 provides a complete listing of all variables, arrays and partitions in the CENTS data dictionary. The variables appear alphabetized by their Long Names, along with their index numbers for easy reference to any of the other tables in this appendix.

G.4 Alphabetized Index of Short Variable Names

Table G.4 provides a complete listing of all variables, arrays and partitions in the CENTS data dictionary. The variables appear alphabetized by their Short Names, along with their index numbers for easy reference to any of the other tables in this appendix.

G.5 References

The following documents are referenced in the Definition column of Table G.1. For convenience, the referencing there is done without the prefix G; e.g., "Reference 1" or "Ref. 2".

G.1 This document.

G.2 CE-CES-59-P, Rev. 004, "Modeler's Manual for the CENTS Generic Control Systems," December 2002.

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
1	CHR_COMMON	Segment	CEER				CH		Character string data. All character string information is collected in this segment	Segment
2	PLANT_DATA_LABEL	Partition	CEER				CH		ID information for the static plant data snapshot file (*._st).	Partition
3	PLANT_DATA_FILE_NAME	Output	CEER			Snap Info	CH		File name of the static plant data snapshot (70 characters). Set by CEER based on the SNAP command's "STATIC (filename)" parameter. Displayed during processing of REST command.	Character
4	PLANT_DATA_TITLE	Input	CEER			Snap Info	CH		Descriptive title of the static plant data snapshot (70 characters). Set by User before SNAP: PLANT_DATA_TITLE = "title text". Displayed during processing of REST command.	Character
5	PLANT_DATA_TIME	Output	CEER			Snap Info	CH		Creation time stamp of the static plant data snapshot (10 characters). Set by CEER during processing of SNAP command. Displayed during processing of REST command.	Character
6	PLANT_DATA_DATE	Output	CEER			Snap Info	CH		Creation date stamp of the static plant data snapshot (10 characters). Set by CEER during processing of SNAP command. Displayed during processing of REST command.	Character
7	SNAPSHOT_LABEL	Partition	CEER				CH		ID information for the dynamic data snapshot file (*._dy).	Partition
8	SNAPSHOT_FILE_NAME	Output	CEER			Snap Info	CH		File name of the dynamic data snapshot (70 characters). Set by CEER based on the SNAP command's "SNAP (filename)" parameter. Displayed during processing of REST command.	Character
9	SNAPSHOT_TITLE	Input	CEER			Snap Info	CH		Descriptive title of the dynamic data snapshot (70 characters). Set by User before SNAP: SNAPSHOT_TITLE = "title text". Displayed during processing of REST command.	Character
10	SNAPSHOT_TIME	Output	CEER			Snap Info	CH		Creation time stamp of the dynamic data snapshot (10 characters). Set by CEER during processing of SNAP command. Displayed during processing of REST command.	Character
11	SNAPSHOT_DATE	Output	CEER			Snap Info	CH		Creation date stamp of the dynamic data snapshot (10 characters). Set by CEER during processing of SNAP command. Displayed during processing of REST command	Character
12	CTL_TITLE	Output	Control			Title Info	CH	1000	Titles of the Control Groups (60 characters). Set by the Control System Input Processor (CSIP) based on titles in the control system input. Displayed by the CSIP when processing the PRINT(F) directive. Reference 2.	Character
13	PLT_DATA	Segment					RE	25000	Static plant data	Segment
18	PLT_RCS	Partition					RE	2350	Static RCS plant data	Partition
19	PLT_RCS_DESIGN	Partition					IN	10	RCS design features	Partition
20	NUM_SG	Input	RCS	SGS		Plant Design	IN		Number of steam generators, up to 4. Plant design dependent. CENTS uses this parameter to determine the nodal structure required by the model. Reference 1, Section 7.2.1.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
22	NUM_PROP_HEATERS	Input	PZR	Heaters	PPCS	Plant Design	IN		Number of proportional heater banks in the pressurizer. Plant design dependent. This parameter can be set to the number of banks, or for simplicity, all the proportional banks may be lumped into one. The advantage to multiple banks is the ability to model failures of individual groups of heaters. The total number of proportional & backup heater groups is limited: NUM_PROP_HEATERS + NUM_BACK_HEATERS ≤ 6.	Counts
23	NUM_BACK_HEATERS	Input	PZR	Heaters	PPCS	Plant Design	IN		Number of backup heater banks in the pressurizer. Plant design dependent. This parameter can be set to the number of banks, or for simplicity, all the backup banks may be lumped into one. The advantage to multiple banks is the ability to model failures of individual groups of heaters. The total number of proportional & backup heater groups is limited: NUM_PROP_HEATERS + NUM_BACK_HEATERS ≤ 6.	Counts
24	NUM_CHGS_PUMPS	Input	CVCS	PLCS	PZR	Plant Design	IN		Number of charging pumps, up to 4 Plant design dependent This parameter indicates the expected number of entries for other arrays of charging pump related variables and controls.	Counts
25	RCS_NUM_MSPRAYVLVS	Input	PZR	PPCS	Spray	Plant Design	IN		Number of pressurizer main spray valves, up to 2. Plant design dependent. This parameter indicates the expected number of entries for other arrays of spray valve related variables and controls.	Counts
26	RCS_NUM_PORVS	Input	PZR	PPCS	PORV	Plant Design	IN		Number of pressurizer PORVs, up to 4. Plant design dependent. This parameter indicates the expected number of entries for other arrays of PORV related variables and controls.	Counts
27	RCS_NUM_SAFETYVLVS	Input	PZR	PSV	Valves	Plant Design	IN		Number of pressurizer safety valves, up to 4. Plant design dependent. This parameter indicates the expected number of entries for other pressurizer safety valve related arrays.	Counts
28	MOD_INIT	System				Flag	LO		Cue for to force initialization and error checking of the Control System. Automatically set by the code to FALSE, except TRUE during the first cycle of INITIAL, immediately after REST, after a variable assignment (from command file, keyboard or triggered WHEN), or upon a CONTROL command.	True False
29	MOD_INITV	System				Flag	LO		Cue for to force initialization and error checking of the process models' internal arrays. Automatically set by the code to FALSE, except TRUE during the first cycle of INITIAL, immediately after REST, after a variable assignment (from command file, keyboard or triggered WHEN), or during an active RAMP.	True False
30	PLT_RCS_NODE	Partition					RE	900	Static RCS nodes data	Partition
31	PLT_RCS_NODALIZATION	Partition					IN	50	RCS nodalization data	Partition
32	RCS_NODE_TOTALS	Partition					IN	6	RCS total number of nodes per group	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
33	NUM_NODES	Input	RCS	Nodes		Plant Design Model Design	IN		Total number of nodes, up to 30. For CE design plants with 2 SGs, this parameter is typically set to 17 (if 2 nodes/SG) or 21 (if 4 nodes/SG). For Westinghouse design plants, it is typically set to 20 with 3 SGs, and 25 with 4 SGs. This parameter determines the expected number of entries for other RCS node related arrays. Reference 1, Section 7 2.1.	Counts
34	NUM_NODES_SEC	Input	RCS	Nodes		Model Design	IN		Number of nodes that are sectionalized for heat transfer calculations. Must equal 1. The core node is the only node that is sectionalized for heat transfer. Reference 1, Sect. 4 8.1.	Counts
35	NUM_SG_NODES	Input	RCS	Nodes	SG	Plant Design Model Design	IN		Number of SG nodes (16 max). Each SG's tubes are divided into 2 or 4 nodes. The hot side from the top of the tube sheet to the top of the bundle, and the cold side from the top of the bundle to the top of the tube sheet, are each represented by 1 or 2 nodes. If using 4 nodes per SG, then the two lower nodes also includes the plena. NUM_SG_NODES / NUM_SG must equal exactly 2 or 4. Reference 1, Section 7.2.1.	Counts
36	NUM_HL_NODES	Input	RCS	Nodes		Plant Design	IN		Number of hot leg nodes, up to 4. Dependent on plant design.	Counts
37	NUM_SL_NODES	Input	RCS	Nodes		Plant Design	IN		Number of suction cold leg nodes, up to 4. Dependent on plant design. Note the two suction legs exiting from each CE design SG are lumped together as one node. Reference 1, Section 7 2.1.	Counts
38	NUM_CL_NODES	Input	RCS	Nodes		Plant Design	IN		Number of discharge cold leg nodes, up to 4. Dependent on plant design. Reference 1, Section 7.2.1.	Counts
39	RCS_NODE_NUMBERS	Partition					IN	30	RCS node numbers	Partition
40	RCS_NODE_HL	Partition					IN	4	Array of hot leg node numbers. NUM_HL_NODES entries are expected.	Partition
41	NODE_HL1	Input	RCS	Nodes		Model Design	IN		Hot leg 1 node number. Reference 1, Section 7.2.1.	Pointer
42	NODE_HL2	Input	RCS	Nodes		Model Design	IN		Hot leg 2 node number. Reference 1, Section 7.2.1.	Pointer
43	NODE_HL3	Input	RCS	Nodes		Model Design	IN		Hot leg 3 node number. Reference 1, Section 7.2.1.	Pointer
44	NODE_HL4	Input	RCS	Nodes		Model Design	IN		Hot leg 4 node number. Reference 1, Section 7.2.1.	Pointer
45	NODE_SG	Input Partition	RCS	Nodes		Plant Design Model Design	IN	16	Array of primary-side SG node numbers, in any order. NUM_SG_NODES entries are expected. Reference 1, Section 7.2.1.	Pointer
46	NODE_SG1H	Input	RCS	Nodes	SG	Model Design	IN		First element of NODE_SG.	Pointer
47	NODE_SG1C	Input	RCS	Nodes	SG	Model Design	IN		Second element of NODE_SG.	Pointer
48	NODE_SG2H	Input	RCS	Nodes	SG	Model Design	IN		Third element of NODE_SG.	Pointer

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
49	NODE_SG2C	Input	RCS	Nodes	SG	Model Design	IN		Fourth element of NODE_SG.	Pointer
50	NODE_SG3H	Input	RCS	Nodes	SG	Model Design	IN		Fifth element of NODE_SG.	Pointer
51	NODE_SG3C	Input	RCS	Nodes	SG	Model Design	IN		Sixth element of NODE_SG.	Pointer
52	NODE_SG4H	Input	RCS	Nodes	SG	Model Design	IN		Seventh element of NODE_SG.	Pointer
53	NODE_SG4C	Input	RCS	Nodes	SG	Model Design	IN		Eighth element of NODE_SG.	Pointer
54	NODE_CL	Partition					IN	4	Array of discharge cold leg node numbers. NUM_CL_NODES entries are expected.	Pointer
55	NODE_CL1	Input	RCS	Nodes		Model Design	IN		Discharge cold leg node number, loop 1. Reference 1, Section 7.2.1.	Pointer
56	NODE_CL2	Input	RCS	Nodes		Model Design	IN		Discharge cold leg node number, loop 2. Reference 1, Section 7.2.1.	Pointer
57	NODE_CL3	Input	RCS	Nodes		Model Design	IN		Discharge cold leg node number, loop 3. Reference 1, Section 7.2.1.	Pointer
58	NODE_CL4	Input	RCS	Nodes		Model Design	IN		Discharge cold leg node number, loop 4. Reference 1, Section 7.2.1.	Pointer
59	RCS_NODE_SL	Partition					IN	4	Array of suction cold leg node numbers. NUM_SL_NODES entries are expected.	Partition
60	NODE_SG1P	Input	RCS	Nodes		Model Design	IN		Suction cold leg node number, loop 1. Includes SG outlet plenum, suction cold leg and loop seal. Reference 1, Section 7.2.1.	Pointer
61	NODE_SG2P	Input	RCS	Nodes		Model Design	IN		Suction cold leg node number, loop 2. Includes SG outlet plenum, suction cold leg and loop seal. Reference 1, Section 7.2.1.	Pointer
62	NODE_SG3P	Input	RCS	Nodes		Model Design	IN		Suction cold leg node number, loop 3. Includes SG outlet plenum, suction cold leg and loop seal. Reference 1, Section 7.2.1.	Pointer
63	NODE_SG4P	Input	RCS	Nodes		Model Design	IN		Suction cold leg node number, loop 4. Includes SG outlet plenum, suction cold leg and loop seal. Reference 1, Section 7.2.1.	Pointer
64	RCS_NODE_OTHERS	Partition					IN	10	Array of remaining node numbers	Partition
65	NODE_CORE	Input	RCS	Nodes	Core	Model Design	IN		Core node number. Reference 1, Section 7.2.1.	Pointer
66	NODE_PRZR	Input	RCS	Nodes	PZR	Model Design	IN		Pressurizer node number. Reference 1, Section 7.2.1.	Pointer
67	NODE_UHEAD	Input	RCS	Nodes	RV	Model Design	IN		RV upper head node number. Reference 1, Section 7.2.1.	Pointer
68	NODE_ANNUL	Input	RCS	Nodes	RV	Model Design	IN		RV annulus node number. Reference 1, Section 7.2.1.	Pointer
69	NODE_CEASH	Input	RCS	Nodes	RV	Model Design	IN		CEA shroud node number. Reference 1, Section 7 2.1.	Pointer
70	RCS_NODE_GEOMETRY	Partition					RE	250	RCS node geometry variables	Partition

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
71	NODE_AREA	Input	RCS	Nodes		Dimension	RE	50	Node average cross sectional areas. Plant dependent. This area must be defined as the ratio of node fluid volume to node height (volume/height), where the volume is derived from plant drawings and data documents, and the height is NODE_HEIGHT. NUM_NODES entries are expected. Reference: Individual plant basedeck calculations.	Ft^2
72	NODE_HEIGHT	Input	RCS	Nodes		Dimension	RE	50	Node heights. Plant dependent. Defined as the difference between the top and bottom elevations of the node, which are normally dependent upon some logical physical boundary, and are obtained from plant drawings and data documents. NUM_NODES entries are expected. Reference: Individual plant basedeck calculations.	Feet
73	N_BOT	Input	RCS	Nodes		Dimension	RE	50	Node bottom elevations, relative to a reference datum (zero elevation). The bottom elevations are plant dependent, and are derived from plant drawings and data documents. NUM_NODES entries are expected. The reference datum is arbitrary, but must be consistent for all base deck elevations, except where specifically defined differently. The reference datum is typically defined either at the lowest elevation in the RCS (usually at the bottom of the reactor vessel) or at the hot leg centerline. Reference. Individual plant basedeck calculations.	Feet
74	N_GEOM	Input	RCS	Nodes		Model Design	IN	50	Node geometry indicators (Reference 1, Section 7.2.1): 0 = Vertical node. The cross-sectional area of horizontal slices is vertically uniform. 1 = Horizontal-pipe node. The cross-section of vertical slices is circular and horizontally uniform. NUM_NODES entries are expected.	Pointer
75	N_SECTIONS	Input	RCS	Nodes	Core	Model Design	IN	50	Number of axial sections in each node for segmented heat transfer calculations (node 1: max 22; rest: max 1). Node 1 (the core node) is modeled with 1 section below the active fuel, CHT_NUM_NODE (typically 12) sections within the active fuel, and 1 section above the active fuel; therefore N_SECTIONS(1) must equal CHT_NUM_NODE+2. All other nodes can only have one section. (However, the pressurizer and RV annulus are geometrically "segmented" to allow proper determination of water level vs. height) NUM_NODES entries are expected. Reference 1, Sect. 4 8 1	Counts
76	RCS_NODE_TH_VARS	Partition					RE	500	RCS node thermal-hydraulic constants	Partition
77	N_HEAT_XFER_LIQ	Input	RCS	Nodes		T/H Dimension	RE	50	Node wall-to-liquid overall heat transfer coefficients (h*A). Plant dependent. NUM_NODES entries are expected. When calculating this parameter, it is common to assume an infinite surface heat transfer coefficient; therefore, the overall heat transfer coefficient is conductivity limited, and depends on the thickness and conductivity of the metal. This parameter is based on the total surface area in contact with RCS fluid. Reference: Individual plant basedeck calculations.	Btu/sec-degF

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
78	N_HEAT_XFER_STM	Input	RCS	Nodes		T/H Dimension	RE	50	Node wall-to-steam overall heat transfer coefficients (h*A). Plant dependent. NUM_NODES entries are expected. Calculated as surface heat transfer coefficient (usually assumed at 10 Btu/hr-F-ft^2) x the total metal surface area in contact with RCS fluid. Reference: Individual plant basedeck calculations.	Btu/sec-degF
79	N_HEAT_XFER_CONT	Input	RCS	Nodes		T/H Dimension	RE	50	Node wall-to-containment overall heat transfer coefficients (h*A). Plant dependent. NUM_NODES entries are expected. Surface heat transfer coefficient is dependent upon the quality and tightness of the insulation surrounding the outside of the RCS components. Often calculated based on an approximate heat loss flux at hot conditions (typical value is 65 Btu/hr-ft^2). This is multiplied by the metal surface area or insulation area in contact with the containment atmosphere, and is divided by the coolant-containment temperature difference. Reference: Individual plant basedeck calculations.	Btu/sec-degF
80	N_HEAT_XFER_BOT	Input	RCS	Nodes		T/H Dimension	RE	50	Node bottom wall-to-liquid heat transfer coefficients. Not used if a node contains only steam or gas. This variable is usually set to zero for all nodes except the pressurizer and the RV upper head. NUM_NODES entries are expected. Reference: Individual plant basedeck calculations.	Btu/sec-ft^2-degF
81	N_HEAT_CAP	Input	RCS	Nodes		T/H Dimension	RE	50	Node wall heat capacities. Plant dependent. NUM_NODES entries are expected. This variable is the sum of the products of mass x specific heat capacity of all of the metal components in each of the nodes. Reference: Individual plant basedeck calculations.	Btu/degF
82	N_XFER_BOIL	Input	RCS	Nodes		T/H Dimension	RE	50	Node boiling heat transfer coefficients. Determines the rate of vaporization at the liquid-steam interface of any node that contains both liquid and superheated steam simultaneously. This is a very minor effect, and this parameter is usually set to zero for all nodes. NUM_NODES entries are expected.	Btu/sec-degF
83	N_XFER_INJ	Input	RCS	Nodes		T/H Multplier	RE	50	Node liquid injection condensation rate multipliers. Multiplies the condensation of steam on cold liquid that enters a node in that node's steam space (except for the pressurizer spray) if the node is in thermal nonequilibrium. This multiplier is independent of plant design. It is used only for tuning or testing, and should always be set to 1.0 in actual transients for all nodes. NUM_NODES entries are expected.	Dimensionless
84	XFER_SURF_POFF	Input	RCS	Nodes		T/H Dimension	RE	50	Node surface condensation coefficients (pump off). Used when a node is in thermal nonequilibrium. This array and XFER_SURF_PON are heat transfer coefficients for condensation at each node's liquid-steam interface. XFER_SURF_PON applies when the RCPs are running, and XFER_SURF_POFF applies when the RCPs are idle. These coefficients are independent of plant design. The values that are used for the quiescent and turbulent conditions are typical physical coefficients for such conditions. NUM_NODES entries are expected.	Btu/sec-ft^2-degF

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
85	XFER_SURF_PON	Input	RCS	Nodes		T/H Dimension	RE	50	Node surface condensation coefficients (pump on). Used when a node is in thermal nonequilibrium. This array and XFER_SURF_POFF are heat transfer coefficients for condensation at each node's liquid-steam interface. XFER_SURF_PON applies when the RCPs are running, and XFER_SURF_POFF applies when the RCPs are idle. These coefficients are independent of plant design. The values that are used for the quiescent and turbulent conditions are typical physical coefficients for such conditions. NUM_NODES entries are expected.	Btu/sec-ft^2-degF
86	AREA_INJ_MULT	Input	RCS	Nodes		T/H Multplier	RE	50	Interfacial condensation area multipliers. This is completely redundant to N_XFER_INJ, and should always be set to 1.0 for all nodes NUM_NODES entries are expected.	Dimensionless
87	RCS_NODE_SECTIONALIZED	Partition					RE	100	RCS sectionalized nodes variables	Partition
88	RCS_PRZR_NSECT	Input	PZR	RCS		Model Design	IN		Number of segments in the pressurizer (max. of 3). Normally set at 3, for the lower head, cylindrical section and upper head. The segmenting of the pressurizer supports accurate determination of mixture level as a function of mixture volume within the node. Reference: Individual plant basedeck calculations.	Counts
89	RCS_PRZR_ASECT	Input	PZR	RCS		Dimension	RE	3	Cross-sectional areas of the segmented pressurizer's sections. Each section's area is calculated by dividing the section volume by its height. The bottom head volume also includes that of the surge line. Reference: Individual plant basedeck calculations. Plant dependent.	Ft^2
90	RCS_PRZR_HSECT	Input	PZR	RCS		Dimension	RE	3	Heights of the segmented pressurizer's sections. The sum of the heights must equal NODE_HEIGHT() of the pressurizer node (NODE_PRZR). Reference: Individual plant basedeck calculations. Plant dependent.	Feet
91	RCS_ANNUL_NSECT	Input	RCS	Annulus		Model Design	IN		Number of segments in the node representing the RV annulus / lower plenum (max. of 3). Normally set at 3, for the lower vessel head, the flow skirt region and the annulus section. The segmenting of the RV annulus supports accurate determination of liquid level as a function of liquid volume within the node. Reference: Individual plant basedeck calculations.	Counts
92	RCS_ANNUL_ASECT	Input	RCS	Annulus		Dimension	RE	3	RV annulus cross-sectional areas. Each segment's area is calculated by dividing the segment volume by its height. Reference: Individual plant basedeck calculations	Ft^2
93	RCS_ANNUL_HSECT	Input	RCS	Annulus		Dimension	RE	3	Heights of the segmented annulus sections. The sum of the heights must equal NODE_HEIGHT() of the annulus node (NODE_ANNUL). Reference: Individual plant basedeck calculations. Plant dependent.	Feet

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
94	N_AREA_SECT	Input	RCS	Core		Dimension	RE	1, 22	Cross-sectional areas of the segmented core's sections (node,section). N_SECTIONS(1) entries are expected -- 1 section below the active fuel, N_SECTIONS(1)-2 sections within the active fuel, and 1 section above the active fuel. Each section's area is calculated by dividing the section volume by its height. Reference: Individual plant basedeck calculations. Plant dependent.	Ft^2
95	N_HEIGHT_SECT	Input	RCS	Core		Dimension	RE	1, 22	Heights of the segmented core's sections (node,section). N_SECTIONS(1) entries are expected. The first section's height is the height within Node 1 below the active core. The last section's height is the height within Node 1 above the active core. The active core region height is divided by N_SECTIONS(1)-2 to attain the individual section heights for those sections. The total height of all N_SECTIONS(1) sections must be identical to NODE_HEIGHT(1). The total volume, i e. the sum of the products of N_AREA_SECT(i) * N_HEIGHT_SECT(i) for all N_SECTIONS(1) pairs, must equal the product NODE_HEIGHT(1) * NODE_AREA(1). Reference: Individual plant basedeck calculations. Plant dependent.	Feet
96	PLT_RCS_PATH	Partition					RE	1400	Static RCS flow paths data	Partition
97	RCS_PATHS_NODALIZATION	Partition					IN	60	RCS paths nodalization variables	Partition
98	RCS_PATHS_TOTALS	Partition					IN	25	RCS flow paths totals	Partition
99	NUM_PATHS_MOM	Input	RCS	Paths		Model Design	IN		Number of momentum paths (50 max). Usually established based on plant design (CE or W). Determines the size of the active input array of momentum path variables. Reference: Individual plant basedeck calculations.	Counts
100	NUM_PATHS_EXT	Input	RCS	Paths		Model Design	IN		Number of external flow paths (25 max). External flow paths include charging, letdown, SIS, SDC (RHR), RCW drains, RCP seal controlled leaks, and gas injection paths. This variable should be set to the maximum of 25, independent of plant design.	Counts
101	NUM_PATHS_LEAK	Input	RCS	Paths		Model Design	IN		Number of leak flow paths (17 max). Leak flow paths include SGTR paths, SBLOCA and LBLOCA flow paths, rod ejection leak path, and RV O-ring seal leak path. This variable should be set to the maximum of 17, independent of plant design.	Counts
102	NUM_PATHS_INT	Input	RCS	Paths		Model Design	IN		Number of internal flow paths (8 max). Internal flow paths include spray, spray bleed, pressurizer reliefs and upper head vents. This variable is set to the maximum of 8, independent of plant design	Counts
103	NUM_PATHS	Input	RCS	Paths		Model Design	IN		Total number of flow paths. Set to 100, independent of plant design.	Counts
104	NUM_SML_BRK	Input	RCS	Paths		Model Design	IN		Number of Small Break leak flow paths (4 max). Set to the maximum of 4.	Counts
105	NUM_PATHS_HL	Input	RCS	Paths		Model Design	IN		Number of hot leg flow paths (8 max) connecting the core node's upper plenum to the hot leg nodes. This is set to the actual number of hot leg flow paths used, 2*NUM_HL_NODES (i e., 2 per hot leg, one in the upper half and one in the lower half of the pipe).	Counts

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
106	NUM_PATHS_CL	Input	RCS	Paths		Model Design	IN		Number of cold discharge leg flow paths (8 max) connecting the discharge cold leg nodes to the RV annulus node. This is set to the actual number of cold leg flow paths used, 2*NUM_CL_NODES (i.e. 2 per discharge cold leg, one in the upper half and one in the lower half of the pipe).	Counts
107	NUM_PATHS_NONM	Input	RCS	Paths		Model Design	IN		Number of RCS non-momentum flow paths. This parameter is set equal to the array size of 50, independent of plant design.	Counts
108	RCS_NUMIN_CHGS	Input	RCS	Paths	CVCS	Plant Design	IN		Number of RCS-CHGS connections (4 max). This variable is the actual number of charging inlet connections, excluding auxiliary pressurizer spray. Dependent on plant design	Counts
109	RCS_NUMOUT_LDNS	Input	RCS	Paths	CVCS	Plant Design	IN		Number of RCS-letdown connections (4 max). This variable is the actual number of letdown outlet connections. Dependent on plant design.	Counts
110	RCS_NUMOUT_RCWDRAINS	Input	RCS	Paths	RCW	Plant Design	IN		Number of RCS-RCW drain connections (1 max). This variable is the actual number of drain connections.	Counts
111	RCS_NUMOUT_SDC	Input	RCS	Paths	SDC	Plant Design	IN		Number of RCS-SDC connections (2 max). This variable is the actual number of SDC inlet connections.	Counts
112	RCS_NUMIN_SIS	Input	RCS	Paths	SIS	Plant Design	IN		Number of RCS-SIS connections. This variable is the actual number of SIS inlet connections, typically one per discharge cold leg.	Counts
113	RCS_NUMMAX_RCP	Input	RCS	Paths	RCP	Model Design	IN		Maximum number of RCP paths. Always set to 4, independent of plant design.	Counts
114	RCS_NUMMAX_CHGSIN	Input	RCS	Paths	CVCS	Model Design	IN		Maximum number of Charging connections to the RCS, not including the auxiliary spray connection. Always set to 4 , independent of plant design.	Counts
115	RCS_NUMMAX_LDNSOUT	Input	RCS	Paths	CVCS	Model Design	IN		Maximum number of letdown connections to the RCS. Always set to 4 , independent of plant design.	Counts
116	RCS_NUMMAX_DRAINSOUT	Input	RCS	Paths	RCW	Model Design	IN		Maximum number of drains to RCW from the RCS. Always set to 1, independent of plant design.	Counts
117	RCS_NUMMAX_SDCOUT	Input	RCS	Paths	SDC	Model Design	IN		Maximum number of SDC connections to RCS (out). Always set to 2 independent of plant design.	Counts
119	RCS_NUMMAX_MOM	Input	RCS	Paths		Model Design	IN		Maximum number of momentum paths. Always set to 50, independent of plant design.	Counts
120	RCS_PATHS_NUMBERS	Partition					IN	35	RCS flow path identifying numbers	Partition
121	PATH_SURGE	Input	RCS	Paths	PZR	Model Design	IN		Surge line path number. Reference 1, Section 7.2.2.	Pointer
122	PATH_ANNUL_CORE	Input	RCS	Paths		Model Design	IN		Annulus-to-inner vessel path number. This parameter identifies the path connecting the annulus/lower-plenum node to the core node. Reference 1, Section 7 2 2.	Pointer
123	PATH_CORE_UHEAD	Input	RCS	Paths		Model Design	IN		Upper head-to-inner vessel path number. This parameter identifies the path connecting the RV upper head node to the core node. Reference 1, Section 7.2.2.	Pointer

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
124	PATH_SPRAY	Input	RCS	Paths	Spray	Model Design	IN		Pressurizer spray path number. This parameter identifies the path that delivers the main and auxiliary spray to the pressurizer node. Set to 93. Reference 1, Section 7.2.2.	Pointer
125	PATH_LB_LOCA	Input	RCS	Paths		Model Design	IN		Large Break LOCA path number. Set to 90. This input is required, although the LBLOCA as defined by the cue MAL_LB_LOCA is disabled. (A LOCA of any size may be defined via the SBLOCA inputs) Reference 1, Section 7.2.2.	Pointer
126	PATH_PUMP	Input	RCS	Paths	RCP	Model Design	IN	4	Array of RCP path numbers (in the same order as other RCP arrays). This array identifies the paths connecting the pump suction legs with their discharge legs. Reference 1, Section 7.2.2.	Pointer
127	PATH_HL	Input	RCS	Paths		Model Design	IN	8	Array of hot leg path numbers. This array identifies the paths connecting the core node's upper plenum to the hot leg nodes. Two paths are used for each hot leg to allow for liquid/steam counter-current flow when the hot legs are not full. NUM_PATHS_HL entries are expected. Reference 1, Section 7.2.2.	Pointer
128	PATH_CL	Input	RCS	Paths		Model Design	IN	8	Array of discharge cold leg path numbers. This array identifies the paths connecting the discharge cold leg nodes to the RV annulus node. Two paths are used for each discharge cold leg to allow for liquid/steam counter-current flow when the cold legs are not full. NUM_PATHS_CL entries are expected. Reference 1, Section 7.2.2.	Pointer
129	PATH_SG	Input	RCS	Paths	SG	Model Design	IN	4	Top of SG tube bundle path numbers. This array identifies the paths connecting each SG's hot-side tube bundle node (the upper node if there are two) to its cold-side tube bundle node (the upper node if there are two). NUM_SG entries are expected. Reference 1, Section 7.2 2.	Pointer
130	PATH_UCEA	Input	RCS	Paths		Model Design	IN		CEA to upper head path number. This parameter identifies the path connecting the CEA node to the RV upper head node. Reference 1, Section 7.2.2.	Pointer
131	RCS_PATHS_GEOMETRY	Partition					RE	1300	RCS paths geometry variables	Partition
132	P_NODE_INLET	Input Partition	RCS	Paths			IN	150	Path connection node numbers. This array/partition identifies the node(s) connected to each flow path, for both the momentum type and the non-momentum type of flow paths. All momentum flow paths connect two nodes each; the nodes at the path inlets are identified in this array/partition, while the nodes at the path exits are identified in the array P_NODE_EXIT. All non-momentum paths are joined to one node each; those are identified in this array/partition. Reference 1, Section 7.2.2.	Pointer
133	RCS_P_NODE_INLET_MOM	Input	RCS	Paths		Model Design	IN	100	Path inlet node numbers (momentum paths). This array identifies the node at the inlet of each momentum flow path. All momentum flow paths connect two nodes each; the nodes at the path inlets are identified in this array, while the nodes at the path exits are identified in the array P_NODE_EXIT. NUM_PATHS_MOM entries are expected. Reference 1, Section 7.2 2.	Pointer

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
134	RCS_P_NODE_INLET_NONM	Input Partition	RCS	Paths		Model Design	IN	50	Path connection node numbers (non-momentum paths). This array/partition identifies the node connected to each non-momentum flow path. All non-momentum paths are joined to one node each. Reference 1, Section 7.2.2.	Pointer
135	RCS_PATHEXT_PNODEIN	Input Partition					IN	25	External paths connection node numbers.	Pointer
136	RCS_RCPLEAK_PNODEIN	Input	RCS	Paths	RCP	Plant Design	IN	4	RCP seal leak connection nodes. This array represents the pump suction line nodes, which are the modeled exit points for RCP leakage. NUM_PUMPS entries are expected. Reference 1, Section 7.2 2.	Pointer
137	RCS_CHGS_PNODEIN	Input	RCS	Paths	CVCS	Plant Design	IN	4	Charging connection nodes. This array identifies the nodes that receive the charging flow, typically some or all of the discharge cold legs. RCS_NUMIN_CHGS entries are expected. Reference 1, Section 7.2.2.	Pointer
138	RCS_LDNS_PNODEIN	Input	RCS	Paths	CVCS	Plant Design	IN	4	Letdown connection nodes. This array identifies the nodes from which letdown is drawn, typically one or all of the pump suction legs. RCS_NUMOUT_LDNS entries are expected. Reference 1, Section 7.2 2.	Pointer
139	RCS_RCW_PNODEIN	Input	RCS	Paths	RCW	Plant Design	IN	1	RCW drains connection node. This parameter identifies the node from which RCW is drawn, typically set to one of the pump suction legs. Reference 1, Section 7.2 2.	Pointer
140	RCS_SDC_PNODEIN	Input	RCS	Paths	SDC	Plant Design	IN	2	Shutdown cooling (SDC; RHR) connection nodes. This array identifies the nodes from which SDC is drawn, typically set to one or more of the hot legs. RCS_NUMOUT_SDC entries are expected. Reference 1, Section 7.2.2.	Pointer
141	RCS_SIS_PNODEIN	Input	RCS	Paths	SIS	Plant Design	IN	8	Safety injection connection nodes. This array identifies the nodes that receive the safety injection flow (from all sources combined - HPSI, LPSI and SITs/accumulators), typically some or all of the discharge cold legs. RCS_NUMIN_SIS entries are expected. Reference 1, Section 7.2 2.	Pointer
142	RCS_GAS_PNODEIN	Input	RCS	Paths	Gas	Plant Design	IN	2	RCS gas injection connection nodes. This array identifies the nodes that receive gas injection flow, typically the pressurizer and/or the RV upper head. This array is currently not used. If GS_PRZR_NONC > 0, then gas injection is directed to the pressurizer via flow path 96 (relief valves). If GS_VES_NONC > 0, then gas injection is directed to the reactor vessel's upper head via flow path 97 (relief valves).	Pointer
143	RCS_PATHLEAK_PNODEIN	Input Partition					IN	17	Leak paths connection nodes	Pointer
144	RCS_SGTR_PNODEIN	Input	RCS	Paths	SG	Model Design	IN	8	RCS SG Tube Rupture connection nodes. This array identifies the nodes at which a tube rupture may occur, corresponding to members of the array MAL_SGTR. Typically set so that flow to the break is supplied from the inlet plenum and exit plenum. 2xNUM_SG entries are expected Reference 1, Section 7 2 2.	Pointer

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
145	RCS_SBLOCA_PNODEIN	Input	RCS	Paths		Model Design	IN	4	RCS small break LOCA connection nodes. This array identifies the nodes at which a SBLOCA may occur, corresponding to members of the array MAL_SB_LOCA. Typically connected to a hot leg, suction leg, cold discharge leg and pressurizer. NUM_SML_BRK entries are expected. Reference 1, Section 7.2 2.	Pointer
146	RCS_RODEJ_PNODEIN	Input	RCS	Paths		Model Design	IN		RCS rod ejection small break connection node. This parameter identifies the node at which a rod ejection leak may occur. Set value should be the RV upper head node number (NODE_UHEAD), independent of plant design. Reference 1, Section 7.2 2	Pointer
147	RCS_ORING_PNODEIN	Input	RCS	Paths		Model Design	IN		RCS O-ring seal leak connection node. This parameter identifies the node at which an O-ring seal leak may occur. Set value should be the RV upper head node number (NODE_UHEAD), independent of plant design. Reference 1, Section 7.2.2.	Pointer
148	RCS_LBLOCA_PNODEIN	Input	RCS	Paths		Model Design	IN		RCS large break LOCA connection node. This parameter identifies the node at which a LBLOCA may occur. This input is required, although the LBLOCA as defined by the cue MAL_LB_LOCA is disabled. (A LOCA of any size may be defined via the SBLOCA inputs) Reference 1, Section 7.2.2.	Pointer
149	RCS_PATHINT_PNODEIN	Input Partition					IN	8	RCS internal paths connection nodes	Pointer
150	RCS_SPRAY_PNODEIN	Input	RCS	Paths	Spray	Plant Design	IN		Pressurizer spray connection node. This parameter identifies the node to which the pressurizer spray (both main and auxiliary) is delivered. Set value should be the pressurizer node number (NODE_PRZR), independent of plant design. Reference 1, Section 7 2 2.	Pointer
151	RCS_SPRAYBLEED_PNODEIN	Input	RCS	Paths	Spray	Plant Design	IN	2	RCS pressurizer main spray bleed connection nodes. This array identifies the nodes from which the pressurizer main spray bleed is drawn, typically one or more discharge cold leg nodes, dependent of plant design. RCS_NUM_MSPRAYVLVS entries are expected. Reference 1, Section 7.2 2.	Pointer
152	RCS_PRZR_RELIEF_PNODEIN	Input	RCS	Paths	PZR	Plant Design	IN		Pressurizer relief valves connection node. This parameter identifies the node from which the pressurizer relief flow (PORV, safety valve and vent) is taken. Set value should be the pressurizer node number (NODE_PRZR), independent of plant design. Reference 1, Section 7 2 2.	Pointer
153	RCS_UHEAD_RELIEF_PNODEIN	Input	RCS	Paths	UH Vent	Plant Design	IN		Upper head relief valves connection node. This parameter identifies the node from which the RV upper head relief flow (vent) is taken. Set value should be the RV upper head node number (NODE_UHEAD), independent of plant design. Reference 1, Section 7.2 2.	Pointer

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
154	P_NODE_EXIT	Input	RCS	Paths		Model Design	IN	100	Path exit node numbers (momentum paths). This array identifies the node at the outlet of each momentum flow path. All momentum flow paths connect two nodes each; the nodes at the path exits are identified in this array, while the nodes at the path inlets are identified in the array RCS_P_NODE_INLET_MOM (or, identically, the first 50 entries of P_NODE_INLET). NUM_PATHS_MOM entries are expected. Reference 1, Section 7.2.2.	Pointer
155	P_ELEV_INLET	Input Partition	RCS	Paths			RE	150	Path inlet elevation. Elevations are relative to a reference datum (zero elevation). The reference datum is arbitrary, but must be consistent for all base deck elevations, except where specifically defined differently. The reference datum is typically defined either at the lowest elevation in the RCS (usually at the bottom of the reactor vessel) or at the hot leg centerline. Reference 1, Section 7 2.2.	Feet
156	RCS_P_ELEV_INLET_MOM	Input	RCS	Paths		Dimension	RE	100	Inlet elevations of momentum flow paths. NUM_PATHS_MOM entries are expected. The elevation at the inlet of each path is plant dependent, relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations. The inlet elevations are defined at the circle center. That is, the intersection of momentum flow path number N with its inlet node forms a circle whose center is located at elevation RCS_P_ELEV_INLET_MOM(N) and whose radius is P_RADIUS(N). [If P_GEOM(N)=2 or 3, then the intersection is a semicircle, but the circle center is still located at RCS_P_ELEV_INLET_MOM(N).] This intersection must be wholly contained within the vertical extent of the node. That is, not part may extend below N_BOT of the node or above N_BOT+NODE_HEIGHT of the node.	Feet
157	RCS_P_ELEV_INLET_NONM	Input Partition	RCS			Dimension	RE	50	Path connection elevations of non-momentum flow paths.	Feet
158	RCS_PATHEXT_PELEVIN	Input Partition	RCS			Dimension	RE	25	External paths Inlet elevations.	Feet
159	RCS_RCPLEAK_PELEVIN	Input	RCS	Paths	RCP	Dimension	RE	4	RCP seal leak connection elevations. These plant dependent elevations are within the nodes identified by RCS_RCPLEAK_PNODEIN. They are normally set at the top of the RCP volume, or the Cold Leg centerline elevation + the pump weir height. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) NUM_PUMPS entries are expected. Reference. Individual plant basedeck calculations.	Feet

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160	RCS_CHGS_PELEVIN	Input	RCS	Paths	CVCS	Dimension	RE	4	Charging connection elevations. This is an array of plant dependent elevations, based on the physical tap locations within the nodes identified by RCS_CHGS_PNODEIN. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) RCS_NUMIN_CHGS entnes are expected. Reference: Individual plant basedeck calculations.	Feet
161	RCS_LDNS_PELEVIN	Input	RCS	Paths	CVCS	Dimension	RE	4	Letdown connection elevations. This is an array of plant dependent elevations, based on the physical tap locations within the nodes identified by RCS_LDNS_PNODEIN. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) RCS_NUMOUT_LDNS entries are expected. Reference: Individual plant basedeck calculations.	Feet
162	RCS_RCW_PELEVIN	Input	RCS	Paths	RCW	Dimension	RE	1	RCW drains connection elevation. This is a plant dependent elevation, based on the physical tap location within the nodes identified by RCS_RCW_PNODEIN. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations.	Feet
163	RCS_SDC_PELEVIN	Input	RCS	Paths	SDC	Dimension	RE	2	Shutdown cooling (SDC; RHR) connection elevations. This is an array of plant dependent elevations, based on the physical tap locations within the nodes identified by RCS_SDC_PNODEIN. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) RCS_NUMOUT_SDC entries are expected. Reference: Individual plant basedeck calculations.	Feet
164	RCS_SIS_PELEVIN	Input	RCS	Paths	SIS	Dimension	RE	8	Safety injection connection elevations. This is an array of plant dependent elevations, based on the physical tap locations within the nodes identified by RCS_SIS_PNODEIN. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) RCS_NUMIN_SIS entries are expected. Reference: Individual plant basedeck calculations.	Feet
165	RCS_GAS_PELEVIN	Input	RCS	Paths	Gas	Dimension	RE	2	RCS gas injection connection elevations, corresponding to the array RCS_GAS_PNODEIN. This array is currently not used. If GS_PRZR_NONC > 0, then gas injection is directed to the pressurizer via flow path 96 (relief valves). If GS_VES_NONC > 0, then gas injection is directed to the reactor vessel's upper head via flow path 97 (relief valves).	Feet
166	RCS_PATHLEAK_PELEVIN	Input Partition					RE	17	Leak paths connection elevations	Feet

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167	RCS_SGTR_PELEVIN	Input	RCS	Paths	SG	Dimension	RE	8	RCS SG tube rupture connection elevations. This is a plant dependent elevation, based on the tube bundle elevations. The elevation can be set anywhere between the bottom and top of the tube node within the nodes identified by RCS_SGTR_PNODEIN. The choice is based on the tube rupture scenario required. Normally basedecks are set with the tube rupture elevations at the tubesheet. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) 2xNUM_SG entries are expected. Reference: Individual plant basedeck calculations.	Feet
168	RCS_SBLOCA_PELEVIN	Input	RCS	Paths		Dimension	RE	4	RCS small break LOCA connection elevations. This is a plant dependent elevation, based on the elevation of the respective node in which the break is occurring (identified by RCS_SBLOCA_PNODEIN). The elevation can be set at anywhere between the bottom and top of the node. The choice is based on the SBLOCA scenario required. Normally basedecks are set with the break elevations at or near the bottom of the respective node. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) NUM_SML_BRK entries are expected. Reference: Individual plant basedeck calculations.	Feet
169	RCS_RODEJ_PELEVIN	Input	RCS	Paths		Dimension	RE		RCS rod ejection small break connection elevation. This is a plant dependent elevation, based on the elevation of the RV upper head node in which the break is occurring. The elevation may be based on the rod chosen for the scenario required. Normally basedecks are set with the break elevations at or near the top of the UH node. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations	Feet
170	RCS_ORING_PELEVIN	Input	RCS	Paths		Dimension	RE		RCS O-ring seal connection elevation. This is a plant dependent elevation. The elevation must be within the range of the inlet node (RV upper head). Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations	Feet
171	RCS_LBLOCA_PELEVIN	Input	RCS	Paths		Dimension	RE		RCS large break LOCA connection elevation. This is a plant dependent elevation. The elevation must be within the range of the node chosen as the inlet node (identified by RCS_LBLOCA_PNODEIN). Normally, the basedeck value is set at or close to the node bottom elevation. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations	Feet
172	RCS_PATHINT_PELEVIN	Input Partition					RE	8	RCS internal paths connection elevation	Feet

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
173	RCS_SPRAY_PELEVIN	Input	RCS	Paths	Spray	Dimension	RE		Pressurizer spray connection elevation. This is a plant dependent elevation, based on the physical spray nozzle location within the pressurizer. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) The most important elevation dimension associated with the spray nozzle is that point at which liquid level within the pressurizer would reach the bottom of the nozzle. Thus, the final calculated elevation is dependent upon the segmented volume/area/height calculations for the pressurizer. Reference: Individual plant basedeck calculations.	Feet
174	RCS_SPRAYBLEED_PELEVIN	Input	RCS	Paths	Spray	Dimension	RE	2	RCS pressurizer main spray bleed connection elevations. This is a plant dependent elevation, based on the physical tap locations within the nodes identified by RCS_SPRAYBLEED_PNODEIN. In most plants, the tap near the top of the discharge cold leg. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations.	Feet
175	RCS_PRZR_RELIEF_PELEVIN	Input	RCS	Paths	PZR	Dimension	RE		Pressurizer relief valves connection elevation. This is a plant dependent elevation, based on the physical tap location within the pressurizer. The elevation is the elevation of the bottom of the pressurizer + the height of the PSV tap above the pressurizer bottom. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations.	Feet
176	RCS_UHEAD_RELIEF_PELEVIN	Input	RCS	Paths	UH Vent	Dimension	RE		Upper head relief valves connection elevation. This is a plant dependent elevation, based on the physical tap location of the RV upper head vent. Normally, it is set at or close to the top of upper head. Elevations are relative to a reference datum. (See discussion of reference datum under P_ELEV_INLET.) Reference: Individual plant basedeck calculations.	Feet

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
177	P_ELEV_EXIT	Input	RCS	Paths		Dimension	RE	100	Exit elevations of momentum flow paths. NUM_PATHS_MOM entries are expected. The elevation at the outlet of each path is plant dependent, relative to a reference datum (zero elevation). The reference datum is arbitrary, but must be consistent for all base deck elevations, except where specifically defined differently. The reference datum is typically defined either at the lowest elevation in the RCS (usually at the bottom of the reactor vessel) or at the hot leg centerline. Reference: Individual plant basedeck calculations. The exit elevations are defined at the circle center. That is, the intersection of momentum flow path number N with its exit node forms a circle whose center is located at elevation P_ELEV_EXIT(N) and whose radius is P_RADIUS(N). [If P_GEOM(N)=2 or 3, then the intersection is a semicircle, but the circle center is still located at P_ELEV_EXIT(N).] This intersection must be wholly contained within the vertical extent of the node. That is, not part may extend below N_BOT of the node or above N_BOT+NODE_HEIGHT of the node.	Feet
178	P_GEOM	Input	RCS	Paths		Model Design	IN	100	Momentum flow paths' end geometry indicators: 0=point, 1=circle, 2=upper semicircle, 3=lower semicircle. The model design dictates the value chosen. Point connections are used for all vertical pipes. Upper and lower semicircles are used in the hot side loop piping and in the discharge cold legs, where dual flow paths are used. In a heterogeneous two-phase condition, the dual flow paths can carry countercurrent flows of liquid and steam if conditions so warrant. All other horizontal momentum flow paths use a circular end geometry. (There is no geometry input for the non-momentum flow paths; they all have point connections by default.) NUM_PATHS_MOM entries are expected. Reference 1, Section 4.9.	Pointer
179	P_RADIUS	Input	RCS	Paths		Dimension	RE	100	Path radii at momentum paths' end-points. P_RADIUS is not related to P_AREA. Plant design dependent. For paths with P_GEOM = 0, the P_RADIUS also = 0.0. For all circular and semi-circular path geometries, the pipe radius is physical fluid flow radius at the exit location. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Feet
180	PATH_TLOA	Input	RCS	Paths		Dimension	RE	100	Combined inertia length/area (dMom/dt) for each momentum flow path. These are plant dependent variables. They are calculated for each path examining each segment of a flow path length, and summing the Length/Flow-Area of all segments. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations	1 / Feet

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
181	PATH_KLOSS_POS	Input	RCS	Paths		T/H Dimension	RE	100	RCS momentum flow paths' geometric forward k-factors. The plant dependent loss factors are determined by flow tuning performed during basedeck compilation. Plant conditions are set to those used in reference documents, then k-factors are adjusted until the pressure drops due to geometric losses equal the reference values. This tuning is done concurrently with that for PATH_LEN_DIAM for the paths' frictional loss factors. For the above procedure, each path is assigned "pressure end points" (PEPs - different from the geometric "connection points" defined by P_ELEV_INLET and P_ELEV_EXIT). Each path's PEPs should be defined well within the connecting nodes, on the general fluid trajectory path. Each path's pressure drop is defined between its PEPs. For flow paths that follow each other in a loop, each path's upstream PEP should coincide with its upstream neighboring path's downstream PEP. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Dimensionless
182	PATH_KLOSS_NEG	Input	RCS	Paths		T/H Dimension	RE	100	RCS momentum flow paths' geometric reverse flow k-factors. Since plant tuning with reverse flow is not performed, these plant dependent variables are normally set to an independent reference, such as a LOCA calculation. In certain path locations, where forward and reverse flow geometries are equal, the tuned forward flow k-factors may also be used for reverse flow. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Dimensionless
183	P_AREA	Input	RCS	Paths		Dimension	RE	100	RCS momentum flow path areas. These plant dependent variables are used in conjunction with the k-factors and L/D's to determine the pressure losses (geometric and frictional) at all momentum flow paths around the RCS. Some paths have several different flow areas along their length. In that case, the most representative area is chosen. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Ft^2
184	PATH_LEN_DIAM	Input	RCS	Paths		T/H Dimension	RE	100	RCS momentum flow paths' length-to-(hydraulic)diameter ratio. These are plant dependent parameters. Preliminary values are calculated by summing the L/Dh for each segment in a flow path. The final values are obtained by RCS flow tuning. Plant conditions are set to those used in reference documents, then L/Dh's are adjusted until the pressure drops due to frictional losses equal the reference values. This tuning is done concurrently with that for PATH_KLOSS_POS for the geometric loss factors for each path. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Dimensionless

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Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
185	P_DIAM_HYD	Input	RCS	Paths		T/H Dimension	RE	100	Path hydraulic diameter. These are plant dependent variables. Hydraulic diameters are used in the calculation of local Reynolds numbers, which are part of the frictional pressure drop calculation. Some paths have several different hydraulic diameters along their length. In that case, the most representative diameter is chosen. NUM_PATHS_MOM entries are expected. Reference: Individual plant basedeck calculations.	Feet
186	PLT_RCS_VES	Partition					RE	60	RCS plant data: Inner vessel	Partition
187	PRES_ATWS_MIN	Input	RCS			Plant Design	RE		RV upper head O-ring seal leak - minimum leakage pressure. Used when extremely high pressure may be experienced, e g. in an ATWS event. The 2 pressures PRES_ATWS_MIN/MAX and the two leak areas P_AREA_ATWS_MIN/MAX form a linear interpolation range for the leak area, which is then multiplied by RCS_UHEAD_RING_SEAL_MULT. The 2 pressures are set in base decks to very high values. Should an ATWS transient be modeled, the USER is required to set these values dependent upon the scenario	Psia
188	P_AREA_ATWS_MIN	Input	RCS			Plant Design	RE		RV upper head O-ring seal leak - leak area at the minimum pressure. Used when extremely high pressure may be experienced, e g. in an ATWS event. The 2 pressures PRES_ATWS_MIN/MAX and the two leak areas P_AREA_ATWS_MIN/MAX form a linear interpolation range for the leak area, which is then multiplied by RCS_UHEAD_RING_SEAL_MULT. The 2 leak areas are set in base decks to 0.0. Should an ATWS transient be modeled, the USER is required to set these values dependent upon the scenario.	Ft^2
189	PRES_ATWS_MAX	Input	RCS			Plant Design	RE		RV upper head O-ring seal leak - maximum leakage pressure. Used when extremely high pressure may be experienced, e.g. in an ATWS event. The 2 pressures PRES_ATWS_MIN/MAX and the two leak areas P_AREA_ATWS_MIN/MAX form a linear interpolation range for the leak area, which is then multiplied by RCS_UHEAD_RING_SEAL_MULT. The 2 pressures are set in base decks to very high values. Should an ATWS transient be modeled, the USER is required to set these values dependent upon the scenario.	Psia
190	P_AREA_ATWS_MAX	Input	RCS			Plant Design	RE		RV upper head O-ring seal leak - leak area at the maximum pressure. Used when extremely high pressure may be experienced, e.g. in an ATWS event. The 2 pressures PRES_ATWS_MIN/MAX and the two leak areas P_AREA_ATWS_MIN/MAX form a linear interpolation range for the leak area, which is then multiplied by RCS_UHEAD_RING_SEAL_MULT. The 2 leak areas are set in base decks to 0.0. Should an ATWS transient be modeled, the USER is required to set these values dependent upon the scenario	Ft^2

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191	P_AREA_RODEJ	Input	RCS			T/H Dimension	RE		CEA ejection leak area. Used only during an CEA ejection transient (MAL_ROD_EJECT not equal to 0.0). The leakage area is set in base decks to 0 0. Should an rod ejection transient be modeled, the USER is required to set this value dependent upon the scenario.	Ft^2
192	N_TOP_UPLEN	Input	RCS			T/H Dimension	RE		Top elevation of upper plenum portion of inner vessel node. This plant dependent parameter is set to the bottom elevation of the upper head node. I.e., N_BOT(NODE_UHEAD).	Feet
193	N_BOT_UPLEN	Input	RCS			T/H Dimension	RE		Bottom elevation of upper plenum portion of the inner vessel node. This plant dependent parameter is = elevation at the bottom of upper head - height of top section of the inner vessel node. I.e., N_BOT(NODE_UHEAD) - N_HEIGHT_SECT(1,N_SECTIONS(1))	Feet
194	KLOSS_UPLEN_POS	Input	RCS			T/H Dimension	RE		Upper plenum geometric form loss coefficient, for forward flow. This plant dependent variable is calculated from referenced pressure loss at given flow conditions. KLOSS_UPLEN_POS = (dP at fwd. flow)/(sp.vol. * W^2)	Dimensionless
195	KLOSS_UPLEN_NEG	Input	RCS			T/H Dimension	RE		Upper plenum geometric form loss coefficient, for reverse flow. This plant dependent variable is calculated from referenced pressure loss at given flow conditions. KLOSS_UPLEN_NEG = (dP at rev. flow)/(sp.vol. * W^2)	Dimensionless
196	CORE_BOT	Input	CORE	RCS		Dimension	RE		Active core bottom elevation, relative to the node bottom. This plant dependent dimension is also = the height of section 1 of node 1.	Feet
197	CORE_TOP	Input	CORE	RCS		Dimension	RE		Active core top elevation, relative to the node bottom. This plant dependent dimension is also = the sum of heights of sections 1 through N_SECTIONS(1)-1 of node 1.	Feet
198	AREA_CORE	Input	CORE	RCS		Dimension	RE		Active core flow area. This plant dependent variable is calculated as core fluid volume/height of fuel rods. Should equal N_AREA_SECT(2...). This parameter is used for calculating the Reynolds number of the core flow, for use in determining core heat transfer coefficients.	Ft^2
199	HA_CEA_CORE	Input	RCS	CORE		T/H Dimension	RE		CEA to Inner Vessel wall heat trans coefficient (hA). The plant dependent variable is calculated from the thickness, conductivity and surface area of the core shrouds in the inner vessel region. hA = (.5k/t)*A. Surface heat transfer is assumed infinite. This liquid heat transfer coefficient is one part of the total for node (1), which includes all the metal contained in the node.	Btu/sec-degF
200	PATH_CEA_LOW	Input	RCS	CORE		Model Design	IN		Inlet path, upper plenum to CEA guide tubes. This is one of the momentum flow paths. The path number is independent of individual plant design. When the CEA guide tubes are inserted, form losses for this path increase. See RCS_CEAIN_KTERM for detailed discussion. Reference 1, Section 7.2.2.	Pointer

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201	PATH_CEA_UP	Input	RCS	CORE		Model Design	IN		Exit path, from CEA guide tubes to upper head. This is one of the momentum flow paths. The path number is same as PATH_UCEA, independent of individual plant design. When the CEA guide tubes are inserted, form losses for this path increase. See RCS_CEAIN_KTERM for detailed discussion. Reference 1, Section 7.2.2.	Pointer
203	CEAS_DIST	Input	RCS	CORE		Dimension	RE		Traveling distance of CEAs. Serves as part of the model that accounts for increased losses associated with flow through the CEA guide tubes when the rods are inserted. If RCS_CEAIN_KTERM=1.0, then CEAS_DIST becomes irrelevant. See RCS_CEAIN_KTERM for detailed discussion of the increased loss model.	Feet
204	EXCORE_BOT	Input	CORE	RCS		Dimension	RE		Lower excore detector elevation, relative to the bottom of the RV annulus node (NODE_ANNUL). CENTS calculates the circumferential specific volume distribution in the RV annulus at this elevation. The resulting array, SVOL_DOWNCOMER, is unused. Therefore, a value for EXCORE_BOT need not be input	Feet
205	EXCORE_TOP	Input	CORE	RCS		Dimension	RE		Upper excore detector elevation, relative to the bottom of the RV annulus node (NODE_ANNUL). CENTS calculates the circumferential specific volume distribution in the RV annulus at this elevation. The resulting array, SVOL_DOWNCOMER, is unused. Therefore, a value for EXCORE_TOP need not be input.	Feet
207	RTRV_BYPASS	Input	CORE	RCS		T/H Dimension	RE		Fraction of vessel flow bypassing core. This fraction is always used and is plant dependent. Vessel flow, in this case is referring to p_flow(1). Most often, bypass flow is given as a fraction of total vessel flow. For CE plants, TOTAL bypass flow (lbm/sec) = rtrv_bypass*p_flow(1)+p_flow(30)+p_flow(31). Reference: Individual plant basedeck calculations.	Fraction
208	RCS_KWEIGHT_HTILT	Input	CORE	RCS		T/H Dimension	RE	4, 4	Coeff. for cold leg to opposite hot leg mixing. This array specifies the fraction of flow from each cold leg which is transported to hot leg 1 or to hot leg 2 to determine mixing in the reactor vessel. The array is 4x4 in order to accommodate other plant types. Vessel mixing factors are most important for the analysis of the Steam Line Break. Semi-scale flow mixing tests have been performed for several CE plant designs. The results were very similar. This matrix of mixing data is plant design dependent. For a mixing factor of X i= hot leg and j= cold Leg i= 1 2 3 4 j= 1: (1-X) X 0 0 2: (1-X) X 0 0 3: X (1-X) 0 0 4: X (1-X) 0 0 Reference: Individual plant basedeck calculations. Reference 1, Section 7.2 5.	Fraction

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209	HA_UHEAD_CORE	Input	RCS			T/H Dimension	RE		Upper head to IV heat transfer coef (hA). This is a plant dependent variable based on thickness, surface area and conductivity of the barrier (UGS plate for CE plants) between the upper head node and the outlet plenum region of node 1. The surface heat transfer coefficient is assumed infinite. Then ha_uhead_core = area of plate/ (thickness/conductivity). For steam at this interface it is usual to set this heat transfer coeff. to 0.0. Reference: Individual plant basedeck calculations.	Btu/sec-degF
210	PLT_RCS_PRZR	Partition					RE	40	RCS plant data: Pressurizer.	Partition
211	NUM_HEATERS	Output	PZR	RCS		Plant Design	IN		Total number pressurizer heater banks. This is set by the code to equal NUM_PROP_HEATERS + NUM_BACK_HEATERS.	Counts
213	AREA_BLEED_MIN	Input	PZR	RCS		T/H Dimension	RE		Pressurizer spray bleed line minimum area. This is a plant dependent variable which is usually determined by initial data base tuning. The line area is adjusted until the correct continuous bleed spray flow is attained.	Ft^2
214	HCAP_HEATER	Input	PZR	RCS		T/H Dimension	RE	6	Heater gross heat capacity. This is a plant dependent variable = number of heaters * mass of one heater * specific heat of the heater material. This is calculated for each heater bank. Reference: Individual plant basedeck calculations.	Btu/degF
215	XFER_HEATER	Input	PZR	RCS		T/H Dimension	RE	6	Heater overall heat transfer coefficient. This is a plant dependent variable. h = 1 / (1/hconv + t/k), where 1/hconv = 0 (i.e. heaters are essentially conduction limited) (user assumed), k = thermal conductivity for heater sheath material t = thickness of heater sheath wall. Reference: Individual plant basedeck calculations.	Btu/sec-degF
216	RESI_HEATER	Input	PZR	RCS		Component Design	RE	6	Heater electrical resistance. This is a plant dependent variable. Resisitance = V^2/(P * No. of Heaters) V = bus voltage P * No. of heaters = power/heater * No. of heaters /bank Reference: Individual plant basedeck calculations.	Ohms
217	TOP_HEATERS	Input	PZR	RCS		Dimension	RE		Top elev of pressurizer heaters. This a plant dependent variable. The height is measured as a distance referenced from the bottom of the pressurizer. Reference: Individual plant basedeck calculations.	Feet
219	LEVL_PRZR_RTD	Input	PZR	RCS		Dimension	RE		Level of pressurizer RTD. This is a plant dependent variable. The height is measured as a distance referenced from the bottom of the pressurizer. Reference: Individual plant basedeck calculations.	Feet
220	LEVL_REF_BOT	Input	PZR	RCS		Dimension	RE		Bottom level of pressurizer reference leg. This is a plant dependent variable. The height is measured as a distance referenced from the bottom of the pressurizer. Reference: Individual plant basedeck calculations.	Feet
221	LEVL_REF_TOP	Input	PZR	RCS		Dimension	RE		Top level of pressurizer reference leg. This is a plant dependent variable. The height is measured as a distance referenced from the bottom of the pressurizer. Reference: Individual plant basedeck calculations.	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
223	DESIGN_FLOW_PORV	Input	PORV	RCS		Component Design	RE		PORV design flow rate. This is a plant dependent variable. It is used for calculating the relief valve vibration signals VIBR_VALVE_RELIEF and the relief valve temperature signals TEMP_VALVE_RELIEF. Those signals are not used. Therefore, the input data for DESIGN_FLOW_PORV may be omitted.	Lbm/sec
224	DESIGN_FLOW_SAFETY1	Input	PSV	RCS		Component Design	RE		PSV-1 design flow rate. This is a plant dependent variable. It is used for calculating the relief valve vibration signals VIBR_VALVE_RELIEF and the relief valve temperature signals TEMP_VALVE_RELIEF. Those signals are not used. Therefore, the input data for DESIGN_FLOW_SAFETY1 has no effect, but must be greater than zero If omitting, set to 100.	Lbm/sec
225	DESIGN_FLOW_SAFETY2	Input	PSV	RCS		Component Design	RE		PSV-2 design flow rate. This is a plant dependent variable. It is used for calculating the relief valve vibration signals VIBR_VALVE_RELIEF and the relief valve temperature signals TEMP_VALVE_RELIEF. Those signals are not used. Therefore, the input data for DESIGN_FLOW_SAFETY2 has no effect, but must be greater than zero. If omitting, set to 100.	Lbm/sec
226	PLT_RCS_QT	Partition					RE	10	RCS plant data: Quench tank	Partition
227	PRES_N2	Input	PZR	QT		Plant Design	RE		Quench Tank nitrogen supply pressure. This is a plant dependent variable. It is not usually part of a safety analysis basedeck because the QT in no way affects results of safety analysis. This input is intended as part of a simulator, best estimate basedeck for special analytical scenarios. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Psia
228	VOLU_QT	Input	PZR	QT		Plant Design	RE		Quench Tank total volume. This is a plant dependent variable. It is not usually part of a safety analysis basedeck because the QT in no way affects results of safety analysis. This input is intended as part of a simulator, best estimate basedeck for special analytical scenarios. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Ft^3
229	HEIGHT_QT	Input	PZR	QT		Dimension	RE		Quench Tank height assuming concentric circular cross section. This is a plant dependent variable. It is not usually part of a safety analysis basedeck because the QT in no way affects results of safety analysis. This input is intended as part of a simulator, best estimate basedeck for special analytical scenarios. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
230	MASS_QT_MAX	Input	PZR	QT		Plant Design	RE		Quench Tank maximum mass of water. This is a plant dependent variable. It is not usually part of a safety analysis basedeck because the QT in no way affects results of safety analysis. This input is intended as part of a simulator, best estimate basedeck for special analytical scenarios. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Lbm
231	QT_RUPTURE_SPOINT	Input	PZR	QT		Plant Design	RE		Quench Tank rupture disk setpoint pressure. This is a plant dependent variable. It is not usually part of a safety analysis basedeck because the QT in no way affects results of safety analysis. This input is intended as part of a simulator, best estimate basedeck for special analytical scenarios.	Psia
232	PLT_RCS_RCP	Partition					RE	450	RCS plant data: Reactor coolant pumps	Partition
233	NUM_PUMPS	Input	RCP	RCS		Plant Design	IN		Number of reactor coolant pumps (RCPs, 4 max). This is a plant dependent variable.	Counts
234	FRAC_TABL	Input	RCP	RCS		Model Design	RE	11	Independent variable array for RCP homologous curves: ratio of normalized speed to normalized flow, or its reciprocal, whichever is smaller.	Dimensionless
235	BAN	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (normal +flow,+speed) This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
236	BVN	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (normal +flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
237	BAD	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
238	BVD	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
239	BAT	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (turbine -flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
240	BVT	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (turbine -flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
241	BAR	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (abnormal +flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless
242	BVR	Input	RCP	RCS		Component Design	RE	11	RCP torque homologous curve (abnormal +flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump torque.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
243	HAN	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (normal +flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
244	HVN	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (normal +flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
245	HAD	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
246	HVD	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
247	HAT	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (turbine -flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
248	HVT	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (turbine -flow,-speed). This is a pump dependent variable See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
249	HAR	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (abnormal +flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
250	HVR	Input	RCP	RCS		Component Design	RE	11	RCP head homologous curve (abnormal +flow,-speed). This is a pump dependent variable. See Reference 1, Section 4.11.1 for definitions and use in determining pump head	Dimensionless
251	HANC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (normal +flow,+speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HANC from the single phase head curve, HAN. See Reference 1, Section 4 11.1 for definitions and use in determining pump head.	Dimensionless
252	HVNC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (normal +flow,+speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HVNC from the single phase head curve, HVN. See Reference 1, Section 4 11.1 for definitions and use in determining pump head	Dimensionless
253	HADC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HADC from the single phase head curve, HAD. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
254	HVDC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (energy dissipation -flow,+speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HVDC from the single phase head curve, HVD. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
255	HATC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (turbine -flow,-speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HATC from the single phase head curve, HAT. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
256	HVTC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (turbine -flow,-speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HVTC from the single phase head curve, HVT. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
257	HARC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (abnormal +flow,-speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HARC from the single phase head curve, HAR See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
258	HVRC	Input	RCP	RCS		Component Design	RE	11	RCP difference head homologous curve (abnormal +flow,-speed). This is a pump dependent variable. During two-phase flow conditions, degraded pump head is calculated by subtracting the product of the degraded head multiplier (hd_deg_mult) and HVRC from the single phase head curve, HVR. See Reference 1, Section 4.11.1 for definitions and use in determining pump head.	Dimensionless
259	FRAC_HD_TABL	Input	RCP	RCS		Component Design	RE	11	RCP head degradation void fraction (independent variable). This independent variable is used in conjunction with the difference head degradation multiplier, which is then multiplied by the difference homologous curves in determining the pump head in two-phase flow conditions.	Dimensionless
260	HD_DEG_TABL	Input	RCP	RCS		Component Design	RE	11	RCP head degradation multiplier. This multiplier is multiplied by the difference homologous curves and the product is then subtracted from the single phase head curve in determining the pump head in two-phase flow conditions.	Dimensionless
261	RATED_PUMP_SPEED	Input	RCP	RCS		Component Design	RE	4	Rated pump speed. This is pump dependent variable provided by the pump manufacturer. It is used in conjunction with the other rated pump conditions and with the homologous pump curves to determine pump head and torque.	Shaft RPM

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
262	RATED_VOL_FLOW	Input	RCP	RCS		Component Design	RE	4	Rated pump volumetric flow. This is pump dependent variable provided by the pump manufacturer. It is used in conjunction with the other rated pump conditions and with the homologous pump curves to determine pump head and torque	Ft^3/sec
263	RATED_PUMP_DENS	Input	RCP	RCS		Component Design	RE	4	Rated pump density. This is pump dependent variable provided by the pump manufacturer. It is used in conjunction with the other rated pump conditions and with the homologous pump curves to determine pump head and torque.	Lbm/ft^3
264	RATED_PUMP_HD	Input	RCP	RCS		Component Design	RE	4	Rated pump head. This is pump dependent variable provided by the pump manufacturer. It is used in conjunction with the other rated pump conditions and with the homologous pump curves to determine pump head and torque.	Feet
265	RATED_PUMP_TORQ	Input	RCP	RCS		Component Design	RE	4	Rated pump torque. This is pump dependent variable provided by the pump manufacturer. It is used in conjunction with the other rated pump conditions and with the homologous pump curves to determine pump head and torque.	Ft-lbf
266	RATED_PUMP_SYNCH	Input	RCP	RCS		Component Design	RE	4	Pump synch speed at rated frequency. This is pump dependent variable provided by the pump manufacturer. It is used in calculating the pump electrical current. See Reference 1, Section 4.11.2 for definitions and equations.	Shaft RPM
267	NUM_POLES	Input	RCP	RCS		Component Design	IN		Number of poles per pump. This is pump dependent variable provided by the pump manufacturer. It is used in calculating the pump motor slip, which in turn is used in determining the electrical torque. See Reference 1, Section 4.11.2 for definitions and equations.	Counts
268	WIND_TORQ_MULT	Input	RCP	RCS		Component Design	RE		Windage/friction torque constant. This is a pump dependent variable. This constant multiplied by (pump-speed / rated-pump-speed)^2 yields the pump frictional torque, which is one term in the conservation equation for pump speed. See Reference 1, Section 4.11.2 for definitions and equations.	Ft-lbf
270	NPTS_TAB	Input	RCP	RCS		Model Design	IN		Number of points in motor tables. This is a plant independent variable. It relates to CENTS the array size for the electrical torque tables. The maximum size is 22.	Counts
271	SLIP_TAB	Input	RCP	RCS		Component Design	RE	22	Table of electrical slip. The definition of slip is (1- angular speed/synchronous speed). This is the pump-dependent table of the independent variable, slip, for determining the normalized electrical torque (from TORQ_TAB) and normalized electrical current (from CURRENT_TAB). See Reference 1, Section 4.11.2 for definitions and equations. See also, the plant basedeck calculation	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
272	TORQ_TAB	Input	RCP	RCS		Component Design	RE	22	Table of normalized electrical torques, corresponding to the electrical slips in SLIP_TAB. This table is pump-dependent. It is the actual electrical torque (at a given speed or slip, and at the rated voltage) divided by the design rated electrical torque. This variable is used by CENTS to calculate electrical torque and pump speed. See Reference 1 Section 4.11.2 for definitions and equations. See also, the plant basedeck calculation.	Dimensionless
274	CURRENT_TAB	Input	RCP	RCS		Component Design	RE	22	Table of normalized electrical currents, corresponding to the electrical slips in SLIP_TAB. This table is pump-dependent. It is derived from design data of electrical current vs. electrical torque. It is defined as the actual current divided by the rated current. The rated current is defined as (rated electrical torque) * (rated pump speed) / (rated voltage). From this multiplier, the pump current is determined. Pump current is an "information only" output variable. It has no use other than to drive a "current meter".	Dimensionless
275	PRESS_LDN	Input	RCP	RCS	CVCS	Plant Design	RE		Letdown line pressure (for RCP leaks). This is a plant dependent input. It is used to determine the backpressure in calculating the amount of expected leakage from the RCPs.	Psia
276	RCP_VOLT_RATED	Input	RCP	RCS		Component Design.	RE		RCP rated voltage. This is plant dependent variable. It is used in calculating electrical torque which in turn is used in determining actual pump speed. See Reference 1, Section 4.11.2 for definitions and equations.	Volts
277	RCP_FREQ_RATED	Input	RCP	RCS		Component Design	RE		RCP rated electrical frequency. This is a pump dependent variable, but it is 60 Hz for all US plants.	Hertz
278	RCS_CONST	Partition					RE	200	RCS tunable constants	Partition
279	RCS_CONST_PRZR	Partition					RE	15	RCS pressurizer tunable constants	Partition
280	PRZR_SPRAY_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier on pressurizer spray (excluding aux.). This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless
281	PRZR_HEATER_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier on total pressurizer heat. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is always set to 1.0 in the plant basedeck.	Dimensionless
282	PRZR_PORV_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier on PORV relief flow rates. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless
283	PRZR_SAFETY_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier on safety valve flow rates. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics It is always set to 1.0 in the plant basedeck.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
284	PRZR_VENT_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier on pressurizer vent valve flows. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is always set to 1 0 in the plant basedeck.	Dimensionless
285	PRZR_RELIEF_RTD_TAU	Input	PZR	RCS		Component Design	RE		First order lag constant for the pressurizer relief valve RTDs. This variable is used always, but only for calculating the simulator output TEMP_VALVE_RELIEF, which is not referenced anywhere else in CENTS. It is used in conjunction with RCS_PRZR_VLVH_MAX_TAU and RCS_PRZR_VLV_REVH_TAU. They are time constants for calculating elements of TEMP_VALVE_RELIEF, the array of pressurizer relief valves' RTD temperatures.	Seconds
286	PRZR_QT_MULT	Input	PZR	RCS	QT	Multiplier	RE		Multiplier on control flow from QT to pressurizer This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Dimensionless
287	RCS_PRZR_FLASH_MULT	Input	PZR	RCS		Multiplier	RE		Multiplier for pressurizer flashing calculation. Used in the pressurizer when it is in thermal nonequilibrium. This is a multiplier on the rate of flashing in the pressurizer. This multiplier is independent of plant design. It is used only for tuning or testing, and should always be set to 1.0 in actual transients	Dimensionless
288	RCS_DM_FLASH_PRZR	Output	PZR	RCS		T/H Dimension	RE		Flashing rate in the pressurizer saturated region.	Lbm/sec
291	VLV_PRZR_KLOSS_UP	Input	PZR	RCS		T/H Dimension	RE		Loss coefficient, pressurizer to relief valves. This is a plant dependent variable based upon the geometry of the nozzle and piping between the pressurizer and the safety valve. See the plant basedeck calculation.	Composite Units
292	VLV_PRZR_KLOSS_DOWN	Input	PZR	RCS		T/H Dimension	RE		Loss coefficient, pressurizer-relief-valves to Quench Tank This is a plant dependent variable based upon the geometry of the outlet nozzle and piping between the safety valves and the quench tank. This is usually set to zero or a dummy value in the basedecks Downstream backpressure from the safety valves is not considered as essential information for determining critical flow rates from the safety valves during plant transients at normal operating conditions	Composite Units
293	RCS_CONST_UHEAD	Partition					RE	10	RCS upper head tunable constants	Partition
294	RTRV_KLOSS_CORE	Input	CORE	RCS		T/H Dimension	RE		Core pressure drop factor for buoyancy. This is a plant dependent variable. It is used only to calculate the output parameter BOUYANCY_CORE. This k =fL/Dh is derived from calculated basedeck parameters. See the plant basedeck calculation	Dimensionless
295	RTRV_VENT_MULT	Input	CORE	RCS		Multiplier	RE		Multiplier on head vent valve flows. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
296	RTRV_HEAD_SEAL_MULT	Input	CORE	RCS		Multiplier	RE		Multiplier on head seal pressure. This is a USER variable, used in calculating the inner O-ring region pressure, RCS_P_ORING. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless
297	RCS_Q_CEA_CORE_MULT	Input	CORE	RCS		Multiplier	RE		Multiplier heat transfer CEA-core. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless
298	RCS_UHEAD_RING_SEAL_MULT	Input	RCS			Multiplier	RE		Multiplier upper head ring seal area. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient (ATWS, O-ring seal leak) or varied for running parametrics. It is usually set to 1.0 in the plant basedeck. See P_AREA_ATWS_MIN et.al.	Dimensionless
299	RTRV_MIX_INLET	Input	RCS			T/H Dimension	RE	2	Core-inlet mixing factor: (1) low flow factor, (2) high flow factor. Used always (except during core uncovery or reverse flow). This variable and RTRV_MIX_OUTLET are mixing factors for the core inlet and outlet plena. They work together with RCS_KWEIGHT_TILT to determine the degree of mixing of core flow coming from the cold legs until it exits to the hot legs. The end result is an adjustment to hot-leg flow enthalpies and qualities (P_ENTH, P_ENTH_LIQ, P_QUAL), which provides the hot-leg enthalpy tilt whenever the cold-leg enthalpies are tilted. (RTRV_MIX_INLET is also used to calculate the array ENTH_QUAD_CORE which is the enthalpy distribution, by quadrants, of the core inlet flow. However, ENTH_QUAD_CORE is not used) The arrays are plant-specific, but there is limited data available to support their calculation. They may be set to zero, with all the mixing effects coming only from RCS_KWEIGHT_TILT (which also comes from limited scale model flow testing, rather than "hard" plant mixing data). Reference 1, Section 7.2.5.	Fraction

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
300	RTRV_MIX_OUTLET	Input	RCS			T/H Dimension	RE	2	Core-outlet mixing factor: (1) low flow factor, (2) high flow factor. Used always (except during core uncovery or reverse flow). This variable and RTRV_MIX_INLET are mixing factors for the core inlet and outlet plena. They work together with RCS_KWEIGHT_TILT to determine the degree of mixing of core flow coming from the cold legs until it exits to the hot legs. The end result is an adjustment to hot-leg flow enthalpies and qualities (P_ENTH, P_ENTH_LIQ, P_QUAL), which provides the hot-leg enthalpy tilt whenever the cold-leg enthalpies are tilted. (RTRV_MIX_INLET is also used to calculate the array ENTH_QUAD_CORE which is the enthalpy distribution, by quadrants, of the core inlet flow. However, ENTH_QUAD_CORE is not used.) The arrays are plant-specific, but there is limited data available to support their calculation. They may be set to zero, with all the mixing effects coming only from RCS_KWEIGHT_TILT (which also comes from limited scale model flow testing, rather than "hard" plant mixing data). Reference 1, Section 7.2.5.	Fraction
301	RCS_CEAIN_KTERM	Input	RCS			Multiplier	RE		CEA's inserted, k-factor multiplier. Used always. This term accounts for the additional losses associated with flow through the CEA guide tubes when the rods are inserted. CENTS calculates a dynamic multiplier, RCS_CEA_MULT, which equals: (1) 1.0 when the CEAs are fully withdrawn, (2) RCS_CEAIN_KTERM when the CEAs are fully inserted, or (3) a linearly interpolated value when the CEAs are partly inserted. RCS_CEA_MULT then multiplies the calculated form loss k-factors through the CEA guide tubes, for the two momentum flow paths that connect to the CEA node (PATH_CEA_LOW and PATH_CEA_UP). Since the CEA guide tubes form a path that connects the core region to the upper head, RCS_CEAIN_KTERM can have an effect on the dynamics of bubble formation and bubble collapse in the upper head. This k-factor multiplier is dependent on plant design, as it represents the ratio of form loss k-factor with the rods inserted to the k-factor with the rods withdrawn.	Dimensionless
302	RCS_CONST_PUMPS	Partition					RE	13	RCS coolant pump tunable constants	Partition
303	RCP_MOM_INERTIA	Input	RCP	RCS		Component Design	RE	4	Reactor coolant pump rotor/flywheel inertia. This is a pump dependent variable provided by the manufacturer as part of the pump design (or as-built) data for each pump. It is used during pump coastdown (or speed change) transients to help determine the rate of the coastdown. The values given in the basedeck may be adjusted based upon known plant coastdown data, compared to CENTS simulated coastdown rates	Lbf*ft2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
304	RCP_HEAT_MULT	Input	RCP	RCS		Multiplier	RE		Reactor coolant pump heat rate multiplier. This is a USER variable, which is often set during initial plant tuning to give a pump heat addition rate equal to whatever groundrules heat rate is considered appropriate. CENTS calculates a heat addition rate based on pump rated inputs and plant conditions. This calculation usually provides heat addition rates which are very close to those required. Hence, the multiplier setting is usually close to 1.0. See the plant basedeck calculation. Reference 1, Section 4.11.1.	Dimensionless
305	RCP_MOM_INERTIA_SPLIT	Input	RCP	RCS		Component Design	RE		Fractional moment of inertia to the motor when sheared shaft occurs. Used only when a RCP sheared shaft malfunction is active. This is the fraction of a pump's inertia that stays with the motor when the shaft shears. The remaining inertia is assigned to the impeller. This is dependent on RCP design.	Fraction
310	RCS_CONST_LOOP	Partition					RE	4	Tunable constants for RCS loop variables	Partition
311	RCS_CONT_HEAT_MULT	Input	RCS			Multiplier	RE		Multiplier on cont. heat xfer rates. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck.	Dimensionless
312	RCS_SGTR_FLOWMULT	Input	RCS			Multiplier	RE		SG tube rupture (SGTR) area multiplier. For each tube ruptured (MAL_SGTR is the input number of ruptured tubes), there are two broken ends. CENTS treats these two ends as separate breaks, with different flow enthalpies and flow fluxes, and with each presenting a break area SG_TUBE_AREA * RCS_SGTR_FLOWMULT. RCS_SGTR_FLOWMULT is normally set to 1.0. Reference 1, Section 7.5 2	Dimensionless
313	RCS_CONST_QT	Partition					RE	6	RCS quench tank addressable constants	Partition
314	QT_N2_MULT	Input	PZR	RCS	QT	Multiplier	RE		Multiplier on nitrogen supply flow. This is a USER variable It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Dimensionless
316	QT_VENT_MULT	Input	PZR	RCS	QT	Multiplier	RE		Multiplier on quench tank vent flow. This is a USER variable. It can be used as a tuning aid or for setting abnormal conditions for a given transient or varied for running parametrics. It is usually set to 1.0 in the plant basedeck. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Dimensionless
318	RCS_CONST_GENERAL	Partition					RE	133	General RCS addressable constants	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
319	RCS_ITER_DP	Input	RCS			T/H Dimension	RE		Equilibrium pressure search convergence band. Used in conjunction with RCS_ITER_DP_NE & RCS_ITER_DH_NE. Used always, except in nodes that are in low-pressure (< 200 psia) equilibrium. These are convergence criteria for the iterative nodal pressure search. In thermal nonequilibrium, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP_NE and the specific enthalpy change is less than RCS_ITER_DH_NE. In thermal equilibrium with the pressure above 200 psia, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP. (At lower pressures in equilibrium, the convergence dP is RCS_ITER_DPL). These parameters are numerical in nature, and are independent of plant design Reference 1, Section 4.4.	Psia
320	RCS_ITER_DP_NE	Input	RCS			T/H Dimension	RE		Non-eq pres search conv band on pressure. Used in conjunction with RCS_ITER_DP & RCS_ITER_DH_NE. Used always, except in nodes that are in low-pressure (< 200 psia) equilibrium. These are convergence criteria for the iterative nodal pressure search. In thermal nonequilibrium, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP_NE and the specific enthalpy change is less than RCS_ITER_DH_NE. In thermal equilibrium with the pressure above 200 psia, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP. (At lower pressures in equilibrium, the convergence dP is RCS_ITER_DPL). These parameters are numerical in nature, and are independent of plant design. Reference 1, Section 4.4.	Psia
321	RCS_ITER_DH_NE	Input	RCS			T/H Dimension	RE		Non-equilibrium pressure search convergence band, based on enthalpy changes. Used in conjunction with RCS_ITER_DP_NE & RCS_ITER_DP. Used always, except in nodes that are in low-pressure (< 200 psia) equilibrium. These are convergence criteria for the iterative nodal pressure search. In thermal nonequilibrium, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP_NE and the specific enthalpy change is less than RCS_ITER_DH_NE. In thermal equilibrium with the pressure above 200 psia, the solution converges when the pressure change from the previous iteration is less than RCS_ITER_DP. (At lower pressures in equilibrium, the convergence dP is RCS_ITER_DPL). These parameters are numerical in nature, and are independent of plant design	Btu/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
322	RCS_DROP_COND_MULT	Input	RCS			Multiplier	RE	50	Multiplier on droplet condensation (nodes with steam region present). Used in conjunction with N_XFER_INJ & AREA_INJ_MULT. Used IFF a node is in thermal nonequilibrium AND liquid is entering the node at an elevation that is within the node's steam space (except for the pressurizer spray). These are condensation rate multipliers, one for each node. They apply to the condensation of steam on cold liquid that enters a node in that node's steam space. N_XFER_INJ multiplies the calculated condensation rate for liquid injection from any path, except the pressurizer spray path. AREA_INJ_MULT and RCS_DROP_COND_MULT redundantly multiply the calculated condensation rate for liquid injection from any momentum path. (They are redundant since they both multiply the interfacial area available for condensation). These multipliers are independent of plant design. They are used only for tuning or testing, and should always be set to NNN*1.0 in actual transients, where NNN is the number of nodes.	Dimensionless
323	RCS_KLOSS_MULT	Input	RCS			Multiplier	RE	100	Geometric losses multipliers. They are used always. They are applied to the individual PATH_KLOSS_POS & PATH_KLOSS_NEG variables. These multipliers are normally set equal to 1 0 unless the code USER requires pressure drops which are tailored to a given set of conditions. These multipliers also provide a means of tuning the pressure drops are the RCS loops without changing base KLOSS values.	Dimensionless
324	RCS_COND_SURF_MULT	Input	RCS			Multiplier	RE	50	Surface condensation multiplier. Used IFF a node is in thermal nonequilibrium. This is an array of condensation rate multipliers, one for each node. It applies to the condensation of steam at the surface of each node's liquid-steam interface. These multipliers are independent of plant design. They are used only for tuning or testing, and should always be set to NNN*1.0 in actual transients, where NNN is the number of nodes.	Dimensionless
325	RCS_CONST_LEAKS	Partition					RE	5	Constants for leak tables and correlations	Partition
326	RCS_SUPERCRIT_FLOW_MULT	Input	RCS			Multiplier	RE		Multiplier on supercritical mass flux. Used always. In the calculation of critical flow, if the upstream pressure exceeds the table limit (3000 psia), then this parameter multiplies the flux determined from the choked flow tables. Otherwise, the flux is multiplied by RCS_SUBCRIT_FLOW_MULT. These parameters are independent of plant design. RCS_SUPERCRIT_FLOW_MULT allows for pressures that exceed the table limits and has a typical value of 1.50.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
327	RCS_SUBCRIT_FLOW_MULT	Input	RCS			Multiplier	RE		Multiplier on leak tables (subcritical flow conditions). Used always. In the calculation of critical flow, if the upstream pressure is below the table limit (3000 psia), then this parameter multiplies the flux determined from the choked flow tables. Otherwise, the flux is multiplied by RCS_SUPERCRIT_FLOW_MULT. These parameters are independent of plant design. RCS_SUBCRIT_FLOW_MULT is used only for tuning or testing and should be set to 1.0 in normal transients.	Dimensionless
328	CONV_GPM_AREA	Input	RCS			T/H Dimension	RE	3	Gal/min-to-area conversion factor at nominal condition. (1) suction cold leg, (2) hot leg, (3) pressurizer. This is a plant dependent input variable. The input for hot leg and pressurizer are not used. It is only used in determining RCP seal leakage rates. The value is that area which provides a 1 gpm leakage at nominal pressure & temperature. To determine its value, initialize at nominal condition, convert 1 gpm to lbm/sec at the suction leg's density, set RCP_SEALS_LEAK=4*1.0, and use CENTS to determine the factor by trial-and-error See the plant basedeck calculation.	Composite Units
329	PLT_RCS_VLVAREA	Input Partition					RE	25	RCS valve areas	Ft^2
330	PLT_VLVAREA_UHEAD_CONT	Input	RCS			Dimension	RE		Area of vent valve from u-head to containment. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data)	Ft^2
331	PLT_VLVAREA_UHEAD_QT	Input	RCS	QT		Dimension	RE	2	Area vents valves u-head to quench tank. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data).	Ft^2
332	PLT_VLVAREA_PRZR_PORV	Input	PZR	RCS		Dimension	RE	4	Area pressurizer PORVs. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data).	Ft^2
333	PLT_VLVAREA_PRZR_SAFETY	Input	PZR	RCS		Dimension	RE	4	Area pressurizer safety valves. This is a calculated plant dependent variable based upon knowing the design critical flow rate at design pressure conditions.	Ft^2
334	PLT_VLVAREA_PRZR_MOV	Input	PZR	RCS		Dimension	RE	4	Area pressurizer movs (in series with PORVs). This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data).	Ft^2
335	PLT_VLVAREA_PRZR_CONT	Input	PZR	RCS		Dimension	RE		Area vent pressurizer to containment. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data).	Ft^2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
336	PLT_VLVAREA_PRZR_QT	Input	PZR	RCS		Dimension	RE	2	Area vents pressurizer to q-tank (in series). This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data).	Ft^2
337	PLT_VLVAREA_PRZR_MSPRAY	Input	PZR	RCS		Dimension	RE	2	Area main spray control valves. This is a plant dependent variable. It may be adjusted during the initial plant tuning to provide a given flow rate for given plant conditions (based on provided test data or calculations).	Ft^2
338	PLT_VLVAREA_QT_GWS	Input	PZR	RCS	QT	Dimension	RE		Quench tank to Gas Waste System vent valve area. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data). This input is not used for safety analysis and the valve sizes are set to zero. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Ft^2
339	PLT_VLVAREA_QT_CONT	Input	PZR	RCS	QT	Dimension	RE		Quench tank to contain. vent vlv area. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data). This input is not used for safety analysis and the valve sizes are set to zero.	Ft^2
340	PLT_VLVAREA_QT_NSUPPLY	Input	PZR	RCS	QT	Dimension	RE		Valve area nitrogen supply to QT. This is a plant dependent variable. It may be set to actual valve size, line size or adjusted to provide a given flow rate for given plant conditions (based on provided test data). This input is not used for safety analysis and the valve sizes are set to zero. This input is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Ft^2
341	RCS_MORE_VARIABLES_504_RO	Partition					RE	41	RCS additional variables partition	Partition
342	RCS_PRZR_DH_SPRAY_EQ	Input	PZR	RCS		T/H Dimension	RE		Pressurizer spray delta-enthalpy for equilibrium. Used IFF the main spray is active beyond the minimum (or bleed) flow AND if the requested nonequilibrium mode of the pressurizer is NE_CANDIDATE(NODE_PRZR) = 3. (For realistic calculations, it SHOULD be 3 for subcooled liquid / superheated steam.) When the above 2 conditions are true AND the pressurizer's liquid inventory is within RCS_PRZR_DH_SPRAY_EQ Btu/lbm of saturation, AND the spray water is subcooled AND there is at least 1.5 ft of steam space AND RCS_PRZR_SPRAY_EQ is True, then the pressurizer is forced into thermal equilibrium. Otherwise, other logic determines the pressurizer's nonequilibrium state. So, typically this will kick in when spray causes rapid depressurization, and the liquid is approaching saturation due to the dropping pressure - this logic will force equilibrium just before saturation is reached.	Btu/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
343	RCS_PRZR_SPRAY_EQ	Input	PZR	RCS		T/H Dimension	LO		Pressurizer spray delta-enthalpy equilibrium flag. Used IFF the main spray is active beyond the minimum (or bleed) flow AND if the requested nonequilibrium mode of the pressurizer is NE_CANDIDATE(NODE_PRZR) = 3. (For realistic calculations, it SHOULD be 3 for subcooled liquid / superheated steam.) When the above 2 conditions are true AND the pressurizer's liquid inventory is within RCS_PRZR_DH_SPRAY_EQ Btu/lbm of saturation, AND the spray water is subcooled AND there is at least 1.5 ft of steam space AND RCS_PRZR_SPRAY_EQ is True, then the pressurizer is forced into thermal equilibrium. Otherwise, other logic determines the pressurizer's nonequilibrium state. So, typically this will kick in when spray causes rapid depressurization, and the liquid is approaching saturation due to the dropping pressure - this logic will force equilibrium just before saturation is reached.	True False

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
344	RCS_PRZR_DT_SUBH	Input	PZR	RCS		T/H Dimension	RE		Pressurizer delta-temperature boil heaters on. Used in conjunction with RCS_PRZR_DT_SUBC, RCS_PRZR_LVLDT_SUBC(2), and RCS_PRZR_TAU_DTSUB. These variables determine the extent to which change-of-phase processes occur in the pressurizer at thermal nonequilibrium -- boiling and flashing in the liquid region and condensation at the liquid-steam interface. This is given by the variable RCS_PRZR_DT_SUB_BOIL which is the amount of subcooling (degF) above which all boiling/flashing ceases and below which the surface condensation stops In the following, the first three variables above are referenced for short as DTH, DTC and LVLDT(2). First determine a temporary DTSBSS from a linear fit DTSBSS = DTC - F1 * F2 * (DTC - DTH) where F1 = (MixLevel - LVLDT(1)) / (LVLDT(2) - LVLDT(1)) F2 = HeaterHeat / 1000 MixLevel = przr mixture level, LEVL_MIX(NODE_PRZR) HeaterHeat = heat from the heaters, Btu/sec F1 and F2 are both bounded by [0.0,1.0]. Then, RCS_PRZR_DT_SUB_BOIL is determined as DTSBSS lagged with a time constant RCS_PRZR_TAU_DTSUB. The rates of flashing and boiling are calculated when the pressurizer is in thermal nonequilibrium. The liquid mass available for flashing is F3 * F4 * <total liquid mass>, and the heat input from the heaters and walls that results in boiling is F3 * F4 * <total heat from heaters and walls>. The two factors are: F3 = (MixLevel - LBOIL(2)) / (LBOIL(1) - LBOIL(2)) F4 = 1.0 - (TSAT - TLIQ) / RCS_PRZR_DT_SUB_BOIL F3 and F4 are both bounded by [0.0,1.0]. LBOIL is the array RCS_PRZR_L_BOIL(2) TSAT is the saturation temperature, TEMP_SAT(NODE_PRZR) TLIQ is the liquid temperature, TEMP_LIQ(NODE_PRZR) RCS_PRZR_DT_SUB_BOIL is the calculated subcooling DT for boiling/flashing. The rate of surface condensation is calculated when the pressurizer is in thermal nonequilibrium as condensation = <cond efficiency> * h * A * delta-T. The effective delta-T is given by delta-T = TSAT - TIQ - RCS_PRZR_DT_SUB_BOIL IF delta-T < 0, then: delta-T = 0 ELSE: 1 <= delta-T <= 5 RCS_PRZR_DT_SUBH and RCS_PRZR_DT_SUBC are plant design independent. RCS_PRZR_TAU_DTSUB is a long time constant that is used for stability, and is independent of plant design. RCS_PRZR_LVLDT_SUBC(2) are dependent on plant design, but their effect is expected to be weak: based on past	Del-DegF

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
345	RCS_PRZR_TAU_DTSUB	Input	PZR	RCS		T/H Dimension	RE		Pressurizer time constant delta-temperature subcooling. Used in conjunction with RCS_PRZR_DT_SUBC, RCS_PRZR_DT_SUBH, and RCS_PRZR_LVLDT_SUBC(2). See RCS_PRZR_DT_SUBH for a full description.	Seconds
351	RCS_PRZR_L_BOIL	Input	PZR	RCS		T/H Dimension	RE	2	Boiling degradation parameters. The absolute values for this parameter are based on pressurizer height dimensions. The ability to achieve boiling into the steam space of the pressurizer degrades from full to nil at approximately 2.5 to 1.5 ft below the top of the pressurizer, based on sensitivity testing of CE plant models. Reference: Plant Basedeck Calculation, Hand Calc. #8	Feet
356	RCS_CRIT_FLOW_CHECK	Input	RCS			T/H Dimension	LO		Mom. paths critical flow check. This is a USER set variable. It determines whether CENTS checks for critical flow conditions along the RCS momentum flow paths. Though critical flow is only considered likely during certain LOCA conditions, it is set to true in the basedecks.	True False
359	RCS_PRZR_MSPRAY_TAU	Input	PZR	RCS		T/H Dimension	RE		Main spray flow time constant. Used always. Effectively used only when the pressurizer main spray valves are open (i e., spray flow greater than minimum). This is a time constant used to lag the calculated main spray flow rate. The time constant (inertia effect) for the main spray flow is not explicitly described in the CENTS main spray flow calculation (Reference CENPD-282-P-A, Volume 1, Section 4.14.1). Normally, a small time constant is implemented to smooth the response without significantly affecting the flow response	Seconds
361	RCS_PRZR_VLVH_MAX_TAU	Input	PZR	RCS		T/H Dimension	RE		Pressurizer relief valves heat transfer maximum time constant. This variable is used always, but only for calculating the simulator output TEMP_VALVE_RELIEF, which is not referenced anywhere else in CENTS. It is used in conjunction with PRZR_RELIEF_RTD_TAU and RCS_PRZR_VLV_REVH_TAU. They are time constants for calculating elements of TEMP_VALVE_RELIEF, the array of przr relief valves' RTD temperatures.	Seconds
362	RCP_FR_SP_RUB_RATCH	Input	RCP	RCS		Component Design	RE		RCP fractional speed in which the pawls rub on ratchet. Used in conjunction with RCP_TORQ_RUB_RATCH. Used always. These parameters determine the effect of the RCP anti-rotation device (ratchets) that engages whenever a pump coasts down toward standstill. The device engages when the pump speed (fraction of rated speed) falls below RCP_FR_SP_RUB_RATCH. With the device engaged, the calculated frictional torque RCP_TORQ_FRIC is subject to an imposed minimum of RCP_TORQ_RUB_RATCH. (In a normal pump coastdown, the effect is evident by a noticeable increase in the deceleration of the pump.). These parameters are dependent on the particular design of RCP and its anti-rotation device The units of RCP_TORQ_RUB_RATCH are Ft-Lbf.	Fraction

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
363	RCP_TORQ_RUB_RATCH	Input	RCP	RCS		Component Design	RE		RCP torque pawls rub on ratchet. Used in conjunction with RCP_FR_SP_RUB_RATCH. Used always. These parameters determine the effect of the RCP anti-rotation device (ratchets) that engages whenever a pump coasts down toward standstill. The device engages when the pump speed (fraction of rated speed) falls below RCP_FR_SP_RUB_RATCH. With the device engaged, the calculated frictional torque RCP_TORQ_FRIC is subject to an imposed minimum of RCP_TORQ_RUB_RATCH. (In a normal pump coastdown, the effect is evident by a noticeable increase in the deceleration of the pump.). These parameters are dependent on the particular design of RCP and its anti-rotation device.	Ft-Lbf
364	RCS_PRZR_HAX_WALL	Input	PZR	RCS		T/H Dimension	RE		Pressurizer walls axial overall heat transfer coefficient. Used always. Overall heat transfer coefficient for axial heat transfer in the pressurizer wall. The wall heat model differs in the pressurizer from all other nodes, in that the pressurizer wall is divided into two sections separated by a moving boundary -- the wall region in contact with liquid and two-phase, and the wall sections in contact with steam. Since the two wall sections have different temperatures, there is some heat transfer between them: Heat = RCS_PRZR_HAX_WALL * delta-T. This variable is dependent on plant design, primary on the pressurizer wall thickness and material conductivity.	Btu/sec-degF
365	RCS_PRZR_LVLDT_SUBC	Input	PZR	RCS		T/H Dimension	RE	2	Pressurizer levels for boiling. Used in conjunction with RCS_PRZR_DT_SUBH, RCS_PRZR_DT_SUBC and RCS_PRZR_TAU_DTSUB. See RCS_PRZR_DT_SUBH for a full description.	Feet
366	RCS_P_ORING_FAIL	Input	RCS			Component Design	RE		Press. for vessel O-ring failure	Psia
374	RCS_PRZR_VLV_REVH_TAU	Input	PZR	RCS		T/H Dimension	RE		Pressurizer relief valves reverse heat transfer time constant. This variable is used always, but only for calculating the simulator output TEMP_VALVE_RELIEF, which is not referenced anywhere else in CENTS. It is used in conjunction with PRZR_RELIEF_RTD_TAU and RCS_PRZR_VLVH_MAX_TAU. They are time constants for calculating elements of TEMP_VALVE_RELIEF, the array of pressurizer relief valves' RTD temperatures.	Seconds
375	RCS_PHTR_RLD_MULT	Input	PZR	RCS		Multiplier	RE		Pressurizer proportional heater admittance multiplier. Used always. This is a multiplier on the admittance (1/resistance) of the proportional pressurizer heaters. The admittance is used in calculating each heater's electrical power as power = <bus voltage> * <voltage> * <admittance>. This multiplier is independent of plant design. It is used only for tuning or testing, and should always be set to 1.0 in actual transients.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
376	RCS_BHTR_RLD_MULT	Input	PZR	RCS		Multiplier	RE		Pressurizer backup heaters admittance multiplier. Used always. This is a multiplier on the admittance (1/resistance) of the backup pressurizer heaters. The admittance is used in calculating each heater's electrical power as power = <bus voltage> * <voltage> * <admittance>. This multiplier is independent of plant design. It is used only for tuning or testing, and should always be set to 1.0 in actual transients.	Dimensionless
379	PLT_SGS	Partition					RE	850	Steam generator data constants	Partition
380	PLT_SGS_INTERNAL	Partition					RE	230	SG data constants - SG internals	Partition
381	SG_DESIGN	Input	SG			Model Design	IN	4	Type of steam generator design (=1,2). There are two possible designs for SGs allowed for each plant. This variable is intended to allow differentiation of SG variables based upon modifications or replacement SGs which only effect some but not all SGs within a given plant.	Pointer
382	ASP_TBL	Partition					RE	15, 2	Table: c. s. area of evaporator region	Ft^2
383	ASP_TBL_DSGN1	Input	SG			Dimension	RE	15	Table: Cross-sectional area of evaporator region, Design #1. This table refers to the cross-sectional flow area in the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with the corresponding volume and height data, to determine the geometric proportions of these regions of the SG. This information is used to determine bubble rise and steam separation characteristics when SG level is at or above the separators. At lower levels, ASEP_SG performs this function. Note that abrupt changes in the area vs. height can cause improper mass flow rates and recirculation. Therefore, the area values are often "smoothed" to retain the proper SG performance. See plant basedeck calculations.	Ft^2
384	ASP_TBL_DSGN2	Input	SG			Dimension	RE	15	Table: Cross-sectional area of evaporator region, Design #2. This table refers to the cross-sectional flow area in the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with the corresponding volume and height data, to determine the geometric proportions of these regions of the SG. This information is used to determine bubble rise and steam separation characteristics when SG level is at or above the separators. At lower levels, ASEP_SG performs this function. Note that abrupt changes in the area vs. height can cause improper mass flow rates and recirculation. Therefore, the area values are often "smoothed" to retain the proper SG performance. See plant basedeck calculations.	Ft^2
385	HSP_TBL	Partition					RE	15, 2	Table: height in evaporator region	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
386	HSP_TBL_DSGN1	Input	SG			Dimension	RE	15	Table: height in evaporator region, design #1. This table refers to the independent variable of height to which cross-sectional flow area and volume are determined for the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with volume and area, to determine the geometric proportions of these regions of the SG. With volume, this information determines level in the region. With area, this information is used to determine bubble rise and steam separation characteristics when SG level is at or above the separators. At lower levels ASEP_SG performs this function. Note that abrupt changes in the area vs. height can cause improper mass flow rates and recirculation. Therefore, the area values are often times "smoothed" to retain the proper SG performance. See plant basedeck calculations.	Feet
387	HSP_TBL_DSGN2	Input	SG			Dimension	RE	15	Table: height in evaporator region, design #2. This table refers to the independent variable of height to which cross-sectional flow area and volume are determined for the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with volume and area, to determine the geometric proportions of these regions of the SG. With volume, this information determines level in the region. With area, this information is used to determine bubble rise and steam separation characteristics when SG level is at or above the separators. At lower levels ASEP_SG performs this function. Note that abrupt changes in the area vs. height can cause improper mass flow rates and recirculation. Therefore, the area values are often times "smoothed" to retain the proper SG performance. See plant basedeck calculations.	Feet
388	VST_TBL	Partition					RE	15, 2	Table: volume in evaporator region	Ft^3
389	VST_TBL_DSGN1	Input	SG			Dimension	RE	15	Table: volume in evaporator region, design #1. This table refers to the dependent variable of volume vs height determined for the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with height, to determine the geometric proportions of these regions of the SG. This information determines level in the region. See plant basedeck calculations.	Ft^3
390	VST_TBL_DSGN2	Input	SG			Dimension	RE	15	Table: volume in evaporator region, design #2. This table refers to the dependent variable of volume vs height determined for the evaporator/riser section or the steam dome region of the SG. It is used in conjunction with height, to determine the geometric proportions of these regions of the SG. This information determines level in the region. See plant basedeck calculations.	Ft^3
391	TBL2_NUM	Input	SG			Model Design	IN	2	Number of entries in evaporator geometry table. This number tells the CENTS code how many entries there are in each of the Volume/Area/Height tables, for each of the two possible design types. A maximum of 15 data points is available per table, per SG design.	Counts
392	HT3_TBL	Partition					RE	15, 2	Table: height in SG downcomer	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
393	HT3_TBL_DSGN1	Input	SG			Dimension	RE	15	Table: height in downcomer, design #1. This table refers to the independent variable of height to which volume is determined for the downcomer section of the SG. Note that the top of the downcomer region is often considered to be the level of the separator can deck. For ease in use of the CENTS code, the top elevation is often considered to be the top of the separators. This allows initialization of level to higher values, since the CENTS code does not allow initialization above the top of the can deck. It is used in conjunction with volume, to determine the geometric proportions of downcomer region of the SG. With volume, this information determines level in the downcomer. See plant basedeck calculations.	Feet
394	HT3_TBL_DSGN2	Input	SG			Dimension	RE	15	Table: height in downcomer, design #2. This table refers to the independent variable of height to which volume is determined for the downcomer section of the SG. Note that the top of the downcomer region is often considered to be the level of the separator can deck. For ease in use of the CENTS code, the top elevation is often considered to be the top of the separators. This allows initialization of level to higher values, since the CENTS code does not allow initialization above the top of the can deck. It is used in conjunction with volume, to determine the geometric proportions of downcomer region of the SG. With volume, this information determines level in the downcomer. See plant basedeck calculations.	Feet
395	V3_TBL	Partition					RE	15, 2	Table: volume in SG downcomer	Ft^3
396	V3_TBL_DSGN1	Input	SG			Dimension	RE	15	Table: volume in downcomer, design #1. This table refers to the dependent variable of volume vs height determined for the downcomer section of the SG. It is used in conjunction with height, to determine the geometric proportions of this region of the SG. This information determines level in the downcomer. See plant basedeck calculations.	Ft^3
397	V3_TBL_DSGN2	Input	SG			Dimension	RE	15	Table: volume in downcomer, design #2. This table refers to the dependent variable of volume vs height determined for the downcomer section of the SG. It is used in conjunction with height, to determine the geometric proportions of this region of the SG. This information determines level in the downcomer. See plant basedeck calculations.	Ft^3
398	TBL3_NUM	Input	SG			Model Design	IN	2	Number of entries in the downcomer geometry table. This number tells CENTS how many entries there are in the Volume/Height table for the downcomer, for each of the two possible design types. A maximum of 15 data points is available per table, per SG design.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
399	ASEP_SG	Input	SG			T/H Dimension	RE	4	Steam separation area at can deck, 100% steady state. This is a plant dependent variable. It can be calculated, and often is, to establish a preliminary value. However, the final basedeck value is always determined by tuning to achieve the correct masses and densities in the various SG nodes It directly affects the bubble rise velocity, which in turn affects the above evaporator mass and density. This variable is usually tuned in conjunction with W32_FLOW_COEFF which affects the recirculation ratio. Normally all the SGs of a given design within the plant have the same final tuned value for this parameter. But, it is possible to tune each SG individually if separate data is available for each SG. See plant basedeck calculations.	Ft^2
400	EVAP_SS_ALPHA	Input	SG			T/H Dimension	RE	4	SG evaporator void fraction at 100% steady state. This is a plant dependent variable calculated from SG reference data concerning the steam volume of the evaporator/riser region divided by the total volume of the evaporator/riser region at full power conditions. Normally all the SGs of a given design within the plant have the same final tuned value for this parameter. But, it is possible to tune each SG individually if specific data is available for each SG. See plant basedeck calculations.	Fraction
402	PERIM	Input	SG			Dimension	RE	2	Perimeter of tube shroud in lower SG. This is a plant dependent variable, usually obtained as a direct dimension of the SG sectional drawing. One value of this parameter is available for each SG design type. This parameter, when multiplied by the height of water in the downcomer (SGS_HT3) and by SG_U23, determines the overall coefficient for evaporator-to-downcomer heat transfer through the shroud.	Feet
403	SF_CONC_IO	Input	SG			Dose	RE		Stripping factor for SG iodine nuc. conc. This is a plant independent variable. It dictates what fraction of the concentration of iodine in the liquid inventory of the SG will be transferred to the steam. It is determined by the USER as dictated by scenario requirements. Often times, it is set to .01.	Dimensionless
404	SG_U12	Input	SG			T/H Dimension	RE		Heat transfer coefficient between regions 1 & 2. This is a plant dependent variable. Region 1 is the steam dome and region 2 is the evaporator/riser region. The can deck is usually considered as the boundary metal between the two regions. The calculated heat transfer coefficient is considered to be conduction limited, with infinite heat transfer capability at the surface. Thus, HTC=1/R=1/(t/k). Note that there is seldom much, if any temperature difference between the two regions; therefore there is little heat transfer. See plant basedeck calculations.	Btu/secft^2 degF

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
405	SG_U23	Input	SG			T/H Dimension	RE		Heat transfer coefficient regions 2 & 3; also 2/4, 3/4(where an economizer is present). This is a plant dependent variable. Region 3 is the downcomer and region 2 is the evaporator/riser region. The tube shroud or "wrapper" is the boundary metal between the two regions. The calculated heat transfer coefficient is considered to be conduction limited, with infinite heat transfer capability at the surface. Thus, HTC=1/R=1/(t/k). See plant basedeck calculations.	Btu/secft^2 degF
406	SG_V2_ACTIVE	Input	SG			T/H Dimension	RE	2	Volume in region 2 to cover tubes. This is a plant dependent variable based on physical plant dimensions. The evaporator fluid volume at the level of the top of the tubes is the required value. There are parameter values available for each SG design type. See plant basedeck calculations.	Ft^3
409	TAURC1	Input	SG			T/H Dimension	RE		Time constant on SG recirculation flow W23. Used in conjunction with SGS_TAURCI_TUNE. Used always. CENTS applies a time constant to the SG recirculation flow (SGS_W23). TAURC1 is the time constant, and SGS_TAURC1_TUNE is a multiplying tuning factor on that time constant. The time constant formed by the product TAURC1 * SGS_TAURC1_TUNE is dependent on plant data, within the definition of the overall model. Its best value is usually determined by tuning. This is usually done by comparing the SG downcomer level trace immediately following scram against available plant data, and tuning this and other parameter until a good match is obtained. (The SGS model has more tuning factors that affect the circulation and recirculation flows than is necessary. Therefore, the usual practice is to tune SGS_TAURC1_TUNE and SGS_FK3_TUNE together, and SGS_TAURC2_MAX to a lesser extent)	Seconds
413	VOLSGS	Input	SG			Dimension	RE	2	SG volume to main steam isolation valve. This is a plant dependent variable calculated to include the entire secondary side SG fluid volume + the volume of the steam line up to the main steam isolation valve. There are parameter values available for each SG design type. See plant basedeck calculations.	Ft^3
415	W32_FLOW_COEFF	Input	SG			T/H Dimension	RE	4	Downcomer to tube bundle flow coefficient, 100% steady state. This is a plant dependent variable = W32*(rho3*L3-rho2*L2)$^{0.5}$, where the downcomer is 3 and the evaporator is 2. It can be calculated to establish a preliminary value. However, the final basedeck value is always determined by tuning to achieve the correct recirculation ratio in the various SG nodes. This variable is usually tuned in conjunction with ASEP_SG. Normally all the SGs of a given design within the plant have the same final tuned value for this parameter. But, it is possible to tune each SG individually if specific SG data is available. See plant basedeck calculations.	Ft/s*SQRT(lbm)
416	SG_REF_LEGS	Partition					RE	18	SG level measurement taps	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
417	SG_REF_NUM	Input	SG			Component Design	IN	2	Number of level instrum. reference legs. This is a plant dependent variable. It indicates how many different SG level indication systems are in each of the two possible SG designs.	Counts
418	SG_REF_BOT	Input	SG			Dimension	RE	2, 3	Lower tap height above tubesheet (design, leg#). These are plant dependent variables. The first two numbers are the height for leg #1(e.g. Narrow Range) for each SG design. The next two numbers are the height for leg #2 (e.g. Wide Range) for each SG design. The last two numbers are for the height of leg #3 for each SG design.	Feet
419	SG_REF_TOP	Input	SG			Dimension	RE	2, 3	Upper tap height above tubesheet (design, leg#). These are plant dependent variables. The first two numbers are the height for leg #1(e.g. Narrow Range) for each SG design. The next two numbers are the height for leg #2 (e g. Wide Range) for each SG design. The last two numbers are for the height of leg #3 for each SG design.	Feet
420	TAU_REFLG_DN	Input	SG			T/H Dimension	RE	2	SG level measurement instrumentation reference leg time constant during cooldown. Used always. This is a time constant for the temperature of the SG reference leg, when the leg is cooling down. (TAU_REFLG_UP applies when the leg is heating up.) The reference leg temperature (SGS_TREFLG) responds to the local containment temperature (CONT_SG_TEMP), and determines the fluid density and the head in the leg. Thus the temperature has an effect (albeit small) on the measured SG downcomer level, which is used by the control systems. (The dimension accommodates two plant designs.) This time constant is dependent on the instrumentation system design of the simulated plant. Normally, the effect of this time constant is nil, since CONT_SG_TEMP is an input constant for each SG, and SGS_TREFLG is set equal to it at initialization. Therefore, an effect will be seen only if the user changes the containment temperature during the transient.	Seconds

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
421	TAU_REFLG_UP	Input	SG			T/H Dimension	RE	2	SG level measurement instrumentation reference leg time constant during heatup. Used always. This is a time constant for the temperature of the SG reference leg, when the leg is heating up. (TAU_REFLG_DN applies when the leg is cooling down.) The reference leg temperature (SGS_TREFLG) responds to the local containment temperature (CONT_SG_TEMP), and determines the fluid density and the head in the leg. Thus the temperature has an effect (albeit small) on the measured SG downcomer level, which is used by the control systems. (The dimension accommodates two plant designs.) This time constant is dependent on the instrumentation system design of the simulated plant. Normally, the effect of this time constant is nil, since CONT_SG_TEMP is an input constant for each SG, and SGS_TREFLG is set equal to it at initialization. Therefore, an effect will be seen only if the user changes the containment temperature during the transient.	Seconds
422	SG_TUBE_AREA	Input	SG			Dimension	RE	2	SG tube internal flow area, one tube. This is a plant dependent variable. It represents the standard leak area for a SG tube rupture. For each tube ruptured (MAL_SGTR is the input number of ruptured tubes), there are two broken ends. CENTS treats these two ends as separate breaks, with different flow enthalpies and flow fluxes, and with each presenting a break area SG_TUBE_AREA * RCS_SGTR_FLOWMULT. Reference 1, Section 7.5 2.	Ft^2
423	ELEV_TUBE_SHEET	Input	SG	RCS		Dimension	RE	4	Tubesheet elevation above common reference. This is a plant dependent variable.	Feet
424	SG_ECONOMIZER	Input	SG			Flag	LO		SG economizer: T=exist, F=none. This is a plant dependent variable, set to True if the SG design includes an economizer, False otherwise.	True False
425	PLT_SGS_HEAT	Partition	SG				RE	70	SG data constants - SG heat transfer	Partition
426	ATUBES_MAX_CS	Input	SG	RCS		Dimension	RE	2	Primary flow area through tubes. This is a plant dependent variable. It equals the cross-sectional flow area of one tube * the number of unplugged tubes being modeled. Normally, this value is set with zero tubes plugged. Thus, there would be a value for each design type. The individual SG flow area is adjusted (for tube plugging) by using the multiplier SGT_Q_MULT for each SG.	Ft^2
427	ATUBES_MAX_HT	Input	SG			Dimension	RE	2	SG tubes heat transfer area. This is a plant dependent variable. It equals the secondary side surface area (in contact with water/steam) of all the tubes. Normally, this value is calculated with zero tubes plugged. The calculation is perimeter * avg. length of a tube * No of tubes. Thus, there would be a value for each design type. The individual SG heat transfer area is adjusted (for tube plugging) by using the multiplier SGT_Q_MULT for each SG.	Ft^2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
429	QSG_TBL	Input	SG			T/H Dimension	RE	20	Rosenow heat flux vs dT table, B/hr-ft2. Used always, in conjunction with TMP_TBL. These two arrays make up the Rosenow correlation of heat flux (QSG_TBL, Btu/hr-ft2) vs. temperature difference (TMP_TBL, degF). This correlation table is entered with the independent variable:delta-T = <local tube metal temp> - <evaporator coolant temp> to produce the correlation heat flux (CF). The secondary-side local heat transfer coefficient is, then: HTCOF = CF / delta-T * (SGS_P/14.7)**0.4 Btu/degF-hr-ft2. These arrays are a correlation that is independent of plant design.	Composite Units
430	TMP_TBL	Input	SG			T/H Dimension	RE	20	Delta temperature for Rosenow heat flux table. Used always, in conjunction with QSG_TBL. These two arrays make up the Rosenow correlation of heat flux (QSG_TBL, Btu/hr-ft2) vs. temperature difference (TMP_TBL, degF). This correlation table is entered with the independent variable:delta-T = <local tube metal temp> - <evaporator coolant temp> to produce the correlation heat flux (CF). The secondary-side local heat transfer coefficient is, then: HTCOF = CF / delta-T * (SGS_P/14.7)**0.4 Btu/degF-hr-ft2. These arrays are a correlation that is independent of plant design.	Del-degF
431	RTUBES	Input	SG			T/H Dimension	RE	2	Thermal resistance of SG tubes. This is a plant & SG design dependent variable. It depends on the conductivity and thickness of the SG tube metal. Rtubes=(Do/(2k))*ln(Do/Di). During plant tuning to achieve the correct SG pressure to match referenced data, the multipliers sgt_htcrtc & sgt_htcrth are adjusted. This is essentially modifying Rtubes. See plant basedeck calculation.	Sec-ft^2-degF/Btu
432	SGMTCP	Input	SG			T/H Dimension	RE	2	Total heat capacity of tubes. This is a plant & SG design dependent variable = Mass of SG tubes * specific heat capacity of the metal, at normal operating conditions. The value for this variable is independent of tube plugging because the tube metal can adsorb or absorb heat during transient conditions regardless of whether it is plugged. See plant basedeck calculation.	Btu/degF
433	SGT_HYD_DIAM	Input	SG	RCS		T/H Dimension	RE	2	Hydraulic diameter of SG tubes primary flow. This is a plant & SG design dependent variable = inside diameter of a SG tube. See plant basedeck calculation.	Feet
434	SG_HCONV	Input	SG			T/H Dimension	RE		Convective htc outside SG wall. This is a plant dependent variable which depends upon the "effectiveness" of the SG insulation. This is often not well documented, thus assumptions are usually made to set heat transfer to a low value (1BTU/hr.ft^2.degF). See plant basedeck calculation.	Btu/secft^2 degF
435	SG_RWALL	Input	SG			T/H Dimension	RE	2	Thermal resistance of SG wall. This is a plant & SG design dependent variable =thickness/conductivity at normal operating conditions. See plant basedeck calculation.	Sec-ft^2-degF/Btu
436	WALL_AREA	Input	SG			Dimension	RE	2	SG surface area for heat loss to containment. This is a plant & SG design dependent variable. The surface area included is the secondary side SG shell. See plant basedeck calculation.	Ft^2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
437	WALL_MCP	Input	SG			T/H Dimension	RE	2	SG wall heat capacity. This is a plant & SG design dependent variable = Mass * density * specific heat at normal operating conditions. The mass included is the secondary side SG shell. See plant basedeck calculation.	Btu/degF
439	PLT_SGS_MSLH	Partition					RE	240	SG data constants - steamline & header.	Partition
440	ASL_MAX	Input	MSL			Dimension	RE	2, 2	Steamline flow area (design,line). This is a plant & SG design dependent variable. Up to two lines as well as two SG designs are allowed. Thus the 2 x 2 matrix of values for this variable. This is the main line flow area; flow restrictions are specified separately via ASL_MIN and MSLH_AFRSL. Reference 1, Section 7.5 2.	Ft^2
441	HA_WALLI_MSLH	Input	MSL			T/H Dimension	RE		Inside MSLH wall heat transfer hA. This is a plant dependent variable. The heat transfer coefficient, h = hDB (Dittus-Boelter correlation). The area, A = length * inside perimeter of the piping. See plant basedeck calculation	Btu/sec-degF
442	HA_WALLO_MSLH	Input	MSL			T/H Dimension	RE		Outside MSLH wall heat transfer hA. This is a plant dependent variable. The heat transfer coefficient is based upon insulation quality and thickness and tightness. It is often assumed , h = 65 Btu/hr.ft^2 * delT , where delT is approx. 400 F. The area, A = length * outside perimeter of the piping See plant basedeck calculation.	Btu/sec-degF
443	MCP_WALL_MSLH	Input	MSL			T/H Dimension	RE		Total heat cap of MSLH pipe wall. This is a plant dependent variable. The heat capacity = wall mass * specific heat . See plant basedeck calculation.	Btu/degF
444	SLI_FLOW_COEFF	Input	MSL			T/H Dimension	RE	8	Flow coefficient, steam nozzle to MSIV, at 100%. This is a plant dependent variable = A*sqrt(2*g*144*/K). The line loss coefficient, K, is calculated from known pressure drops at a given steam flow rate and pressure. The area, A, is ASL_MAX. See plant basedeck calculation.	Composite Units
445	SLO_FLOW_COEFF	Input	MSL			T/H Dimension	RE	8	Flow coefficient, MSIV to header, at 100% This is a plant dependent variable = sqrt(2*g*144/K). The line loss coefficient, K, is calculated from known pressure drops at a given steam flow rate and pressure. Note that the definition for this variable differs from SLI_FLOW_COEFF because line area is not included. See plant basedeck calculation.	Composite Units
447	VEL100	Input	MSL			T/H Dimension	RE	8	Steamline velocity at 100% flow. This is a plant dependent variable = (mass flow rate per line)/(steam density * line area). The mass flow rate and density can either be calculated from plant design power conditions or by iteration with CENTS trial runs and tuning. See plant basedeck calculation.	Ft/sec
448	VOL_MSLH	Input	MSL			Dimension	RE		Header and SL volume from MSIV to turb stop. This is a plant dependent variable = sum of line areas * lengths for all unisolable steam line piping from the MSIVs to the Turbine Stop Valves. This variable is important during transients where secondary steam pressure is changing. This volume capacity acts to slow the pressure changes by acting as an "accumulator". See plant basedeck calculation.	Ft^3

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
449	MSLB_AREA	Input	MSL	SG		Dimension	RE		Standard area for main steamline breaks. This is a transient dependent variable that should be set (or at least checked) by the USER. The area for steam line break is for a slot break. A double ended guillotine break should be modelled by setting the break area to a large number > 2* line area. Anything less than a very large number will act more like a slot break, where the various SGs are "competing" for steam flow, based on the pressure drops from each SG to the break.	Ft^2
450	MSLH_MSIV_AMAX	Input	MSL			Dimension	RE	2, 2	MSIV full-open flow area (design,line). This is a plant & SG design dependent variable. It is used during transients where the valves may close to determine when during the closing sequence that choke flow conditions may exist.	Ft^2
451	MSLH_MSIV_BYPASS_AMAX	Input	MSL			Dimension	RE	2, 2	MSIBV full-open flow area (design,line). This is a plant & SG design dependent variable. It is used during transients where the bypass valves may be open and the MSIVs are closed. This variable is used in the calculation of steam line flow rates and pressure drops for that plant condition. Normally, for standard safety analysis, the bypass valves are assumed to be shut.	Ft^2
452	MSLH_VALVE_AMAX	Input	MSL			Dimension	RE	50	Steamline ext valves full open flow areas. These are plant dependent variables. The full open valve area for the ADVs, MSSVs, turbine bypass & dump valves and the Turbine Admission Valve are normally modeled for the steam lines. Usually, the size of these valves is determined by calculation based upon known flow rates and design conditions. The CRITCO critical flow correlation is then used to back out an effective full open valve area. See plant basedeck calculation.	Ft^2
453	MSLH_VALVE_INLET	Input	MSL			Plant Design	IN	50	Steamline ext valves upstream region. These are plant dependent variables. This pointer indicates what region of the steam line is associated with the valve "entrance". The numbering scheme is based upon the number of steam lines/per SG * No. of SGs + the steam header. The highest number refers to the header and the lower numbers each refer to an individual steam line (upstream of the MSIV). Reference 1, Section 7.3.3.	Pointer
454	MSLH_VALVE_EXIT	Input	MSL			Plant Design	IN	50	Steamline ext valves downstream regions. These are plant dependent variables. This pointer indicates what region of the steam line is associated with the valve "exit". 1= atmosphere, 2= condenser, 3=containment, 4= turbine. Reference 1, Section 7.3 3.	Pointer
455	MSLH_VALVE_NUM	Input	MSL			Plant Design	IN		# of steamline external valves <50-NUM_SG*NUM_SL. This is a plant dependent variable. It represents the sum of all the ADVs, MSSVs, Turbine bypass & dump valves and TAV modeled in the basedeck. Note it does not include the MSIVs or MSIV bypass valves which are considered "internal" valves.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
456	P_ATMOSPHERE	Input	MSL			T/H State	RE		Atmospheric pressure. This is a plant independent variable, though it may be adjusted slightly by the USER for different scenarios. It determines the expected backpressure for all MSLH valves which exit to atmosphere.	Psia
457	MSLH_TATM	Input	MSL			T/H State	RE		Atmospheric temperature at MSLH. This is a plant independent variable, though it may be adjusted by the USER for different scenarios. It is used to determine the dTemp for steam line wall heat transfer.	Degree F
458	SLI_CHECK_VALVE	Input	MSL			Plant Design	LO	2, 2	Steamline check valve: Yes (True)/No (False) (design,line). This is a plant dependent variable. Certain plants have an in-line check valve in their steam line, usually associated with the MSIV. This valve is intended to quickly shut should an accident condition exist which would cause reverse steam flow (i.e. an MSLB).	True False
459	SLI_DP100	Input	MSL			T/H Dimension	RE	8	Pressure drop, steam nozzle to MSIV, at 100% power. This is a plant dependent variable. If K_i is known, this may be calculated as (mass flow rate)^2 / (steam density) * K_i / (2*g*144*A^2) or it may be given directly from a reference. See plant basedeck calculation	Psid
460	SLO_DP100	Input	MSL			T/H Dimension	RE	8	Pressure drop, MSIV to header, at 100%. This is a plant dependent variable. If K_o is known, this may be calculated as (mass flow rate)^2 / (steam density) * K_o / (2*g*144*A^2) or it may be given directly from a reference. See plant basedeck calculation.	Psid
461	ASL_MIN	Input	MSL	SG		Dimension	RE	2, 2	Steamline restrictor minimum flow area (design,line) between the SG nozzle and the MSIV, or between the SG nozzle and the break if the steamline has a break (MSLB). This is a plant dependent variable. It becomes important when an excess steam demand event is in progress, particularly a MSLB where critical flow conditions exist in the steam lines. This parameter can be set to the SG nozzle flow area when the MSLB is at the SG outlet nozzle. It can be adjusted by the code USER to be whatever the smallest flow area is between SGs and critical flow point. (See also MSLH_AFRSL.) Reference 1, Section 7.5 2.	Ft^2
462	NUM_SL	Input	MSL			Plant Design	IN		Number of steamlines per steam generator. This plant dependent variable tells CENTS how many entries are required in the various MSLH variable arrays.	Counts
463	PLT_SGS_FWS	Partition					RE	225	SG data constants - main & aux feedwater	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
464	FW_COEFF	Input	FW			T/H Dimension	RE	4	FW coeff at 100%. used for NUM_FWS_PUMPS=0 only. This input is used only during a FW line break to determine the pressure drop from the SG to the break location (usually set at the check valve location by setting FWLB_LOCATION = 0.0). The flow coefficient is determined by knowing the pressure drop from the valve to the SG for a given flow and temperature condition. $FW\_COEFF=((Mdot^2 * sp.vol.)/delP)^{0.5}$. See basedeck calculation. The pressure at the break point for the feedline break flow calculation is calculated as follows: $Pbreak = Psg - Frac*W^2/(rho* Fw\_coeff^2)$ Where: Psg = Pressure at the SG nozzle (psia) rho = Feedline break flow density (lbm/ft3 W = Feed line break flow from the SG (lbm/sec) Frac = Fraction distance from the SG nozzle to the Feedwater check valve.	Composite Units
465	FWS_FLOW100	Input	FW			T/H Dimension	RE	4	Feedwater flow at 100% power, each SG. This input parameter is used by CENTS to calculate several variable concerning SG recirculation and masses in the downcomer and evaporator. See plant basedeck calculation.	Lbm/sec
466	WFW100	Input	FW			T/H Dimension	RE		Feedwater flow at 100% power, all SGs. This is the sum of FWS_FLOW100( ). This variable is not used by the code, and needs to be input only if accessed by controllers. See plant basedeck calculation.	Lbm/sec
467	FWLB_AREA	Input	FW	SG		Dimension	RE		Standard area for feedwater line breaks. This break size is scenario dependent. It is set by the USER, usually during parametrics to determine the limiting event. Note that this break area is seen by CENTS as the area available for critical backflow from the affected SG. The "real" break size would be larger, because FW flow would also be exiting via the break.	Ft^2
468	FWS_NOZ_HEIGHT	Partition					RE	2, 3	Feedwater nozzle heights	Partition
469	HTNOZ	Input	FW	SG		Dimension	RE	2	Height of downcomer feedwater nozzle. This is a plant & SG design dependent variable. The heights are referenced to the top of the tube sheet.	Feet
470	HTNOZ_ECON	Input	FW	SG		Dimension	RE	2	Height of economizer feedwater nozzle. This is a plant & SG design dependent variable. The heights are referenced to the top of the tube sheet. It is only applicable to plants having economizers in their SGs.	Feet
471	HTNOZ_EFW	Input	FW	SG		Dimension	RE	2	Height of aux. feedwater nozzle. This is a plant & SG design dependent variable. The heights are referenced to the top of the tube sheet. For many designs, the auxiliary FW enters via the downcomer feed ring which would make it equal to HTNOZ.	Feet
472	NUM_FWS_PUMPS	Input	FW			Plant Design	IN		Number of feedwater pumps (max 4). A value greater than 0 turns on the detailed feedwater network model.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
490	FWS_LINE_VOLUMES	Input Partition					RE	4, 2	FW line volumes downstream of valves. Required if NUM_FWS_PUMP > 0.	Ft^3
491	FWS_VOL	Input	FW			Dimension	RE	4	FW line volume after downcomer valve. Required if NUM_FWS_PUMP > 0.	Ft^3
492	FWS_ECON_VOL	Input	FW			Dimension	RE	4	FW line volume after economizer valve. Required if NUM_FWS_PUMP > 0.	Ft^3
496	NUM_AFW_PUMPS	Input	FW			Plant Design	IN		Number of AFW pumps (max 4)	Counts
497	PLT_SGS_SGBD	Partition					RE	30	SG data constants - SG blowdown system	Partition
498	SGBD_ACROSS	Input	SG	SGBD		Dimension	RE		Cross section area of SGBD tank. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Ft^2
499	HA_WALLI_SGBD	Input	SG	SGBD		T/H Dimension	RE		Inside SGBD tank heat transfer hA. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Btu/sec-degF
500	HA_WALLO_SGBD	Input	SG	SGBD		T/H Dimension	RE		Outside SGBD tank heat transfer hA. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Btu/sec-degF
501	MCP_WALL_SGBD	Input	SG	SGBD		T/H Dimension	RE		Total heat cap of SGBD tank wall. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Btu/degF
502	SGBD_VOL	Input	SG	SGBD		Dimension	RE		SGBD tank volume. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Ft^3
503	SGBD_SG_COEFF	Input	SG	SGBD		T/H Dimension	RE	8	Partition of flow coefficients, blowdown nozzles to tank.	Partition
504	SGBD_SURF_COEFF	Input	SG	SGBD		T/H Dimension	RE	4	Flow coeffs, surface blowdown nozzles to tank. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Composite Units
505	SGBD_BOT_COEFF	Input	SG	SGBD		T/H Dimension	RE	4	Flow coeffs, bottom blowdown nozzles to tank. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Composite Units
506	SGBD_SG_HTNOZ	Input	SG	SGBD		Dimension	RE	4	Partition of elevations of SG blowdown nozzles above tubesheet.	Partition
507	SGBD_SURF_HTNOZ	Input	SG	SGBD		Dimension	RE	2	Elevations of SG surface blowdown nozzles above tubesheet. Dimensioned on SG design (SG_DESIGN). Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
508	SGBD_BOT_HTNOZ	Input	SG	SGBD		Dimension	RE	2	Elevations of SG bottom blowdown nozzles above tubesheet. Dimensioned on SG design (SG_DESIGN). Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Feet
509	SGBD_OUT_HTNOZ	Input	SG	SGBD		Dimension	RE	2	Hts above bottom, 2 BD tank outlet nozls. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Feet
510	SGBD_OUT_COEFF	Input	SG	SGBD		T/H Dimension	RE	2	Flow coeffs, 2 BD tank outlet nozzles. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Composite Units
511	SGBD_RELIEF_AMAX	Input	SG	SGBD		Dimension	RE		Bd tank relief valve full-open flow area. Not currently Used. To be used, all the blowdown system inputs would require appropriate values and the blowdown system would require activation by setting MOD_OFF_SGBD =. F.	Ft^2
512	PLT_SGS_MSLH2	Partition	MSLH				RE	40	SG data constants - enhanced steam line header model.	Partition
513	NUM_MSLH	Input	MSLH				IN		Number of MSLH nodes = 1 or 2. The one header model is chosen (MUM_MSLH=1) if shutting the Turbine Stop Valve (TSV) has no effect on the steam flow between SGs or from the intact SG to a break. If, however, shutting the TSV affects the flow rate between one steam line and the other, then the two-header model should be chosen (NUM_MSLH=2).	Counts
514	MSLH_AFRSL	Input	MSLH				RE	8	Steamline minimum flow area (i.e., flow restrictor) between the MSIV and the steamline header, or between the break and the header if the steamline has a break (MSLB). Any restrictions in line size, such as a flow measuring venturi, can be indicated by this parameter. This becomes important when an excess steam demand event is in progress, particularly a MSLB where critical flow conditions exist in the steam lines. If MSLH_AFRSL is 0.0, then it is treated as equal to ASL_MAX. (See also ASL_MIN.)	Ft^2
515	MSLH_FKBRK	Input	MSLH				RE	8	Steamline K-factor (flow resistance) from SG to the steamline break (MSLB) location. CENTS uses this line loss factor, in conjunction with the steamline flow coefficients, to calculate the pressure drops and flow balances from each SG to the break. This value must be less than the total flow resistance from the SG to the header node. If MSLH_FKBRK is 0.0, then the break location defaults to the equivalent of SLI_FLOW_COEFF, and a message is issued.	Composite Units
516	MSLH_ACROSS	Input	MSLH				RE		Steamline header cross tie flow area when the TSVs are shut (Turbine tripped). This variable, in conjunction with the cross tie k-factor and the line flow coefficients, determine the steam flow from one steam line to other(s) by calculating the pressure balance in the steam lines. It is only used when the 2-header model option is chosen.	Ft^2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
517	MSLH_ACROSST	Input	MSLH				RE		Steamline header cross tie flow area with the turbine available. This variable, in conjunction with the cross tie k-factor and the line flow coefficients, determine the steam flow from one steam line to other(s) by calculating the pressure balance in the steam lines. It is only used when the 2-header model option is chosen.	Ft^2
518	MSLH_FKCROSS	Input	MSLH				RE		Steamline header cross tie flow resistance k-factor when TSVs are shut (turbine tripped). This variable, in conjunction with the cross tie line area and the line flow coefficients, determine the steam flow from one steam line to other(s) by calculating the pressure balance in the steam lines. It is only used when the 2-header model option is chosen.	Composite Units
519	MSLH_FKCROSST	Input	MSLH				RE		Steamline header cross tie flow resistance k-factor with the turbine on-line. This variable, in conjunction with the cross tie line area, the header flow area and the line flow coefficients, determine the steam flow from one steam line to other(s) by calculating the pressure balance in the steam lines. It is only used when the 2-header model option is chosen.	Composite Units
520	PLT_CTL	Partition					RE	20700	Control module variables	Partition
521	CTL_CONTROLLER_NUMBERS	Partition					IN	150	Controller numbers. Reference 2	Partition
522	CTL_AFWS_CONTROLLERS	Input	Control	AFWS		Model Design	IN	4	AFWS flow controller number. This array is the numbers of the controllers which affect flow rate of AFW to the SGs. NUM_SG entries are required. Reference 2.	Pointer
523	CTL_CEA_CONTROLLER	Input	Control	CORE	RCS	Model Design	IN		Control rod speed controller number. This variable is the number of the controller which calculates the control rod motion (non-scram). It is required even if the control rod motion is not modeled. Reference 2.	Pointer
524	CTL_CHGS_CONTROLLERS	Input	Control	CVCS	RCS	Model Design	IN	4	Charging pump controller numbers. This array is the numbers of the controllers which affect flow rate from charging pumps to the RCS NUM_CHGS_PUMPS entries are required. Reference 2.	Pointer
525	CTL_FWS_CONTROLLERS	Input	Control	FWS		Model Design	IN	4	Main feedwater flow controller numbers. This array is the numbers of the controllers which affect flow rate of MFW to the SGs. NUM_SG entries are required. Reference 2.	Pointer
526	CTL_FWS_ECON_CONTROLLERS	Input	Control	FWS		Model Design	IN	4	Economizer FW valve controller numbers. This array is the numbers of the controllers which affect flow rate of MFW to the SGs, via the economizer. NUM_SG entries are required if SG_ECONOMIZER is True. Reference 2.	Pointer
527	CTL_FWS_PUMP_CONTROLLERS	Input	Control	FWS		Model Design	IN	4	Main FW pumps speed controller numbers. Reference 2.	Pointer
528	CTL_FWS_TRIP_CONTROLLER	Input	Control	FWS		Model Design	IN		Main feedwater trip controller number. Reference 2.	Pointer
529	CTL_HEATER_CONTROLLERS	Input	Control	PZR	RCS	Model Design	IN	2	Pressurizer heater controller numbers: proportional, backup. This array is the numbers of the controllers which affect operation / energizing of the heaters. Both entries are required. Reference 2.	Pointer

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
530	CTL_LETDOWN_CONTROLLERS	Input	Control	CVCS	RCS	Model Design	IN	4	Letdown flow controller numbers. This array is the numbers of the controllers which affects flow rate from the RCS via the letdown system. RCS_NUMOUT_LDNS entries are required. Reference 2.	Pointer
531	CTL_MSIV_CONTROLLERS	Input	Control	MSL		Model Design	IN	8	MSI valve controller numbers. This array is the numbers of the controllers which affect operation of the various MSIVs, usually during a transient which results in an MSIS condition. NUM_SG*NUM_SL entries are required Reference 2.	Pointer
532	CTL_MSIS_TRIP_CONTROLLER	Input	Control	SG	MSL	Model Design	IN		MSI signal controller number. This variable is the number of the controller which determines whether the conditions exist for a Main Steam Isolation signal. This variable is required. Reference 2.	Pointer
533	CTL_MSLH_CONTROLLERS	Input	Control	MSL		Model Design	IN	50	MSLH valve controller numbers. Each valve in the MSLH system is controlled by its own separate valve controller which determines the fraction open for the valve. The pointers in this array determine which controller affects which valve's position. The order is the same as for MSLH_VALVE_AMAX, .. _INLET, .._EXIT. MSLH_VALVE_NUM entries are required. Reference 2.	Pointer.
534	CTL_PORV_CONTROLLERS	Input	Control	PZR	RCS	Model Design	IN	4	Pressurizer PORV controller numbers. Each valve is controlled by its own separate valve controller which determines the fraction open for the valve. The pointers in this array determine which controller affects which valve's position. RCS_NUM_PORVS entries are required. Reference 2.	Pointer
535	CTL_PSV_CONTROLLERS	Input	Control	PZR	RCS	Model Design	IN	4	Pressurizer safety valves controller numbers. Each valve is controlled by its own separate valve controller which determines the fraction open for the valve. The pointers in this array determine which controller affects which valve's position. RCS_NUM_SAFETYVLVS entries are required. Reference 2.	Pointer
536	CTL_RPS_CONTROLLERS	Input	Control	RCS		Model Design	IN	20	RPS channel controller numbers. Each reactor protection system function is controlled by its own separate controller which determines the corresponding trip channel status. The pointers in this array determine which controller affects which protection system function/channel. The channels so identified are used to energize the appropriate signal in the output array CTL_CORE_TRIP_SIG after scram, but they have no effect on the scram function. Reference 2.	Pointer
537	CTL_SIAS_TRIP_CONTROLLER	Input	Control	RCS		Model Design	IN		SIAS trip controller number. This variable is the number of the controller which determines whether the conditions exist for a Safety Injection Actuation signal. This variable is required. Reference 2.	Pointer
538	CTL_SPRAY_CONTROLLERS	Input	Control	RCS	PZR	Model Design	IN	2	Pressurizer spray controller numbers. This array is the numbers of the controllers which affect operation of the pressurizer main spray valves. Each valve is controlled by its own separate valve controller which determines the fraction open for the valve. RCS_NUM_MSPRAYVLVS entries are required. Reference 2.	Pointer

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
539	CTL_T_AVG_CONTROLLER	Input	Control	RCS		Model Design	IN		Controller number for loop average temperature. This variable is the number of the controller which calculates the RCS average temperature. This is intended to be part of the control systems for (as applicable): Turbine Runback/Setback, Steam Dump & Bypass, Pressurizer Level, Reactor Regulating System, or others as required. This variable is optional. Reference 2.	Pointer
540	CTL_T_REF_CONTROLLER	Input	Control	RCS		Model Design	IN		Controller number for demand reference temperature. This variable is the number of the controller which calculates the RCS reference temperature as a function of power. This is intended to be part of the control systems for (as applicable): Turbine Runback/ Setback, Reactor Regulating System, or others as required. This variable is optional. Reference 2.	Pointer
541	CTL_TURB_TRIP_CONTROLLERS	Input	Control	MSL		Model Design	IN	2	Turbine trip controller numbers (trip/close). Element 1 of this array is the number of the controller which determines whether the conditions exist for a Turbine Trip signal. Element 2 of this array is the number of the controller which determines the turbine valve (admission/stop) position immediately following a Turbine Trip. Both entries are required. Reference 2.	Pointer
542	CTL_CORE_TRIP_CONTROLLER	Input	Control	RCS	CORE	Model Design	IN		Core trip controller number. This variable is the number of the controller which determines whether the conditions exist for a Reactor Trip signal This variable is required. Reference 2.	Pointer
543	CTL_POWER_CUTBACK_CONTROLLER	Input	Control	RCS	CORE	Model Design	IN		Reactor power cutback controller number. This variable is the number of the controller which determines whether the conditions exist for a Reactor Power Cutback signal. This variable is not required, unless a Cutback signal is to be modeled. Reference 2.	Pointer
544	CTL_TURB_SETBACK_CONTROLLER	Input	Control	RCS	MSL	Model Design	IN		Turbine setback controller number. This variable is the number of the controller which determines whether the conditions exist for a Turbine Setback signal. This variable is not required, unless a Setback signal is to be modeled. Reference 2.	Pointer
545	CTL_TURB_RUNBACK_CONTROLLER	Input	Control	RCS	MSL	Model Design	IN		Turbine runback controller number. This variable is the number of the controller which determines whether the conditions exist for a Turbine Runback signal. This variable is not required, unless a Runback signal is to be modeled. Reference 2.	Pointer
546	CTL_PRZR_LVL_ERR_CONTROLLER	Input	Control	PZR	RCS	Model Design	IN		Pressurizer level error calculation controller number. This variable is the number of the controller which calculates the deviation of the pressurizer level from the program level. This variable is optional. Reference 2.	Pointer
547	CTL_PRZR_PROG_LVL_CONTROLLER	Input	Control	PZR	RCS	Model Design	IN		Pressurizer program level controller number. This variable is the number of the controller which calculates the correct pressurizer program level should be, based on power level. This variable is optional Reference 2.	Pointer
548	CTL_FWS_BYPS_CONTROLLERS	Input	Control	FWS		Model Design	IN	4	FWS bypass valve controller number. This array is the numbers of the controllers which affect bypass valve demand signal. NUM_SG entries are required if bypass valve is modeled. Reference 2.	Pointer

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
549	CTL_FWS_ISOL_CONTROLLERS	Input	Control	FWS		Model Design	IN	4	FWS isolation valve controller number. This array is the numbers of the controllers which affect FWS isolation valve position. NUM_SG entries are required if FWS isolation valves modeled. Reference 2.	Pointer
550	CTL_AFWS_VALVE_CONTROLLERS	Input	Control	AFWS		Model Design	IN	14	AFWS control valve controller number. This array is the numbers of the controllers which affect the demand signal of the AFWS flow control valves. Reference 2.	Pointer
551	CTL_ATM_DUMP_NUM	Input	Control	MSL		Model Design	IN		Number of MSLH atm. dump valves. This is a plant dependent number. It tells CENTS how many ADVs there are in the MSLH system. The ADVs are defined by the controller system in conjunction with CTL_ATM_DUMP_PATH which dictates which MSLH path numbers represent the valves and CTL_MSLH_CONTROLLERS which determine the controllers which operate the valves. Reference 1 Section 7.3.3, and Reference 2.	Counts
552	CTL_ATM_DUMP_PATH	Input	Control	MSL		Model Design	IN	10	Path number for MSLH atm. dump valve. This is a plant dependent number. It tells CENTS which MSLH path numbers represent the valves. The ADVs are defined by the controller system in conjunction with CTL_ATM_DUMP_NUM, how many ADVs there are in the MSLH system, and CTL_MSLH_CONTROLLERS which determine the controllers that operate the valves. Reference 1 Section 7.3 3, and Reference 2.	Pointer
553	CTL_TAV_NUM	Input	Control	MSL		Model Design	IN		Number of turbine admission valves (TAV). This is a plant dependent number. It tells CENTS how many TAVs there are in the MSLH system. The TAVs are defined by the controller system in conjunction with CTL_TAV_PATH which dictates which MSLH path numbers represent the valves and CTL_MSLH_CONTROLLERS which determine the controllers which operate the valves. Reference 1 Section 7.3.3, and Reference 2.	Counts
554	CTL_TAV_PATH	Input	Control	MSL		Model Design	IN	5	Path number for turbine admission valve(s). This is a plant dependent number. It tells CENTS which MSLH path numbers represent the valves. The TAVs are defined by the controller system in conjunction with CTL_TAV_NUM, how many TAVs there are in the MSLH system, and CTL_MSLH_CONTROLLERS which determine the controllers that operate the valves. Reference 1 Section 7.3.3, and Reference 2.	Pointer
555	CTL_TURB_BYPASS_NUM	Input	Control	MSL		Model Design	IN		Number of turbine bypass valves(TBV). This is a plant dependent number. It tells CENTS how many TBVs there are in the MSLH system. The TBVs are defined by the controller system in conjunction with CTL_TURB_BYPASS_PATH which dictates which MSLH path numbers represent the valves and CTL_MSLH_CONTROLLERS which determine the controllers which operate the valves. Reference 1 Section 7.3.3, and Reference 2.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
556	CTL_TURB_BYPASS_PATH	Input	Control	MSL		Model Design	IN	5	Path number for turbine bypass valve. This is a plant dependent number. It tells CENTS which MSLH path numbers represent the valves. The TBVs are defined by the controller system in conjunction with CTL_TURB_BYPASS_NUM, how many TBVs there are in the MSLH system, and CTL_MSLH_CONTROLLERS which determine the controllers that operate the valves. Reference 1 Section 7 3.3, and Reference 2.	Pointer
557	DBADD	Output (Method A) Input (Method B)	Control			Model Design	IN	100	Offset locations of variables in Common. Always used, with DBCOM. These two arrays tell the Control System (CS) model where to find each variable that is referenced by the input array ELIN. For each variable, DBCOM points to a common block, and DBADD is the offset in the block. Reference 2. • CS Input Method A – Via the Input Processor (CSIP) CSIP initializes DBCOM and DBADD to represent the Correspondence Table (see Reference) – variables typically used by the CS – (a) at the first CONTROL command from CEER if the CS arrays are empty, or (b) following a CONTROL ... CLEAR ... directive. CSIP inserts additional pointer/offset data whenever it finds reference to a variable that is not represented in DBCOM/ DBADD. User input to DBCOM/DBADD is strongly discouraged. • CS Input Method B – Directly to the CS arrays (old method) DBCOM and DBADD are input, to represent the Correspondence Table (see above) and any other variables referenced by the particular CS implementation. These arrays are independent of plant design, except for the possibly unique use of certain variables in a particular plant CS design.	Pointer
558	DBCOM	Output (Method A) Input (Method B)	Control			Model Design	IN	100	Pointers to Common blocks. Always used, with DBADD. These two arrays tell the Control System (CS) model where to find each variable that is referenced by the input array ELIN. For each variable, DBCOM points to a common block, and DBADD is the offset in the block. Reference 2. See Input Method discussion under DBADD, above.	Pointer
559	ELEMS	Output (Method A) Input (Method B)	Control			Model Design	IN	1000	No. of elements per controller. Always used. The number is based upon the design of each controller which is dependent on plant design. In conjunction with ELTYPE & ELIN, the entire configuration of the array of controllers is established. See Reference 2. • CS Input Method A – Via the Input Processor (CSIP): CSIP sets ELEMS for each controller, based on the input to CSIP. • CS Input Method B – Directly to the CS arrays (old method): ELEMS is input directly as part of the Control System basedeck.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
560	ELIN	Output (Method A) Input (Method B)	Control			Model Design	RE	10000	Inputs to controller elements. Always used. This array includes all the setpoints, variable references and inter-element communication used in each of the elements of each controller. These element inputs appear in the array sequentially, from the first element's first input to the last element's last input. In conjunction with ELEMS & ELTYPE, the entire configuration of the array of controllers is established. Reference 2. • CS Input Method A – Via the Input Processor (CSIP): CSIP sets ELIN for each element input, based on the input to CSIP. • CS Input Method B – Directly to the CS arrays (old method): ELIN is input directly as part of the Control System basedeck. Variables are referenced by a numeric pointer which can be found in the Variable Correspondence Table (see Reference).	Pointer
561	ELTYPE	Output (Method A) Input (Method B)	Control			Model Design	IN	3000	Controller element type cues. Always used. This array indicates each element's type (e.g , Add, Mult). In conjunction with ELEMS & ELIN, the entire configuration of the array of controllers is established. Reference 2. • CS Input Method A – Via the Input Processor (CSIP): CSIP sets ELTYPE for each element, based on the input to CSIP. • CS Input Method B – Directly to the CS arrays (old method): ELTYPE is input directly as part of the Control System basedeck.	Pointer
562	GROUPS	Output (Method A) Input (Method B)	Control			Model Design	IN		Total number of controllers. The controller deck for each plant uses a specific number of controllers to define all the required functions and to provide informational controllers. Reference 2. • CS Input Method A – Via the Input Processor (CSIP): CSIP sets GROUPS, based on the input to CSIP. • CS Input Method B – Directly to the CS arrays (old method): GROUPS is input directly as part of the Control System basedeck. CENTS uses GROUPS to determine the actual number of controllers to be expected in a given deck.	Counts
563	NOTAB	Input	Control			Model Design	IN	100	No. of entries in user function table. This provides CENTS with the number of active X vs. Y values in each table. The number of non zero entries in this 30 value array can also be used to see how many active X,Y tables there are. These tables are used by the controllers for various functions such as pressure vs. flow for various pump combinations, etc. A maximum of 30 tables is possible. Reference 2	Counts
564	PTTAB	Input	Control			Model Design	IN	100	Pointer to start of user function table. This variable indicates to CENTS the location of the first value for each X,Y table used by the controllers. Thus, for table #2 or PTTAB (2), a value of 10 would indicate that the first entry for table 2 is XTAB(10) & YTAB(10). A maximum of 30 tables is possible. Reference 2	Pointer

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
565	SEQNCE	Output / Input (Method A) Input (Method B)	Control			Model Design	IN	1000	Order of execution of controllers. This array determines the sequence in which controllers are executed at each time step. This is important and will affect results, since the output of some controllers is used as input to others. Thus, the sequence determines whether any given reference to the output of another controller is "backward" (from the current time step) or "forward" (from the previous step). Reference 2. • CS Input Method A – Via the Input Processor (CSIP): As each controller is defined via the input to CSIP, CSIP inserts the new controller into SEQNCE at the end of the sequence. Following a CONTROL ... ORDER ... directive, CSIP reorganizes this array to optimize the sequence for minimum number of forward references. The User may then adjust the sequence, if necessary. • CS Input Method B – Directly to the CS arrays (old method) : SEQNCE is input directly as part of the Control System basedeck. Care should be taken to avoid forward references.	Pointer
566	XTAB	Input	Control			Model Design	RE	2000	Ind. variable values for user function. This single array of values provides each of the independent variable (X) values for all the X, Y Tables used by the controllers. In conjunction with NOTAB & PTTAB, CENTS determines which values correspond to each table A maximum of 1000 entries is possible for all 30 possible tables, combined. Reference 2	Undefined
567	YTAB	Input	Control			Model Design	RE	2000	Dep. variable values for user function. This single array of values provides each of the dependent variable (Y) values for all the X, Y Tables used by the controllers. In conjunction with NOTAB & PTTAB, CENTS determines which values correspond to each table. A maximum of 1000 entries is possible for all 30 possible tables, combined. Reference 2	Undefined
570	INPED	Input	Control			Model Design	LO		Control system structure display cue. Used in conjunction with INPED_SEQNCE, INPED_PAGE, CTL_DBG(202). The flags INPED and CTL_DBG are always checked These user flags control the CENTS output of GCS controllers' structures and/or their dynamic debug outputs. INPED activates the structure display, and CTL_DBG limits that display to selected controllers. (This method of displaying the controllers structure is an alternative to the CONTROL ... PRINT directive.) CTL_DBG also activates the dynamic debug output of controller calculations when used with INPED=F. These flags are strictly user controls, independent of plant design Reference 2.	True False

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
571	INPED_SEQNCE	Input	Control			Flag	LO		Controller structure display order: T=seqnce, F=input. Used in conjunction with INPED, INPED_PAGE, CTL_DBG(202). Used when INPED is True to determine the order in which controllers' structure is displayed – in the original input order (F), or in the order of execution (T). This flag is strictly a user control, independent of plant design. (The CONTROL ... PRINT directive ignores this flag, displaying the controllers' structure in the original input order.) Reference 2.	True False
572	INPED_PAGE	Input	Control			Model Design	IN		Lines/page in INPED output. 0=no paging. Used in conjunction with INPED, INPED_SEQNCE, CTL_DBG(202). Used when INPED is True to set the requested number of lines per page of structure display (no page breaks if set to 0). This flag is strictly a user control, independent of plant design. (The CONTROL ... PRINT directive ignores this flag, displaying the controllers' structure with no page breaks.) Reference 2.	Counts
573	CTL_DBG	Input	Control			Model Design	LO	1002	Controller cues for edits of structure or dynamic debug. Used in conjunction with INPED, INPED_PAGE, INPED_SEQNCE. The flags INPED and CTL_DBG are always checked. These user flags control the CENTS output of GCS controllers' structures and/or their dynamic debug outputs. INPED activates the structure display, and CTL_DBG limits that display to selected controllers. (This method of displaying the controllers structure is an alternative to the CONTROL ... PRINT directive.) CTL_DBG also activates the dynamic debug output of controller calculations when used with INPED=F. These flags are strictly user controls, independent of plant design. Reference 2.	True False
574	CTL_CONSTS	Partition	Control			Model Design	RE	10	Useful constants	Partition
575	CTL_ZERO	Constant	Control			Model Design	RE		Floating point zero (0.0). This is one of several constants which is used repeatedly in controller file logic. Therefore, a special input variable has been established for it. Its variable correspondence number is 99001. This variable is independent of plant design. Its value cannot be changed. Reference: Modeler's Manual for CENTS Reference 2.	Dimensionless
576	CTL_HALF	Constant	Control			Model Design	RE		Floating point one-half (0.5). This is one of several constants which is used repeatedly in controller file logic. Therefore, a special input variable has been established for it. Its variable correspondence number is 99002. This variable is independent of plant design. Its value cannot be changed. Reference 2.	Dimensionless
577	CTL_ONE	Constant	Control			Model Design	RE		Floating point one (1.0). This is one of several constants which is used repeatedly in controller file logic. Therefore, a special input variable has been established for it. Its variable correspondence number is 99003. This variable is independent of plant design. Its value cannot be changed. Reference 2.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
578	CTL_M_ONE	Constant	Control			Model Design	RE		Floating point minus-one (-1.0). This is one of several constants which is used repeatedly in controller file logic. Therefore, a special input variable has been established for it. Its variable correspondence number is 99004. This variable is independent of plant design Its value cannot be changed. Reference 2.	Dimensionless
579	CTL_LIMITS	Partition	Control			Model Design	IN	10	Dimensioned limits of the control system	Partition
580	ELMAX	Constant	Control			Model Design	IN		Maximum total number of elements in the entire controller array. This array size is independent of plant design. Its value cannot be changed. The current size is 3000 elements.	Counts
581	LSTMAX	Constant	Control			Model Design	IN		Maximum total number of last-values. This array size is independent of plant design. Its value cannot be changed. The current size is 1000 last values.	Counts
582	INMAX	Constant	Control			Model Design	IN		Max total number of controller inputs. This array size is independent of plant design. Its value cannot be changed. The current size is 10000 inputs.	Counts
583	GRPMAX	Constant	Control			Model Design	IN		Maximum number of controller groups. This array size is independent of plant design. Its value cannot be changed. The current size is 1000 groups.	Counts
584	CTLMAX	Constant	Control			Model Design	IN		Dimension of CTL_CONTROLLER_NUMBERS. This array size is independent of plant design. Its value cannot be changed. The current size is 150.	Counts
585	TABMAX	Constant	Control			Model Design	IN		Maximum number of user-defined functions. This parameter is independent of plant design. Its value cannot be changed. The current size is 100 functions.	Counts
586	FCTMAX	Constant	Control			Model Design	IN		Maximum total number of user-defined function table entries. This array size is independent of plant design. Its value cannot be changed The current size is 2000.	Counts
587	CTL_WARN	Input	Control			Flag	IN		User control over the display of Control System warnings (Reference 2): If CTL_WARN = 0, all warning messages are suppressed, except for a reminder at the first time that warning conditions are detected. If CTL_WARN = 1, each warning message appears only once. This is the normal mode. If CTL_WARN = 2, all applicable warning messages appear each time the system undergoes re-preprocessing.	Pointer
588	INPED_FILE	Input	Control			Flag	LO		Control system structure display target: T=output to file, F=display to console. Reference 2	True False
589	CHT_COMMON	Segment					RE	1500	Core heat transfer segment	Segment
590	CHT_INPUTS	Partition					RE	50	Input variables from other models	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
591	CHT_NREGIONS_RAD	Input	Core	CHT		Model Design	IN		Number of radial regions in the fuel pin heat transfer mesh, up to 10. Usually set at N=10. The first N-2 regions are the fuel pellet, the next is the gap, and the last is the clad. This parameter relates to CORE_RAD_OUT & CHT_FRAC_HT_GEN. Used always. It is used in the heat transfer algorithm. Independent of core design. Reference: Individual plant basedeck calculations, and Reference 1, Section 7.1.2.	Counts
592	CORE_RAD_OUT	Input	CORE	RCS		Dimension	RE	10	Outer radii of radial regions of the fuel rod, C.H.T. mesh. The number of entries in this array should equal CHT_NREGIONS_RAD, which is usually set to N=10. The radii are dependent upon the fuel design. The first N-2 mesh regions are concentric regions of the fuel pellet. The N-1'th mesh is the gap region and the N'th is the clad. Reference Individual plant basedeck calculations.	Feet
593	MATTYP	Input	CORE	RCS		Flag	IN	10	Radial fuel rod region material (1/2/3=Fuel/Clad/Gap). This array is used in conjunction with CORE_RAD_OUT & CHT_NREGIONS_RAD. Usually, the first eight mesh regions are established as concentric regions of the fuel pellet. The 9th mesh is the gap region and the 10th is the clad. Reference: Individual plant basedeck calculations.	Pointer
594	CORE_HYD_DIA	Input	Core	CHT		T/H Dimension	RE		Core hydraulic diameter for flow in the active fuel region of the core. Dependent on core design.	Feet
595	FUEL_DENSITY	Input	Core	CHT		Dimension	RE		Density of uranium fuel. This parameter represents the fuel pellet density, normally given in gm/cc and converted to lbm/ft^3. Dependent on core design. Reference: Individual plant basedeck calculations.	Lbm/ft^3
596	CORE_HT_AREA	Input	Core	CHT		T/H Dimension	RE		Core heat transfer area at the clad/coolant interface. To calculate: pin perimeter x pin height x number of fuel pins in the core. Dependent on core design. Reference: Individual plant basedeck calculations.	Ft^2
597	CHT_COND_FUEL_MULT	Input	CORE	RCS		Multiplier	RE		Multiplier fuel conductivity. This is a USER controlled input, independent of plant design. Usually, it is set to 1.0 in the basedeck. It can be used to perform parametrics studies on core temperature or heat transfer capabilities.	Dimensionless
598	CHT_GAP_HCAP	Input	CORE	RCS		T/H Dimension	RE		Fuel-clad gap thermal heat capacity. This is a plant and fuel reload dependent variable. The density of the gas in gap is calculated assuming the ideal gas law. Then CHT_GAP_HCAP = density * Cp for the gas mixture. See plant basedeck calculation.	Btu/ft^3-degF

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
599	CHT_PRESS_SUPERCRIT	Input	CORE	RCS		T/H Dimension	RE		Pressure for supercritical DNB calculation. Used in conjunction with CHT_H_SUPER_MULT. Used always. This is the "supercritical pressure" for the purpose of calculating heat flux. When vessel pressure exceeds this value (typically 2700 psia), CENTS does the following: (1) it forces the heat transfer mode to be in "forced convection", even if other conditions call for the "pool boiling" mode, and (2) it calculates the heat flux coefficient as CHT_H_SUPER_MULT * CHT_HTCOF_SUB, where the latter is the calculated heat transfer coefficient to subcooled liquid. These parameters are independent of plant design.	Psia
600	CHT_CHF_MULT	Input	CORE	RCS		Multiplier	RE		Multiplier on calculated critical heat flux. Used always, as long as the core heat transfer is in forced convection. This multiplier is independent of plant design. It is used only for tuning or testing, and should always be set to 1.0 in actual transients.	Dimensionless
601	CHT_CONST_LEV	Input	CORE	RCS		T/H State	RE		Time constant for level calculation in the core. Used always. The model calculates core heat transfer rates and distributions. It requires the current height of the two-phase region in order to determine the mode of heat transfer (forced convection or pool boiling) and to determine the local heat transfer coefficients at various elevations. Oscillations or rapid fluctuations (even of small magnitude) of the two-phase height can result in corresponding fluctuations in the core heat transfer that are inherently self-sustaining. Therefore, the model uses a "smoothed" two-phase height for all its calculations: <smoothed height> = <actual height> + CHT_CONST_LEV * (<previous smoothed height> - <actual height>). This "pseudo time constant" for lagging height in heat transfer calculations is for stability only. It is independent of plant design. A value of 0.0 results in no lag.	Fraction
602	TGAPIN	Input	CORE	RCS		T/H Dimension	RE		New initial core gap conductance for system initialization.	Btu/hr-ft2-degF
603	CHT_FRAC_HT_GEN	Input	CORE	RCS		T/H State	RE	11	Fraction of power generated in each of the radial regions of the fuel rod (fuel, gap & clad) and in the coolant. The number of entries in this array should equal N+1, where N=CHT_NREGIONS_RAD (which is usually set to 10; hence usually 11 entries). The sum of all entries in this array must equal 1.0. The first N-2 mesh regions are concentric regions of the fuel pellet. The N-1'th mesh is the gap region, the N'th is the clad, and the N+1'th is the coolant. The power generation fractions are dependent on the fuel design. Reference: core physics calculations.	Fraction
604	CHT_NNOD_BO	Partition					IN		Number of core axial nodes	Partition
605	CHT_NUM_NODE	Input	Core	CHT		Model Design	IN		No. of core axial nodes, used in core heat transfer mesh, max. 20. Must equal N_SECTIONS(1)-2, typically 20, independent of plant design.	Counts
607	CHT_PROPERTIES	Partition	CORE	RCS		T/H State	RE	25	CHT steam and liquid properties	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
608	CHT_ENTH_SAT_LIQ_M1	Output	CORE	RCS		T/H State	RE		Enthalpy of saturated liquid in the core node, at the previous time step. Used by CENTS to calculate the flashing rate during depressurization.	Btu/lbm
609	CHT_ENTH_SAT_LIQ	Output	CORE	RCS		T/H State	RE		Core average saturated liquid enthalpy.	Btu/lbm
610	CHT_ENTH_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam enthalpy.	Btu/lbm
611	CHT_SVOL_SAT_LIQ	Output	CORE	RCS		T/H State	RE		Core average saturated liquid specific volume.	Ft^3/lbm
612	CHT_SVOL_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam specific volume.	Ft^3/lbm
613	CHT_TEMP_SAT	Output	CORE	RCS		T/H State	RE		Core average saturated temperature.	Degree F
614	CHT_DHF_DP	Output	CORE	RCS		T/H State	RE		Core average derivative of saturated liquid enthalpy wrt pressure.	Composite Units
615	CHT_DHG_DP	Output	CORE	RCS		T/H State	RE		Core average derivative of saturated steam enthalpy wrt pressure.	Composite Units
616	CHT_DTSAT_DP	Output	CORE	RCS		T/H State	RE		Core average partial derivative of subcooled temperature wrt pressure.	Composite Units
617	CHT_DTSAT_DH	Output	CORE	RCS		T/H State	RE		Core average partial derivative of subcooled temperature wrt enthalpy.	Composite Units
618	CHT_DVSATL_DP	Output	CORE	RCS		T/H State	RE		Core average partial derivative of subcooled liquid specific volume wrt pressure.	Composite Units
619	CHT_DVSATG_DP	Output	CORE	RCS		T/H State	RE		Core average partial derivative of superheated steam specific volume wrt pressure.	Composite Units
620	CHT_DVSATL_DH	Output	CORE	RCS		T/H State	RE		Core average partial derivative of subcooled liquid specific volume wrt enthalpy.	Composite Units
621	CHT_DVSATG_DH	Output	CORE	RCS		T/H State	RE		Core average partial derivative of superheated steam specific volume wrt enthalpy.	Composite Units
622	CHT_VISCOS_WAT	Output	CORE	RCS		T/H State	RE		Core average liquid viscosity.	Lbm/ft-sec
623	CHT_VISCOS_STM	Output	CORE	RCS		T/H State	RE		Core average steam viscosity.	Lbm/ft-sec
624	CHT_VISCOS_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam viscosity.	Lbm/ft-sec
625	CHT_COND_WAT	Output	CORE	RCS		T/H State	RE		Core average liquid thermal conductivity.	Btu/sec-ft-degF
626	CHT_COND_STM	Output	CORE	RCS		T/H State	RE		Core average steam thermal conductivity.	Btu/sec-ft-degF
627	CHT_COND_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam thermal conductivity.	Btu/sec-ft-degF
628	CHT_PRAN_WAT	Output	CORE	RCS		T/H State	RE		Core average liquid Prandtl Number.	Dimensionless
629	CHT_PRAN_STM	Output	CORE	RCS		T/H State	RE		Core average steam Prandtl Number.	Dimensionless
630	CHT_PRAN_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam Prandtl Number.	Dimensionless
631	CHT_SPEC_HT_WAT	Output	CORE	RCS		T/H State	RE		Core average liquid specific heat capacity.	Btu/lbm-degF
632	CHT_SPEC_HT_SAT_STM	Output	CORE	RCS		T/H State	RE		Core average saturated steam specific heat capacity.	Btu/lbm-degF
633	CHT_STATE	Partition					RE	25	CHT internal variables for restart	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
634	CHT_BOILING	Output	CORE	RCS		Flag	LO		Flag for heat transfer mode T=boiling (natural circulation), F=forced circulation. This is a plant independent variable that flags when the core heat transfer model shifts modes from natural circulation (pool boiling) to forced circulation. The shift from forced circulation to NC is made for the following conditions: core pressure <supercritical, and either RCP d/p <2.0 psid or flow reversal in the core region. Reference 1, Section 7.1.2.	True False
635	CHT_FLUX_CRIT	Output	CORE	RCS		T/H State	RE		Core Critical heat flux	Btu/sec-ft^2
636	CHT_TERM	Output	CORE	RCS		T/H State	RE		Core Transition boiling term	Composite Units
637	CHT_TERM2	Output	CORE	RCS		T/H State	RE		Core Departure from nucleate boiling term	Composite Units
638	CHT_TEMP_CRIT	Output	CORE	RCS		T/H State	RE		Core Critical temperature	Degree F
639	CHT_HTCOF_NB	Output	CORE	RCS		T/H State	RE		Core Nucleate boiling heat transfer coefficient	Btu/secft^2 degF
640	CHT_HTCOF_SUB	Output	CORE	RCS		T/H State	RE		Core heat transfer coefficient to subcooled liquid	Btu/secft^2 degF
641	CHT_FLASH_RATE_LAST	Output	CORE	RCS		T/H State	RE		Core flashing rate at the previous time step	Lbm/sec
642	CHT_LEVL_MIX_LAST	Output	CORE	RCS		T/H State	RE		Core mixture level at the previous time step	Feet
643	CHT_AVG_HEAT_FLUX	Output	CORE	RCS		T/H State	RE		Core-wide average heat flux	MegBtu/hr-ft^2
644	CHT_TEMP_FUEL_AV	Output	CORE	RCS		T/H State	RE		Average temperature of fuel	Degree F
647	CHT_QUAL	Output	CORE	RCS		T/H State	RE	20	Core node section coolant quality in forced convection	Fraction
648	CHT_TEMP_CROSS	Output	CORE	RCS		T/H State	RE	20	Core crossover temperature	Degree F
649	CHT_HTCOF_FB	Output	CORE	RCS		T/H State	RE	20	Core film boiling heat transfer coefficient	Btu/secft^2 degF
650	CHT_FLX_DNB	Output	CORE	RCS		T/H State	RE	20	Critical heat flux in forced convection	Btu/sec-ft^2
651	CHT_TEMP_NB_FC	Output	CORE	RCS		T/H State	RE	20	Critical temperature in forced convection	Degree F
653	CHT_FLOW_STM_BO	Output	CORE	RCS		T/H State	RE	20	Steam flow rate - pool boiling mode. This plant independent output variable is calculated for each of the axial nodes in the core. Reference 1, Section 7.1.2.	Lbm/sec
654	CHT_GAP_COND	Output	CORE	RCS			RE	20	Fuel-clad gap thermal conductivity. It is calculated by the code at INITIALization as: TGAPIN * (gap thickness) / 3600.	Btu/sec-ft-degF
655	CHT_HT_GEN_ZR_WAT	Output	CORE	RCS		T/H State	RE	20	Heat rate of Zr-water reaction. High cladding temperatures, which can occur during core uncovery, result in zirc oxidation, generation of hydrogen and heat. This variable is the CENTS calculated heat measured for each node section, using the Baker-Just correlation. Reference 1, Section 7.1.2 and 3.1.3.	Btu/sec
656	CHT_IHT	Output	CORE	RCS		Flag	IN	20	Cue for heat transfer regime by node. When CHT_BOILING = T, the heat transfer regime is determined by CENTS at the bottom of each node section (and core exit). The regimes are: 1=subcooled; 2=Nucleate Boiling; 4=Transition Boiling; 5= Stable film boiling; 7= Steam; & 8= Supercritical steam. Reference 1, Section 7.1.2.	Dimensionless
657	CHT_SPEC_HT_STM	Output	CORE	RCS		T/H State	RE	20	Core average steam specific heat capacity.	Btu/lbm-degF

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
658	CHT_HTCOF_ST	Output	CORE	RCS		T/H State	RE	20	Core heat transfer coefficients to steam for each core section.	Btu/secft^2 degF
659	CHT_HT_FLUX	Output	CORE	RCS		T/H State	RE	20	Heat flux into moderator for each core section.	Btu/sec-ft^2
660	CHT_TEMP_SURF	Output	CORE	RCS		T/H State	RE	20	Node temperature at the clad-moderator interface for each core section.	Degree F
661	CFTH_RCSAXIAL_Q	Output	CORE	RCS		T/H State	RE	20	Total power in each core axial section. The power in each section is calculated by CENTS based on the current core power and the input axial power distribution. The power in each section is used to calculated the core thermal-hydraulic conditions.	Btu/sec
662	CHT_HEAT_LIQ	Output	CORE	RCS		T/H State	RE	20	Rod heat transfer to liquid	Btu/sec
663	CHT_HEAT_STM	Output	CORE	RCS		T/H State	RE	20	Rod heat transfer to steam	Btu/sec
664	CHT_AXIAL_DATA_ALL	Output	CORE	RCS		T/H State	RE	50	Partition for Core Axial temperature and enthalpy	Partition
665	CHT_ENTH_COOL	Output	CORE	RCS		T/H State	RE	21	Coolant enthalpy at bottom of each core section. For N core sections, the N+1'th value is the core exit enthalpy. Reference 1, Section 7.1.2.	Btu/lbm
666	CHT_TEMP_COOL	Output	CORE	RCS		T/H State	RE	21	Coolant temperature at bottom of each core section. For N core sections, the N+1'th value is the core exit temperature. Reference 1, Section 7.1.2.	Degree F
667	CHT_ROD_RADIAL	Output	CORE	RCS		T/H State	RE	600	Partition containing fuel rod radial temperature, conductivity, and heat capacity.	Partition
668	CHT_TEMP_ROD	Output	CORE	RCS		T/H State	RE	10, 20	Temp. distribution in fuel rod	Degree F
669	CHT_COND_ROD	Output	CORE	RCS		T/H State	RE	10, 20	Rod th. cond. at last prop. calc.	Btu/sec-ft-degF
670	CHT_HT_CAP_ROD	Output	CORE	RCS		T/H State	RE	10, 20	Rod heat cap. at last prop. calc.	Btu/ft^3-degF
671	CHT_SECTIONS_OUTPUT	Partition					RE	41	Mass and enthalpy of the fluid in each of the core axial sections	Partition
672	CHT_M_CORE_SECT	Output	CORE	RCS		T/H State	RE	20	Mass in core sections	Lbm
673	CHT_H_CORE_SECT	Output	CORE	RCS		T/H State	RE	20	Enthalpy of liq in core sections	Btu/Lbm
674	CHT_USE_NEW_ENTHALPY_OPTION	Input	CORE	RCS		T/H State	RE		1 => Use the new (version 02280) CHT enthalpy rise calculation	Dimensionless
675	POWER_COMMON	Segment					RE	1700	Segment for core power variables	Segment
676	POW_USER_COMMON	Partition					RE	80	Variables for user control of power	Partition
677	POW_USER_INP	Partition					RE	60	User control input variables	Partition
679	POW_USER_IFUPOW	Input	CORE	RCS		Flag	LO		User option for using power table. This flag allows the code USER to bypass the core power calculation of CENTS. When this is set to True, and simultaneously CTL_CORE_CONTROL_AUTO is False, then a table of power (POW_USER_POWT) vs. time (POW_USER_TPOWT) substitutes for the CENTS point kinetics calculation.	True False
680	POW_USER_POWZ	Input	CORE	RCS		Plant Design	RE		Plant design full steady-state power. This plant dependent variable indicates the rated core power. It is used with initial power fraction, KFRAIN, to calculate the initial core power at the start of any transient.	Megawatts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
681	POW_USER_NPOWT	Input	CORE	RCS		Model Design	IN		No. of pairs in power vs time table. If POW_USER_IFUPOW=T and CTL_CORE_CONTROL_AUTO=F, then this array indicates to CENTS how many power vs. time entries (20 maximum) there are in POW_USER_POWT & POW_USER_TPOWT.	Counts
682	POW_USER_POWT	Input	CORE	RCS		Model Design	RE	20	Power values for power vs time table. If POW_USER_IFUPOW=T and CTL_CORE_CONTROL_AUTO=F, then this array indicates to CENTS the USER required power in the power vs. time table.	Fraction
683	POW_USER_TPOWT	Input	CORE	RCS		Model Design	RE	20	Time values for power vs time table. If POW_USER_IFUPOW=T, then this variable indicates to CENTS the USER required power in the power vs. time table.	Seconds
684	POW_USER_STATE	Partition	CORE	RCS			RE	10	User power state variables	Partition
685	POW_USER_QC	Output	CORE	RCS		Physics	RE		Final kinetics fission power fraction	Fraction
686	POW_USER_QCD	Output	CORE	RCS		Physics	RE		Final kinetics decay power fraction	Fraction
687	POW_KIN_COMMON	Partition					RE	630	Power kinetics variables	Partition
688	POW_KIN_INP	Partition					RE	580	Kinetics input variables	Partition
689	POW_KIN_ALPHA	Input	CORE	RCS		Physics	RE	11	Fission products disintegration energies. This array provides a normalized fractional energy for each fission product group. This is a plant independent array obtained from WAPD-TM-534, 5/66. Reference 1, Section 3.1.1.	Fraction
690	POW_KIN_DLAM	Input	CORE	RCS		Physics	RE	11	Decay constants for fission products. This array is associated with the fission product groups whose fractional energies are in POW_KIN_ALPHA. This is a plant independent array obtained from WAPD-TM-534, 5/66. Reference 1, Section 3.1.1. These input parameters are used in the calculation of decay heat. A decay heat term is calculated both before and after trip. The decay heat term is added to the calculated fission power to give total core power. Decay power is important for the long-term behavior of the system after trip. It affects requirements on aux feedwater delivery and also can affect the amount of calculated steam released which is important to dose calculations. CENTS uses an 11 group model in the calculation of decay heat. It is important to note the following. Infinite operation at the initial power is assumed. This could be important for events initialized at low or zero power because at those conditions it might be appropriate to base the decay heat on full power. Uncertainties are not included. Heavy element decay is not included. If decay power after trip is important for some event, the user should use the decay heat table by setting the variable POW_DKHT_DHCBEG to an appropriate value.	1/seconds

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
691	POW_KIN_BETA	Input	CORE	RCS		Physics	RE	6	Effective delayed neutron fractions. The six groups of delayed neutron precursors are plant, reload and time in core life dependent. Therefore, they become inputs which the code USER must review and update. The basedeck values are strictly representative values which provide for stable steady state code behavior for purposes of tuning and basedeck verification. Minimum beta fraction results in a faster power rise for power-increasing events.	Fraction
692	POW_KIN_PLAM	Input	CORE	RCS		Physics	RE	6	Decay constants for delayed neutrons. The decay constants for the six groups of delayed neutron precursors are plant, reload and time in core life dependent. Therefore, they become inputs which the code USER must review and update. The basedeck values are strictly representative values which provide for stable steady state code behavior for purposes of tuning and basedeck verification.	1/seconds
693	POW_KIN_BBAR	Output	CORE	RCS		Physics	RE		Total delayed neutrons fraction.	Fraction
695	POW_KIN_DKCONZ	Output	CORE	RCS		Physics	RE		Reference boric acid reactivity. This output parameter represents the moderator boric acid reactivity for initial conditions in the system. It is used in conjunction with moderator temperature reactivity, unless the moderator density option is used. In that case, the boric acid reactivity must be considered as part of the density change reactivity. Reference 1, Section 7.1.1.	Reactivity
696	POW_KIN_DKCTMZ	Output	CORE	RCS		Physics	RE		Reference moderator temp reactivity. This output parameter represents the moderator temperature reactivity for initial conditions in the system. It is used in conjunction with boric acid reactivity, unless the moderator density option is used. In that case, the boric acid reactivity must be considered as part of the density change reactivity. Reference 1, Section 7.1.1.	Reactivity
697	POW_KIN_DKDENZ	Output	CORE	RCS		Physics	RE		Reference moderator density reactivity. This output parameter represents the moderator density reactivity for initial conditions in the system; the boric acid reactivity must be considered as part of the density reactivity. It is used normally for transients where voiding is expected to occur in the core region Otherwise, the moderator temperature & boric acid reactivity option is used. Reference 1, Section 7.1.1.	Reactivity
698	POW_KIN_DKTMPZ	Output	CORE	RCS		Physics	RE		Reference Doppler reactivity. This output parameter represents the reactivity associated with fuel temperature for initial conditions in the system. Reference 1, Section 7.1.1.	Reactivity
699	POW_KIN_DKINSZ	Output	CORE	RCS		Physics	RE		Reference control rod insertion reactivity. This output parameter represents the reactivity associated with control rod regulating system for initial rod position in the core. Reference 1, Section 7.1.1.	Reactivity
701	POW_KIN_NDKCON	Input	CORE	RCS		Model Design	IN		No. pairs, reactivity vs boric acid concentration table. This input parameter tells CENTS the size of the array. The maximum number is 30 values. Reference 1, Section 7.1.1.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
702	POW_KIN_NDKCTM	Input	CORE	RCS		Model Design	IN		No. pairs, reactivity vs. moderator temperature table. This input parameter tells CENTS the size of the array. The maximum number is 30 values. Reference 1, Section 7.1.1.	Counts
703	POW_KIN_NDKDEN	Input	CORE	RCS		Model Design	IN		No. pairs, react vs moder density table. This input parameter tells CENTS the size of the array. The maximum number is 30 values. Reference 1, Section 7.1.1.	Counts
704	POW_KIN_NDKTMP	Input	CORE	RCS		Model Design	IN		No. pairs, Doppler reactivity vs fuel temperature table. This input parameter tells CENTS the size of the array. The maximum number is 30 values. Reference 1, Section 7.1.1.	Counts
705	POW_KIN_NQDK	Input	CORE	RCS		Model Design	IN		No. pairs, control rod scram reactivity vs time table. This input parameter tells CENTS the size of the array. The maximum number is 30 values. Reference 1, Section 7.1.1.	Counts
706	POW_KIN_SIGD2	Output	CORE	RCS		Physics	RE		Total fission (1.0 - sum POW_KIN_ALPHA). The value of this parameter normally is calculated to be .93, independent of plant design.	Fraction
707	POW_KIN_STARL	Input	CORE	RCS		Physics	RE		Prompt neutron lifetime. This is a plant, cycle and time in cycle dependent variable, established by the USER for each analysis. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. Minimum l* has no effect for most events. It has an effect on prompt critical or near-prompt critical events. For these cases, minimum l* results in a faster power rise.	Seconds
708	POW_KIN_TSS	Input	CORE	RCS		Physics	RE		Maximum kinetics time step. This is an output variable which is set internally. A dummy value is required for the first pass.	Seconds
709	POW_KIN_DKCON	Input	CORE	RCS		Physics	RE	30	Boric acid reactivity, for reactivity vs concentration table. This is a plant, cycle & time in cycle dependent array, established by the USER. It is used only if POW_KIN_BORON_FB_OPTION=T. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. It is used in conjunction with moderator temperature reactivity, unless the moderator density option is used. In that case, the boric acid reactivity must be considered as part of the density change reactivity. This table is typically used only for steam line break analyses. For other analyses, the boron concentration does not change. Other analyses use the option to calculate reactivity as a function of moderator temperature. A dummy table is input into the base deck. Reference 1, Section 7 1.1.	Reactivity
710	POW_KIN_TDKCON	Input	CORE	RCS		Physics	RE	30	Boric acid concentration for reactivity vs concentration table. This is a plant, cycle & time in cycle dependent array, established by the USER. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. It is used only if POW_KIN_BORON_FB_OPTION=T. Reference 1, Section 7.1.1.	Parts/million

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
711	POW_KIN_DKCTM	Input	CORE	RCS		Physics	RE	30	Moderator temperature reactivity for reactivity vs temperature table. This is a plant, cycle & time in cycle dependent array, set by the USER. It is used only if POW_KIN_MOD_TEMP_FB_OPTION=T. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. It is used in conjunction with boric acid reactivity, unless the moderator density option is used. Reference 1, Section 7.1.1.	Reactivity
712	POW_KIN_TDKCTM	Input	CORE	RCS		Physics	RE	30	Moderator temperature for reactivity vs temperature table. This is a plant, cycle & time in cycle dependent array, established by the USER. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. It is used only if POW_KIN_MOD_TEMP_FB_OPTION=T. Reference 1, Section 7.1.1.	Degree F
713	POW_KIN_DKDEN	Input	CORE	RCS		Physics	RE	30	Moderator density reactivity for reactivity vs density table. This is a plant, cycle & time in cycle dependent array, set by the USER. It is used only if POW_KIN_MOD_DENSITY_FB_OPTION=T. If used, then boric acid reactivity needs to be considered when determining the density reactivity. The basedeck values are often set to zero for this variable because moderator temperature and boric acid reactivity are used for tuning and testing of the input deck. Reference 1, Section 7.1.1.	Reactivity
714	POW_KIN_TDKDEN	Input	CORE	RCS		Physics	RE	30	Moderator density for reactivity vs density table. This is a plant, cycle & time in cycle dependent array, established by the USER. It is used only if POW_KIN_MOD_DENSITY_FB_OPTION=T. Reference 1, Section 7.1.1.	Lbm/ft^3
715	POW_KIN_DKTMP	Input	CORE	RCS		Physics	RE	30	Reactivity for Doppler reactivity vs fuel temperature table. This is a plant, cycle & time in cycle dependent array, set by the USER. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. Always used, but the calculated reactivity is used only if POW_KIN_DOPPLER_FB_OPTION=T. Reference 1, Section 7.1.1.	Reactivity
716	POW_KIN_TDKTMP	Input	CORE	RCS		Physics	RE	30	Fuel temperature for Doppler reactivity vs fuel temperature table. This is a plant, cycle & time in cycle dependent array, set by the USER. The basedeck value is strictly a representative value which provides for stable steady state code behavior for purposes of tuning and basedeck verification. Always used, but the calculated reactivity is used only if POW_KIN_DOPPLER_FB_OPTION=T. Reference 1, Section 7.1.1.	Degree F

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
717	POW_KIN_QDK	Input	CORE	RCS		Physics	RE	30	Scram reactivity for reactivity vs time table. This is a plant, cycle & time in cycle dependent array, set by the USER. The total scram rod worth, the delay for de-energizing the control rod UV coils and the ASI must all be considered when establishing this table. The basedeck values are strictly representative values which provides for stable steady state code behavior for purposes of tuning and basedeck verification. Disabled if POW_KIN_SCRAM_ROD_OPTION=F. See the plant basedeck calculation for an example of the calculation to establish this table. Reference 1, Section 7.1.1.	Reactivity
718	POW_KIN_TQDK	Input	CORE	RCS		Physics	RE	30	Time for Scram reactivity vs time table. This is a plant, cycle & time in cycle dependent array, set by the USER. The total scram rod worth, the delay for de-energizing the control rod UV coils and the ASI must all be considered when establishing this table. The basedeck values are strictly representative values which provides for stable steady state code behavior for purposes of tuning and basedeck verification. Disabled if POW_KIN_SCRAM_ROD_OPTION=F. See the plant basedeck calculation for an example of the calculation to establish this table. Reference 1, Section 7.1.1.	Seconds
719	POW_KIN_T	Output	CORE	RCS		T/H State	RE		Average core fuel temperature. This is the independent variable calculated and used by CENTS to determine the interpolation point into the doppler reactivity feedback table. Reference 1, Section 7.1.1.	Degree F
720	POW_KIN_DENCOR	Output	CORE	RCS		T/H State	RE		Core average moderator density. If the moderator density reactivity option is chosen by the USER, then this is the independent variable calculated and used by CENTS to determine the interpolation point into the moderator density reactivity feedback table. Reference 1, Section 7.1.1.	Lbm/ft^3
721	POW_KIN_DKINS	Input	CORE	RCS		Physics	RE	100	Reactivity for reactivity vs CEA position table. This is a plant, cycle & time in cycle dependent array, set by the USER. The rod worth for the given ASI must be considered when establishing this table. Used only before Scram (CTL_CORE_TRIP=F) if the flag POW_KIN_REG_ROD_OPTION=T. Normally, for safety analysis, this flag is False, so basedeck values are set to zero. Reference 1, Section 7.1.1.	Reactivity
722	POW_KIN_TDKINS	Input	CORE	RCS		Physics	RE	100	Position (steps) for reactivity vs CEA position table. This is a plant, cycle & time in cycle dependent array, set by the USER. The rod worth for the given ASI must be considered when establishing this table. Used only before Scram (CTL_CORE_TRIP=F) if the flag POW_KIN_REG_ROD_OPTION=T. Normally, for safety analysis, this flag is False, so basedeck values are set to zero. Reference 1, Section 7.1 1.	Counts

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
723	POW_KIN_NDKINS	Input	CORE	RCS		Model Design	IN		No. pairs in regulating rod worth vs position table. The maximum value is 100 data pairs. Normally, for safety analysis, POW_KIN_REG_ROD_OPTION=F. Thus basedeck values are set to zero. Reference 1, Section 7.1.1.	Counts
724	POW_IFUPOW_TIM	Output	CORE	RCS		Model Design	RE		Time elapsed since switch to user-power via POW_USER_IFUPOW=T. Used to provide the requested power as a function of time elapsed since switch to user-power. Reference 1, Section 7.1.1.	Seconds
725	POW_KIN_CUTBACK	Input	CORE	RCS		Physics	RE	10	Reactivity for Reactor Power Cutback (RPC) reactivity insertion table. This is a plant, cycle & time in cycle dependent array, set by the USER. The rod worth for the given ASI must be considered when establishing this table. Used only when the RPC signal is active (CTL_RPCS_TRIP=T) if the flag POW_KIN_CUT_ROD_OPTION=T. Normally, for safety analysis, this flag is False, so basedeck values are set to zero. Reference 1, Section 7.1.1.	Reactivity
726	POW_KIN_TCUTBACK	Input	CORE	RCS		Physics	RE	10	Times for Reactor Power Cutback (RPC) reactivity insertion table. This is a plant, cycle & time in cycle dependent array, set by the USER. Used only when the RPC signal is active (CTL_RPCS_TRIP=T) if the flag POW_KIN_CUT_ROD_OPTION=T. Normally, for safety analysis, this flag is False, so basedeck values are set to zero. Reference 1, Section 7.1.1.	Seconds
727	POW_KIN_NCUTBACK	Input	CORE	RCS		Model Design	IN		No. points in RPC react insertion table. The maximum value is 10 data pairs. Normally, for safety analysis, POW_KIN_CUT_ROD_OPTION=F. Thus, basedeck values are set to zero. Reference 1, Section 7.1.1.	Counts
728	POW_KIN_SOURCE	Input	CORE	RCS		Physics	RE		Kinetics source term - fraction of FP. Used always. Neutron source term for subcritical calculation. Although the exact source term is core specific, it is has little or no effect. Therefore, it may be treated as independent of plant design. This value is only significant for initially subcritical conditions. The initial subcriticality is calculated by CENTS based on this parameter and on the initial power level. This considered a user input.	Fraction
729	POW_KIN_DK_INIT	Output	CORE	RCS		Physics	RE		Initial subcriticality. Calculated by CENTS at INITIALization as -POW_KIN_SOURCE / KFRAIN.	Reactivity
730	POW_KIN_OUT	Partition					RE	10	Kinetics output variables	Partition
731	POW_KIN_DKT	Output					RE		Total reactivity. This is the summation of all the reactivity feedbacks at each time step.	Reactivity
732	POW_KIN_DK	Output	CORE	RCS		Model Design	RE		User-specified reactivity (e g. stuck rod). IFF POW_USER_IFUPOW=True, then this output describes the reactivity feedback, in dk/k, at each time step as dictated by the change in core power from the USER input table.	Reactivity

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
733	POW_KIN_DKBOR	Output	CORE	RCS		Physics	RE		Boric acid reactivity. IFF POW_KIN_BORON_FB_OPTION=T, then this output is the reactivity feedback in dk/k related to the boric acid concentration.	Reactivity
734	POW_KIN_DKMOD	Output	CORE	RCS		Physics	RE		Core moderator density reactivity. IFF POW_KIN_MOD_DENSITY_FB_OPTION=T, then this output is the reactivity feedback in dk/k related to the moderator density.	Reactivity
735	POW_KIN_DKDOP	Output	CORE	RCS		Physics	RE		Fuel temperature Doppler reactivity. This output is the reactivity feedback in dk/k related to the fuel temperature. It is used only if POW_KIN_DOPPLER_FB_OPTION=T.	Reactivity
736	POW_KIN_DKTMD	Output	CORE	RCS		Physics	RE		Moderator temperature reactivity. IFF POW_KIN_MOD_TEMP_FB_OPTION=T, then this output is the reactivity feedback in dk/k related to the moderator temperature.	Reactivity
737	POW_KIN_DKROD	Output	CORE	RCS		Physics	RE		Control rod regulating system reactivity. This output is the reactivity feedback in dk/k related to the control rod regulating system. Normally the reactivity worth for this system is set to zero in the basedeck. It is zero after Scram (CTL_CORE_TRIP=T). It is always zero if POW_KIN_REG_ROD_OPTION=F.	Reactivity
738	POW_KIN_DKSCRAM	Output	CORE	RCS		Physics	RE		Scram rods reactivity. This output is the reactivity feedback in dk/k related to the control rod scram worth vs. time after reactor trip. It is zero unless POW_KIN_SCRAM_ROD_OPTION=True	Reactivity
739	POW_KIN_DKCUT	Output	CORE	RCS		Physics	RE		Reactor power cutback reactivity. This output is the reactivity feedback in dk/k related to the reactor cutback system. Normally the reactivity worth for this system is set to zero in the basedeck. It is zero unless POW_KIN_CUT_ROD_OPTION=True	Reactivity
740	POW_KIN_DKHERMC	Output	CORE	RCS		Physics	RE		Hermite 3-D credit reactivity. This output is the reactivity feedback in dk/k related to Hermite credits. It is zero unless POW_KIN_HERM_CREDIT_OPTION=True. Reference 1, Appendix E.	Reactivity
741	POW_KIN_STATE	Partition					RE	25	Kinetics state variables	Partition
742	POW_KIN_CHI2	Output	CORE	RCS		Physics	RE	11	Normalized concentration for fission products. This is the normalized fraction of each of the eleven groups of fission products (based upon 100% steady state = 1.0)	Fraction
743	POW_KIN_EX2	Output	CORE	RCS		Physics	RE	6	Normalized concentration for delayed neutrons. This output represents the normalized fraction of each of the six groups of delayed neutron precursors (based upon 100% steady state = 1.0).	Fraction
744	POW_KIN_QD2	Output	CORE	RCS		T/H State	RE		Current kinetics decay heat fraction. If the reactor is critical, then this variable remains Sum(POW_KIN_ALPHA) * CTL_CORE_POWER_FRACTION. When the reactor scrams and the prompt core power drops off, then this value decays down based upon the delayed neutron kinetics inputs. When the decay heat table is used to determine the interpolated value from the table is used.	Fraction

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
745	POW_KIN_QF2	Output	CORE	RCS		Physics	RE		Current prompt power fraction. If the reactor is critical, then this variable remains (1 - Sum(POW_KIN_ALPHA)) * CTL_CORE_POWER_FRACTION. When the reactor scrams and the prompt core power drops off, then this value decays down based upon the delayed neutron kinetics inputs When the decay heat table is used to determine the interpolated value from the table is used.	Fraction
746	POW_KIN_EN2	Output	CORE	RCS		Physics	RE		Temporary prompt power fraction.	Fraction
747	POW_CORE_TRIP_FRACTION	Output	CORE	RCS		T/H State	RE		Core Power fraction at the time of reactor trip.	Fraction
748	POW_DKHT_COMMON	Partition					RE	100	Partition for decay heat variables	Partition
749	POW_DKHT_INP	Partition					RE	85	Partition for decay heat inputs	Partition
750	POW_DKHT_TIMDHT	Input	CORE	RCS		T/H State	RE	40	Time for ANS decay heat vs time table. This array of up to forty values represents the independent variable of time after reactor trip vs. the table lookup for decay heat fraction.	Seconds
751	POW_DKHT_ANSDHC	Input	CORE	RCS		T/H State	RE	40	Decay heat fraction for decay heat vs time table. This array of up to forty values represents the dependent variable of decay heat fraction vs. time after reactor trip.	Fraction
752	POW_DKHT_NDHC	Input	CORE	RCS		Model Design	IN		No. of pairs in decay heat vs time table. This variable indicates the active number (maximum 40) of data pairs in the decay heat vs. time tables.	Counts
753	POW_DKHT_DHCBEG	Input	CORE	RCS		T/H Dimension	RE		Power fraction for switch to decay heat. After scram, CENTS continues to calculate power from the physics equations, until the calculated power falls below POW_DKHT_DHCBEG. At this time, the model switches to the decay heat curve. POW_DKHT_DHCBEG is a scenario dependent variable which must be established by the USER so that a switchover occurs at the time when the two power levels are equal. Alternatively, a WHEN command can be set up that will make the transfer bumpless by forcing it at exactly the right time. For details, see POW_USER_QCD_LOOKUP, and Reference 1, Section 7.1.1.	Fraction
754	POW_DKHT_DHCFCT	Input	CORE	RCS		Multiplier	RE		Multiplier on tabular decay heat. This input parameter provides a convenient method for the USER to adjust the decay heat level for conservatism or parametrics, etc. It is input based on the assumed long-term core power operation, and on the required conservatism.	Dimensionless
755	POW_DKHT_STATE	Partition					RE	5	Switch to decay heat variables	Partition
756	POW_DKHT_IFDHC	Output	CORE	RCS		Flag	LO		Signal: switched to decay heat. This Output flag identifies that the power level at which the switch to decay heat should occur, POW_DKHT_DHCBEG, has been reached.	True False
757	POW_DKHT_TIMDHC	Output	CORE	RCS			RE		Time of switch to decay heat.	Seconds

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
758	POW_USER_QCD_LOOKUP	Output	CORE	RCS			RE		Current decay power fraction from the decay heat curve, as a function of time since scram (which is 0.0 before scram), multiplied by the decay heat multiplier POW_DKHT_DHCFCT. This output variable is calculated at every time step, whether or not the model has switched from physics calculated power to the decay heat table. Using this output, a WHEN command can be set up that will make the transfer to the decay heat table bumpless by forcing it at exactly the right time. For details, Reference 1, see Section 7.1.1.	Fraction
759	POW_ZRH2O_COMMON	Partition					RE	8	Zirconium oxidation variables	Partition
760	POW_ZRH2O_INP	Partition					RE	5	Zr-H2O input variables	Partition
761	POW_ZRH2O_NYZIR	Input	CORE	RCS		Flag	LO		Option: calculate zirc-oxidation. This flag is a USER controlled input. When True, it indicates to CENTS that a Zr oxidation heat addition calculation should be performed (using the Baker & Just correlation) and incorporated into the power solution by CENTS	True False
762	POW_ZRH2O_FZBJ	Input	CORE	RCS		Multiplier	RE		Multiplier on Baker-Just generated heat. This is a USER controlled multiplier on the Zr oxidation rate. Reference 1, Section 3.1.3 and Table 7 3	Dimensionless
763	POW_ZRH2O_STATE	Partition					RE	1	Zr-H2O state variables	Partition
764	POW_ZRH2O_H2M	Output	CORE	RCS		Zr Reaction	RE		Hydrogen release rate due to Zr-H2O. Reference 1, Section 3.1.3 and Table 7.3.	Lbm/sec
765	POW_INITIAL_CONDITIONS	Partition					RE	20	Power initial conditions	Partition
766	KFRAIN	Input	CORE	RCS		T/H Dimension	RE		New initial core power fraction. This plant independent input variable should be set by the USER for each scenario. It provides power fraction input required by CENTS to create the initial plant T/H conditions. Kfrain * POW_USER_POWZ is the initial heat generation rate in Megawatts. Reference 1, Appendix D.	Fraction
767	POW_KIN_HERMITE_INPUT	Partition					RE	380	Hermite-torq 3D fb reactivity input	Partition
768	POW_KIN_HERMITE_PARAM	Partition					RE	30	Hermite-torq 3D feedback reactivity parameters	Partition
769	POW_KIN_HERM_TD	Input	CORE	RCS		CESEC Emulation	RE		Time delay for Hermite credit 3D feedback. Reference 1, Appendix E.	Seconds
770	POW_KIN_HERM_MULT	Input	CORE	RCS		CESEC Emulation	RE		Fraction of Hermite 3D feedback taken. Reference 1, Appendix E.	Fraction
771	POW_KIN_TEMP_TILT_MIN	Input	CORE	RCS		CESEC Emulation	RE		Minimum temperature tilt. Reference 1, Appendix E.	Degree F
772	POW_KIN_POWTOFLOW_MIN	Input	CORE	RCS		CESEC Emulation	RE		Minimum power to flow ratio (3D feedback). Reference 1, Appendix E	Dimensionless
773	POW_KIN_FLOWFRAC_MIN	Input	CORE	RCS		CESEC Emulation	RE		Minimum flow fraction (3D feedback). Reference 1, Appendix E.	Fraction
774	POW_KIN_TEMP_TILT_MAX	Input	CORE	RCS		CESEC Emulation	RE		Maximum temperature tilt (3D feedback). Reference 1, Appendix E.	Degree F
775	POW_KIN_POWTOFLOW_MAX	Input	CORE	RCS		CESEC Emulation	RE		Maximum power to flow ratio (3D fb). Reference 1, Appendix E.	Dimensionless

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
776	POW_KIN_HERM_POW_REF	Input	CORE	RCS		CESEC Emulation	RE		Power for normalization (3D feedback). Reference 1, Appendix E.	Megawatts
777	POW_KIN_HERM_FLOW_REF	Input	CORE	RCS		CESEC Emulation	RE		Flow for normalization (3D feedback). Reference 1, Appendix E.	Lbm/sec
778	POW_KIN_HERM_N_FLOWFR	Input	CORE	RCS		CESEC Emulation	IN		Number of flow fractions (3D feedback). Reference 1, Appendix E.	Counts
779	POW_KIN_CORE_W_FRACTAB	Input	CORE	RCS		CESEC Emulation	RE	8	Core flow fraction table for Hermite 3D feedback. Reference 1, Appendix E.	Fraction
780	POW_KIN_HERM_CREDITTAB	Input	CORE	RCS		CESEC Emulation	RE	350	Hermite reactivity table trivariant (3D feedback). Reference 1, Appendix E.	Composite Units
781	POW_KIN_MIXING_INPUT	Partition					RE	10	Hermite-torq 3D feedback mixing input	Partition
784	POW_KIN_EDGE_WEIGHT	Input	CORE	RCS		CESEC Emulation	RE		Edge temperature geom weight (3D feedback). Variable Pow_kin_edge_weight is a multiplier on the difference in inlet enthalpy to calculate the cold edge conditions. The enthalpy calculation is: Hedge = Hcore in + edge_weight*(HCLmin -HCLavg) + factor*delHCore The input deck includes the standard setup: Cold edge reactivity is not calculated. The option to calculate cold edge temperature is enabled. The weighting factors are set to values which are typically used in the SLB analyses. Reference 1, Appendix E.	Fraction
785	POW_KIN_DH_FACTOR	Input	CORE	RCS		CESEC Emulation	RE		Core enthalpy rise fraction (3D feedback). Variable POW_KIN_DH_FACTOR is the fraction of the core enthalpy rise which is added to the core inlet temperature in the calculation of the cold edge temperature. Reference 1, Appendix E.	Fraction
786	POW_KIN_FEEDBACK_OPTIONS	Partition					RE	15	Core reactivity feedback options	Partition
787	POW_KIN_SCRAM_ROD_OPTION	Input	CORE	RCS		Physics	LO		Scram control rod reactivity option. If True, enables calculation of scram rod reactivity. Reference 1, Section 7.1.1.	Active Inactive
788	POW_KIN_REG_ROD_OPTION	Input	CORE	RCS		Physics	LO		Regulating rod reactivity option. If True, enables calculation of regulating rod reactivity. Reference 1, Section 7.1.1	Active Inactive
789	POW_KIN_CUT_ROD_OPTION	Input	CORE	RCS		Physics	LO		Reactor Power cutback system (RPCS) reactivity option. If True, enables calculation of RPCS reactivity insertion. Reference 1, Section 7.1.1.	Active Inactive
790	POW_KIN_DOPPLER_FB_OPTION	Input	CORE	RCS		Physics	LO		Doppler reactivity option. If True, enables calculation of the Doppler reactivity feedback. Reference 1, Section 7.1.1.	Active Inactive
791	POW_KIN_BORON_FB_OPTION	Input	CORE	RCS		Physics	LO		Moderator boric acid reactivity option. If True, enables calculation of the boron reactivity feedback. Reference 1, Section 7.1.1.	Active Inactive
792	POW_KIN_MOD_TEMP_FB_OPTION	Input	CORE	RCS		Physics	LO		Moderator temperature reactivity option. If True, enables calculation of the moderator temperature reactivity feedback. Reference 1, Section 7.1.1.	Active Inactive

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
793	POW_KIN_MOD_DENSITY_FB_OPTION	Input	CORE	RCS		Physics	LO		Moderator density reactivity option. If True, this flag tells the code to calculate reactivity as a function of the variable moderator density. This option is normally used only for the steam line break analysis, and is otherwise set to False in the base deck. Reference 1, Section 7.1.1.	Active Inactive
794	POW_KIN_MOD_DENSITY_OPTION	Input	CORE	RCS		CESEC Emulation	LO		Option flag - cold edge moderator density feedback. This flag activates a CESEC emulation model which is not physical. This is a user flag, independent of plant design. It causes the moderator density to be calculated at the cold edge of the core, for input to the moderator density reactivity feedback calculation. Otherwise, core average conditions are used. This option has no effect unless the flag POW_KIN_MOD_DENSITY_FB_OPTION is True. Reference 1, Section 7.1.1 and Appendix E.	True False
795	POW_KIN_HERM_CREDIT_OPTION	Input	CORE	RCS		CESEC Emulation	LO		Hermite credit 3D feedback reactivity - option flag. The Hermite credit table is only used for the Steam Line Break analysis. This table is user option. Normally, this flag is False, and dummy values are supplied in the base deck. Reference 1, Section 7.1.1 and Appendix E.	Active Inactive
796	POW_EXCORE_OUT	Partition					RE	74	Variables for excore detectors	Partition
797	POW_EXCORE_DISP	Partition					RE	25	Excore readings - used for display only	Partition
798	EXCORE_POWERD	Output	CORE	RCS		Display	RE	8	Total excore power readings - 4 lower, 4 upper (display)	Fraction
799	EXCORE_POWER	Output	CORE	RCS		Display	RE	4	Total excore power readings - 4 circumferential locations (display)	Fraction
800	EXCORE_OFFSET	Output	CORE	RCS		Display	RE	4	Excore axial offsets - 4 circumferential locations (display)	Dimensionless
801	EXCORE_POWER_AV	Output	CORE	RCS		Display	RE		Average excore power (display)	Fraction
802	EXCORE_OFFSET_AV	Output	CORE	RCS		Display	RE		Average excore axial offset (display)	Dimensionless
804	POW_EXCORE_DATA	Partition					RE	25	Excore readings: used by controls & RPS	Partition
805	POW_EXCORE_POWERD	Output	CORE	RCS		Physics	RE	8	Total excore power readings - 4 lower, 4 upper	Fraction
806	POW_EXCORE_POWER	Output	CORE	RCS		Physics	RE	4	Total excore power readings - 4 circumferential locations	Fraction
807	POW_EXCORE_OFFSET	Output	CORE	RCS		Physics	RE	4	Excore axial offsets - 4 circumferential locations	Dimensionless
808	POW_EXCORE_POWER_AV	Output	CORE	RCS		Physics	RE		Average excore power	Fraction
809	POW_EXCORE_OFFSET_AV	Output	CORE	RCS		Physics	RE		Average excore axial offset	Dimensionless
816	POW_USER_QAXL	Output					RE	20	Axial power shape	Dimensionless
817	POW_ZRH2O_IZX	I/O	CORE	RCS		Zr Reaction	LO	20	Indicator: non-reacted clad is present, separately for each section. If POW_ZRH2O_NYZIR=T and the zirc-water reaction is desired, then the first CHT_NUM_NODE elements of this array must be initialized to True. Reference 1, Section 3 1.3 and Table 7.3	True False
818	POW_ZRH2O_PCZR	Output	CORE	RCS		Zr Reaction	RE	20	Percent zirconium reacted. Reference 1, Section 3.1.3 and Table 7 3.	Percent
819	POW_ZRH2O_ZX	Output	CORE	RCS		Zr Reaction	RE	20	Thickness of reacted cladding. Reference 1, Section 3.1.3 and Table 7.3	Feet
820	POW_ZRH2O_QZRH2O	Output	CORE	RCS		Zr Reaction	RE	20	Zr-H2O heat generation flux. Reference 1, Section 3.1.3 and Table 7 3.	Btu/sec-ft^2

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
821	KSHAPIN	Input	CORE	RCS		T/H Dimension	RE	50	Core power shape. This results in the fraction of power generated in each of the axial sections. This input is obtained from ASI information. Note that the basedeck data represents one shape which requires review by the USER to ensure applicability to a given scenario. The exact definition of KSHAPIN depends on the input option AXPD_INPUT_OPT. See AXPD_INPUT OPT for full details. Reference 1, Section 7.1.1.	Fraction
822	ZSHAPIN	Input	CORE	RCS		T/H Dimension	RE	50	Fraction of core height, used in conjunction with the power shape KSHAPIN if AXPD_INPUT_OPT = 1. See AXPD_INPUT OPT for full details. Reference 1, Section 7.1.1.	Fraction
823	AXPD_INPUT_OPT	Input	CORE	RCS		Flag	IN		Axial power shape input option: 0=node average, 1=end points, 2=direct. See AXPD_INPUT OPT for full details. Reference 1, Section 7.1.1. AXPD_INPUT_OPT = 0 KSHAPIN is the node average powers for equally spaced axial sections. CENTS finds the number of input points by counting the non-zero elements in KSHAPIN. The user must zero out any unused array elements. The input shape need not be normalized. AXPD_INPUT_OPT = 1 KSHAPIN is the pointwise powers, as a function of ZSHAPIN which is the normalized axial heights. AXPD_NUM_POINTS is the number of points in KSHAPIN and ZSHAPIN. If points are not provided for ZSHAPIN= 0.0 or ZSHAPIN= 1.0, the power at these points is found by extrapolation. The input shape KSHAPIN need not be normalized. AXPD_INPUT_OPT = 2 No processing of the KSHAPIN array is performed. The first CHT_NUM_NODE of the KSHAPIN array are transferred to the array POW_USER_QAXL.	Dimensionless
824	AXPD_NUM_POINTS	Input	CORE	RCS		Model Design	IN		Number of points in the input pointwise axial power distribution KSHAPIN as a function of the normalized axial heights ZSHAPIN Used only if AXPD_INPUT_OPT = 1. See AXPD_INPUT OPT for full details. Reference 1, Section 7.1.1.	Dimensionless
825	AXPD_PRINT_NORMALIZATION	Input	CORE	RCS		Flag	IN		The details of the normalization of KSHAPIN are printed if this flag is set to 1. Reference 1, Section 7.1.1.	Dimensionless
826	RCS_COMMON	Segment					RE	12000	RCS global common variables	Segment
827	MODEL_OFF	Partition					LO	10	Turns off models	Partition
828	MOD_OFF_RCP	Input	RCP	RCS		Flag	LO		Turns off RCP model. Except during model testing, this flag should always be set to False, which keeps the pump model active. This flag is only used for debug in order to isolate some problem to one of the major models.	True False

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
830	MOD_OFF_CHT	Input	CORE	RCS		Flag	LO		Turns off CHT model. Except during model testing, this flag should always be set to False, which keeps the Core heat transfer model active. This flag is only used for debug in order to isolate some problem to one of the major models. This flag is only used for debug in order to isolate some problem to one of the major models.	True False
831	MOD_OFF_RCS	Input	RCS			Flag	LO		Turns off RCS model. Except during model testing, this flag should always be set to False, which keeps the RCS model active.	True False
832	MOD_OFF_QT	Input	PZR	RCS		Flag	LO		Turns off QT model. This flag is most often set to true, unless specific Quench Tank transients are required to be analyzed. In that case, the Quench Tank inputs should be reviewed by the USER since they may be just dummy values, used as "place holders". This model is not needed for safety analyses.	True False
833	MOD_OFF_POWER	Input	CORE	RCS		Flag	LO		Turns off POWER model. Except during model testing, this flag should always be set to False, which keeps the POWER model active. This flag is only used for debug in order to isolate some problem to one of the major models.	True False
834	RCS_INTERNAL	Partition					RE	8400	RCS internal variables	Partition
835	RCS_NODE_VARIABLES	Partition					RE	3100	Node variables	Partition
836	RCS_NODE_PRESSURES	Partition					RE	100	Node pressure arrays	Partition
837	PRES_PRED	Output	RCS			T/H State	RE	50	Predicted node pressures.	Psia
838	PRESS	Output	RCS			T/H State	RE	50	RCS Node pressures	Psia
839	RCS_NODE_ENERGIES	Partition					RE	100	RCS Node energy arrays	Partition
840	ENGY_TOT	Output	RCS			T/H State	RE	50	RCS Node total energies	Btu
841	ENGY_STM	Output	RCS			T/H State	RE	50	RCS Node steam energies	Btu
842	RCS_NODE_MASSES	Partition					RE	200	RCS Node mass arrays	Partition
843	MASS_TOT	Output	RCS			T/H State	RE	50	RCS Node total masses	Lbm
844	MASS_LIQ	Output	RCS			T/H State	RE	50	RCS Node liquid masses	Lbm
845	MASS_STM	Output	RCS			T/H State	RE	50	RCS Node steam masses	Lbm
846	MASS_BUB	Output	RCS			T/H State	RE	50	Mass of entrained bubbles	Lbm
847	RCS_NODE_ENTHALPIES	Partition					RE	300	RCS Node enthalpy arrays	Partition
848	ENTH_TOT	Output	RCS			T/H State	RE	50	RCS Node average enthalpies	Btu/lbm
849	ENTH_LIQ	Output	RCS			T/H State	RE	50	RCS Node liquid enthalpies	Btu/lbm
850	ENTH_STM	Output	RCS			T/H State	RE	50	RCS Node steam enthalpies	Btu/lbm
851	ENTH_MIX	Output	RCS			T/H State	RE	50	RCS Node two-phase mixture enthalpies	Btu/lbm
852	ENTH_LIQ_SAT	Output	RCS			T/H State	RE	50	RCS Node saturated liquid enthalpies	Btu/lbm
853	ENTH_STM_SAT	Output	RCS			T/H State	RE	50	RCS Node saturated steam enthalpies	Btu/lbm
854	RCS_NODE_SPEC_VOLUME	Partition					RE	250	RCS Node specific volume arrays	Partition
855	SVOL_TOT	Output	RCS			T/H State	RE	50	RCS Node average specific volumes	Ft^3/lbm
856	SVOL_LIQ	Output	RCS			T/H State	RE	50	RCS Node liquid specific volumes	Ft^3/lbm
857	SVOL_STM	Output	RCS			T/H State	RE	50	RCS Node steam specific volumes	Ft^3/lbm
858	SVOL_LIQ_SAT	Output	RCS			T/H State	RE	50	RCS Node saturated liquid specific volumes	Ft^3/lbm
859	SVOL_STM_SAT	Output	RCS			T/H State	RE	50	RCS Node saturated steam specific volumes	Ft^3/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
860	RCS_NODE_TEMPERATURE	Partition					RE	350	RCS Node temperature arrays	Partition
861	TEMP_TOT	Output	RCS			T/H State	RE	50	RCS Node fluid temperatures. This is TEMP_LIQ if the node is 100% liquid, TEMP_STM if the node is 100% steam, and TEMP_SAT if the node is two-phase (even in thermal nonequilibrium).	Degree F
862	TEMP_LIQ	Output	RCS			T/H State	RE	50	RCS Node liquid temperatures	Degree F
863	TEMP_STM	Output	RCS			T/H State	RE	50	RCS Node steam temperatures	Degree F
864	TEMP_SAT	Output	RCS			T/H State	RE	50	RCS Node saturation temperatures	Degree F
865	TEMP_WALL	Output	RCS			T/H State	RE	50	RCS Node wall temperatures	Degree F
866	SUBC_LIQ	Output	RCS			T/H State	RE	50	RCS Node liquid subcooling	Del-DegF
867	TEMP_CONT	Input	RCS			T/H Dimension	RE	50	RCS Node containment temperatures. Typically, there is only one temperature set for the containment which is used for all RCS Nodes. This input parameter is set by the USER. CENTS does not model containment transients; therefore, this variable changes only by USER manipulation, such as with a RAMP statement	Degree F
868	RCS_NODE_HEAT_RATES	Partition					RE	350	RCS Node heat rate arrays	Partition
869	HEAT_WALL	Output	RCS			T/H State	RE	50	RCS Node wall to coolant heat rates. This output is calculated based on fluid and wall temperature differences and N_HEAT_XFER_LIQ and/or _STM. HEAT_WALL=HEAT_LIQ+HEAT_STM	Btu/sec
870	HEAT_CONT	Output	RCS			T/H State	RE	50	RCS Node wall to containment heat rates. This output is calculated based on containment and wall temperature differences and N_HEAT_XFER_CONT.	Btu/sec
871	HEAT_EXT	Output	RCS			T/H State	RE	50	RCS Node external heat rates. External heat sources in the RCS typically refers to either the pressurizer heaters or the RCPs. Other RCS Nodes values are =0.0 Various CENTS outputs are equivalent. heat_ext(2)=(sumof)heat_heater(1,..,6)=heat_przr heat_ext(9,10)=heat_pump(1,2)=rcp_heat(1,2) heat_ext(15,16)=heat_pump(3,4)=rcp_heat(3,4)	Btu/sec
872	HEAT_TOT	Output	RCS			T/H State	RE	50	RCS Node total heat rates. This output parameter is a summation of all the heat addition rates on the fluid within each RCS Node. HEAT_TOT=HEAT_LIQ+HEAT_STM+HEAT_EXT+HEAT_COND	Btu/sec
873	HEAT_STM	Output	RCS			T/H State	RE	50	RCS Node wall-to-steam heat rates = (TEMP_STM-TEMP_WALL)*N_HEAT_XFER_STM	Btu/sec
874	HEAT_LIQ	Output	RCS			T/H State	RE	50	RCS Node wall-to-liquid heat rates = (TEMP_LIQ-TEMP_WALL)*N_HEAT_XFER_LIQ	Btu/sec
875	HEAT_COND	Output	RCS			T/H State	RE	50	RCS Node condensation heat rates. This output is calculated by CENTS based upon the temperature difference between the liquid and the steam within a RCS Node and XFER_SURF_POFF or _PON	Btu/sec
876	RCS_NODE_LEVELS	Partition	RCS				RE	100	RCS Node coolant level arrays	Partition
877	LEVL_MIX	Output	RCS			T/H State	RE	50	RCS Node two-phase mixture levels	Feet

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
878	LEVL_LIQ	Output	RCS			T/H State	RE	50	Subcooled (or collapsed) liquid level	Feet
879	RCS_NODE_STEAM_FRAC	Partition	RCS				RE	150	RCS Node steam fraction arrays	Partition
880	QUAL_TOT	Output	RCS			T/H State	RE	50	RCS Node steam mass fractions (qualities)	Fraction
881	QUAL_MIX	Output	RCS			T/H State	RE	50	Two-phase mix mass fractions (qualities)	Fraction
882	VOID_FRAC	Output	RCS			T/H State	RE	50	RCS Node void fractions	Fraction
883	RCS_NODE_DERIVATIVES	Partition	RCS				RE	650	Derivative arrays	Partition
884	DPDM_TOT	Output	RCS			T/H State	RE	50	RCS Node Pressure derivatives, on total mass	Composite Units
885	DPDM_LIQ	Output	RCS			T/H State	RE	50	RCS Node Pressure derivatives, on liquid mass	Composite Units
886	DPDM_STM	Output	RCS			T/H State	RE	50	RCS Node Pressure derivatives, on steam mass	Composite Units
887	DPDU_TOT	Output	RCS			T/H State	RE	50	RCS Node Pressure derivatives, on total energy	Composite Units
888	DPDU_STM	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative on steam	Composite Units
891	DVDP_TOT	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative on total spec volume	Composite Units
892	DVDH_TOT	Output	RCS			T/H State	RE	50	RCS Node Enthalpy derivative on total spec volume	Composite Units
893	DHF_DP	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative of sat. liquid enthalpy	Composite Units
894	DHG_DP	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative of sat. steam enthalpy	Composite Units
895	DVF_DP	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative of sat. liquid spec. volume	Composite Units
896	DVG_DP	Output	RCS			T/H State	RE	50	RCS Node Pressure derivative of sat. steam spec. volume	Composite Units
897	RCS_NODE_BUBBLES	Partition	RCS				RE	100	RCS Node bubble release arrays	Partition
898	RELE_BUB	Output	RCS			T/H State	RE	50	RCS Node bubble release rates	Lbm/sec
899	DRFT_BUB	Output	RCS			T/H State	RE	50	RCS Node bubble drift velocities	Feet
900	RCS_NODE_CONDENSATION	Partition	RCS				RE	250	Steam to liquid condensation variables	Partition
901	COND_TOT	Output	RCS			T/H State	RE	50	Total steam condensation rate in RCS Node	Lbm/sec
902	COND_BOIL	Output	RCS			T/H State	RE	50	Change-of-phase rate due to vaporization	Lbm/sec
903	COND_SURF	Output	RCS			T/H State	RE	50	RCS Node Liquid-steam surface condensation rate	Lbm/sec
904	COND_INJ	Output	RCS			T/H State	RE	50	RCS Node Condensation rate due to incoming liquid	Lbm/sec
905	COND_BUB	Output	RCS			T/H State	RE	50	RCS Node Condensation rate of entrained bubbles	Lbm/sec
906	RCS_NODE_STATES	Partition	RCS				RE	150	Non-equilibrium and heterogeneity flags	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
907	NE_CANDIDATE	Input	RCS			Flag	IN	50	Thermal non-equilibrium (N/E) state in RCS nodes. This array of pointer flags is Modeler-supplied, to define the possible nonequilibrium states in each RCS node. For each node, this flag is applicable when, and only when, the node contains both liquid and steam simultaneously. Then, thermal N/E allows the two phases to coexist at two different temperatures. At each calculational time step, for each two-phase node, CENTS begins with the N/E state indicated in NE_CANDIDATE and tests its validity. If not valid, CENTS tests the lower states, until one is valid, or until state 0 which is always valid. The resulting N/E state is stored in the output array NON_EQ_STATE: 3 = Thermal N/E with subcooled liquid and superheated steam. 2 = Thermal N/E with saturated liquid and superheated steam. 1 = Thermal N/E with subcooled liquid and saturated steam. 0 = Thermal equilibrium only. Non-equilibrium not possible. For example, if subcooled water enters the node, then just enough steam will condense and release latent heat to saturate the water. For realistic calculations, NE_CANDIDATE should be 3 in at least the following RCS Nodes: inner vessel, upper head, pressurizer. It should be 1 in at least the following RCS Nodes (unless they have 3): downcomer, cold legs; it may be 0 in all other RCS Nodes, but a value of 1 is much preferred. This is an array of model pointer flags, and is independent of plant design, except for its dependence on the specific nodalization. Reference 1, Section 4.4.	Pointer
908	NON_EQ_STATE	Output	RCS			Flag	IN	50	Non-equilibrium state currently in existence in RCS nodes. See full description under NE_CANDIDATE. Reference 1, Section 4 4.	Pointer
909	N_HETERO	Output	RCS			Flag	LO	50	Flag indicating RCS Node is heterogeneous	True False
910	VOL_MIX	Output	RCS			T/H State	RE	50	Volume of two-phase mixture in node	Partition
911	RCS_SECT_NODE_VARIABLES	Partition					RE	71	RCS sectionalized node variables	Partition
912	RCS_MBUB_SS	Output	RCS			T/H State	RE		SS bubble mass sect. Node.	Lbm
913	RCS_RELE_PRIME	Output	RCS			T/H State	RE		Derivative of bubble release rate.	Composite Units
914	RCS_VOID_TOP	Output	RCS			T/H State	RE		SS surf. void fraction	Fraction
915	RCS_VOID_TRAN	Output	RCS			T/H State	RE		Trans. surf. void fraction	Fraction
916	RCS_TRANS_CORR	Output	RCS			T/H State	RE		Transient bub. rel. correction	Dimensionless
917	QUAL_MIX_SECT	Output	RCS			T/H State	RE	1, 22	Array of core axial section, two-phase mix qualities.	Fraction
918	MASS_BUB_SECT	Output	RCS			T/H State	RE	1, 22	Array of core axial section bubble masses	Lbm
919	SLIP_SECT	Output	RCS			T/H State	RE	1, 22	Array of core axial section slip ratios	Fraction
920	RCS_PATH_VARIABLES	Partition					RE	2750	Path variables	Partition
921	RCS_PATH_FLOW_RATES	Partition					RE	250	Path flow rate arrays	Partition

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
922	P_FLOW	Output Partition					RE	150	Path mass flow rates	Lbm/sec
923	RCS_P_FLOW_MOM	Output	RCS			T/H State	RE	100	Momentum paths mass flow rate	Lbm/sec
924	RCS_P_FLOW_NONM	Output Partition					RE	50	Non momentum paths mass flow rate	Lbm/sec
925	RCS_PATHEXT_FLOW	Output Partition					RE	25	External paths mass flow rate	Lbm/sec
926	RCS_RCPLEAK_FLOW	Input	RCS	RCP		T/H State	RE	4	RCP leak mass flow	Lbm/sec
927	RCS_CHGS_FLOW	Output	RCS	CVCS		T/H State	RE	4	Charging mass flow	Lbm/sec
928	RCS_LDNS_FLOW	Output	RCS	CVCS		T/H State	RE	4	RCS- letdown mass flow	Lbm/sec
929	RCS_RCW_FLOW	Output	RCS	RCW		T/H State	RE	1	RCS RCW drains flow	Lbm/sec
930	RCS_SDC_FLOW	Output	RCS			T/H State	RE	2	RCS shutdown cooling flow	Lbm/sec
931	RCS_SIS_FLOW	Output	RCS	SIS		T/H State	RE	8	RCS safety injection flow	Lbm/sec
932	RCS_PATHLEAK_FLOW	Output Partition					RE	17	Leak paths mass flow rate	Lbm/sec
933	RCS_SGTR_FLOW	Output	RCS	SG		T/H State	RE	8	RCS SG tube rupture flow	Lbm/sec
934	RCS_SBLOCA_FLOW	Output	RCS			T/H State	RE	4	RCS small break LOCA flow	Lbm/sec
935	RCS_RODEJ_FLOW	Output	RCS			T/H State	RE		RCS rod ejection small break flow	Lbm/sec
936	RCS_ORING_FLOW	Output	RCS			T/H State	RE		RCS O-ring seal flow	Lbm/sec
937	RCS_LBLOCA_FLOW	Output	RCS			T/H State	RE		RCS large break LOCA flow	Lbm/sec
938	RCS_PATHINT_FLOW	Output Partition					RE	8	RCS internal paths mass flow rate	Lbm/sec
939	RCS_SPRAY_FLOW	Output	RCS	PZR		T/H State	RE		RCS pressurizer spray flow	Lbm/sec
940	RCS_SPRAYBLEED_FLOW	Output	RCS	PZR		T/H State	RE	2	RCS pressurizer spray bleed flow	Lbm/sec
941	RCS_PRZR_RELIEF_FLOW	Output	RCS	PZR		T/H State	RE		Pressurizer relief valves flow	Lbm/sec
942	RCS_UHEAD_RELIEF_FLOW	Output	RCS			T/H State	RE		Upper head relief valves flow	Lbm/sec
943	P_FLOW_CRIT	Output	RCS			T/H State	RE	100	Path critical flow rates	Lbm/sec
944	RCS_PATH_ENTHALPIES	Partition					RE	400	Path flow enthalpies	Partition
945	P_ENTH	Output Partition					RE	150	Path average enthalpies	Btu/lbm
946	RCS_P_ENTH_MOM	Output	RCS			T/H State	RE	100	Momentum paths enthalpy	Btu/lbm
947	RCS_P_ENTH_NONM	Output Partition					RE	50	Non momentum paths enthalpy	Btu/lbm
948	RCS_PATHEXT_ENTH	Output Partition					RE	25	External paths enthalpy	Btu/lbm
949	RCS_RCPLEAK_ENTH	Output	RCS	RCP		T/H State	RE	4	RCP leak enthalpy	Btu/lbm
950	RCS_CHGS_ENTH	Output	RCS	CVCS		T/H State	RE	4	Charging enthalpy	Btu/lbm
951	RCS_LDNS_ENTH	Output	RCS	CVCS		T/H State	RE	4	RCS- letdown enthalpy	Btu/lbm
952	RCS_RCW_ENTH	Output	RCS	RCW		T/H State	RE	1	RCS RCW drains enthalpy	Btu/lbm
953	RCS_SDC_ENTH	Output	RCS			T/H State	RE	2	RCS shutdown cooling enthalpy	Btu/lbm
954	RCS_SIS_ENTH	Output	RCS	SIS		T/H State	RE	8	RCS safety injection enthalpy	Btu/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
955	RCS_PATHLEAK_ENTH	Output Partition					RE	17	Leak paths enthalpy	Btu/lbm
956	RCS_SGTR_ENTH	Output	RCS	SG		T/H State	RE	8	RCS SG tube rupture enthalpy	Btu/lbm
957	RCS_SBLOCA_ENTH	Output	RCS			T/H State	RE	4	RCS small break LOCA enthalpy	Btu/lbm
958	RCS_RODEJ_ENTH	Output	RCS			T/H State	RE		RCS rod ejection small break enthalpy	Btu/lbm
959	RCS_ORING_ENTH	Output	RCS			T/H State	RE		RCS o-ring seal enthalpy	Btu/lbm
960	RCS_LBLOCA_ENTH	Output	RCS			T/H State	RE		RCS large break LOCA enthalpy	Btu/lbm
961	RCS_PATHINT_ENTH	Output Partition					RE	8	RCS internal paths enthalpy	Btu/lbm
962	RCS_SPRAY_ENTH	Output	RCS	PZR		T/H State	RE		RCS pressurizer spray enthalpy	Btu/lbm
963	RCS_SPRAYBLEED_ENTH	Output	RCS	PZR		T/H State	RE	2	RCS pressurizer spray bleed enthalpy	Btu/lbm
964	RCS_PRZR_RELIEF_ENTH	Output	RCS	PZR		T/H State	RE		Pressurizer relief valves enthalpy	Btu/lbm
965	RCS_UHEAD_RELIEF_ENTH	Output	RCS			T/H State	RE		Upper head relief valves enthalpy	Btu/lbm
966	P_ENTH_LIQ	Output	RCS			T/H State	RE	100	Path liquid enthalpies	Btu/lbm
967	P_ENTH_STM	Output	RCS			T/H State	RE	100	Path steam enthalpies	Btu/lbm
968	P_SVOL	Output	RCS			T/H State	RE	100	Path average specific volumes	Ft^3/lbm
969	RCS_PATH_QUALITIES	Partition					RE	500	Path flow qualities	Partition
970	P_QUAL	Output Partition					RE	150	Path average steam fractions (quality)	Fraction
971	RCS_P_QUAL_MOM	Output	RCS			T/H State	RE	100	Momentum paths quality	Fraction
972	RCS_P_QUAL_NONM	Output Partition					RE	50	Non momentum paths quality	Fraction
973	RCS_PATHEXT_QUAL	Output Partition					RE	25	External paths quality	Fraction
974	RCS_RCPLEAK_QUAL	Output	RCS	RCP		T/H State	RE	4	RCP leak quality	Fraction
975	RCS_CHGS_QUAL	Output	RCS	CVCS		T/H State	RE	4	Charging quality	Fraction
976	RCS_LDNS_QUAL	Output	RCS	CVCS		T/H State	RE	4	RCS- letdown quality	Fraction
977	RCS_RCW_QUAL	Output	RCS	RCW		T/H State	RE	1	RCS RCW drains qual	Fraction
978	RCS_SDC_QUAL	Output	RCS			T/H State	RE	2	RCS shutdown cooling qual	Fraction
979	RCS_SIS_QUAL	Output	RCS	SIS		T/H State	RE	8	RCS safety injection qual	Fraction
980	RCS_PATHLEAK_QUAL	Output Partition					RE	17	Leak paths quality	Fraction
981	RCS_SGTR_QUAL	Output	RCS	SG		T/H State	RE	8	RCS SG tube rupture qual	Fraction
982	RCS_SBLOCA_QUAL	Output	RCS			T/H State	RE	4	RCS small break LOCA qual	Fraction
983	RCS_RODEJ_QUAL	Output	RCS			T/H State	RE		RCS rod ejection small break qual	Fraction
984	RCS_ORING_QUAL	Output	RCS			T/H State	RE		RCS O-ring seal qual	Fraction
985	RCS_LBLOCA_QUAL	Output	RCS			T/H State	RE		RCS large break LOCA qual	Fraction
986	RCS_PATHINT_QUAL	Output Partition	RCS				RE	8	RCS internal paths quality	Fraction
987	RCS_SPRAY_QUAL	Output	RCS	PZR		T/H State	RE		RCS pressurizer spray qual	Fraction
988	RCS_SPRAYBLEED_QUAL	Output	RCS	PZR		T/H State	RE	2	RCS pressurizer spray bleed qual	Fraction

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
989	RCS_PRZR_RELIEF_QUAL	Output	RCS	PZR		T/H State	RE		Pressurizer relief valves qual	Fraction
990	RCS_UHEAD_RELIEF_QUAL	Output	RCS			T/H State	RE		Upper head relief valves qual	Fraction
991	P_VOID	Output	RCS			T/H State	RE	100	Path average steam void fractions	Fraction
992	P_STM_UP	Output Partition	RCS				RE	150	Fraction of path fluid from upstream steam region (modified flow quality)	Fraction
993	RCS_P_STM_UP_MOM	Output	RCS			T/H State	RE	100	Fraction of path fluid from upstream steam region (modified flow quality), momentum paths	Fraction
994	RCS_P_STM_UP_NONM	Output Partition	RCS				RE	50	Fraction of path fluid from upstream steam region (modified flow quality), non-momentum paths	Fraction
995	RCS_PATHEXT_STM_UP	Output Partition	RCS				RE	25	External paths steam quality	Fraction
996	RCS_RCPLEAK_STM_UP	Output	RCS	RCP		T/H State	RE	4	RCP leak steam quality	Fraction
997	RCS_CHGS_STM_UP	Output	RCS	CVCS		T/H State	RE	4	Charging steam quality	Fraction
998	RCS_LDNS_STM_UP	Output	RCS	CVCS		T/H State	RE	4	RCS- letdown steam quality	Fraction
999	RCS_RCW_STM_UP	Output	RCS	RCW		T/H State	RE	1	RCS RCW drains steam quality	Fraction
1000	RCS_SDC_STM_UP	Output	RCS			T/H State	RE	2	RCS shutdown cooling steam quality	Fraction
1001	RCS_SIS_STM_UP	Output	RCS	SIS		T/H State	RE	8	RCS safety injection steam quality	Fraction
1002	RCS_PATHLEAK_STM_UP	Output Partition					RE	17	Leak paths steam quality	Fraction
1003	RCS_SGTR_STM_UP	Output	RCS	SG		T/H State	RE	8	RCS SG tube rupture steam quality	Fraction
1004	RCS_SBLOCA_STM_UP	Output	RCS			T/H State	RE	4	RCS small break LOCA steam quality	Fraction
1005	RCS_RODEJ_STM_UP	Output	RCS			T/H State	RE		RCS rod ejection small break steam quality	Fraction
1006	RCS_ORING_STM_UP	Output	RCS			T/H State	RE		RCS o-ring seal steam quality	Fraction
1007	RCS_LBLOCA_STM_UP	Output	RCS			T/H State	RE		RCS large break LOCA steam quality	Fraction
1008	RCS_PATHINT_STM_UP	Output Partition					RE	8	RCS internal paths steam quality	Fraction
1009	RCS_SPRAY_STM_UP	Output	RCS	PZR		T/H State	RE		RCS pressurizer spray steam quality	Fraction
1010	RCS_SPRAYBLEED_STM_UP	Output	RCS	PZR		T/H State	RE	2	RCS pressurizer spray bleed steam quality	Fraction
1011	RCS_PRZR_RELIEF_STM_UP	Output	RCS	PZR		T/H State	RE		Pressurizer relief valves steam quality	Fraction
1012	RCS_UHEAD_RELIEF_STM_UP	Output	RCS			T/H State	RE		Upper head relief valves steam quality	Fraction
1013	P_STM_DOWN	Output	RCS			T/H State	RE	100	Frac of fluid to downstream steam region	Fraction
1014	RCS_PATH_PRESS_DROPS	Partition					RE	900	Path flow pressure drops	Partition
1015	DP_MOM	Output	RCS			T/H State	RE	100	Momentum pressure drop	Psid
1016	DP_FRIC	Output	RCS			T/H State	RE	100	Friction pressure drop	Psid
1017	DP_ELEV	Output	RCS			T/H State	RE	100	Elevation pressure drop	Psid
1018	DP_LOSS	Output	RCS			T/H State	RE	100	Form loss pressure drop	Psid
1019	DP_HEAD	Output	RCS			T/H State	RE	100	Head pressure drop	Psid
1020	DP_EXT	Output	RCS			T/H State	RE	100	Externally driven pressure drop	Psid
1021	DP_TOT	Output	RCS			T/H State	RE	100	Total pressure drop	Psid
1022	DP_ACTUAL	Output	RCS			T/H State	RE	100	Actual pressure drop (adjacent nodes)	Psid
1023	DP_CHECK	Output	RCS			T/H State	RE	100	Pressure drop check (DP_ACTUAL - DP_TOT)	Psid

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
1024	RCS_PATH_DERIVATIVES	Partition					RE	200	Path momentum terms	Partition
1025	ESUBK	Output	RCS			T/H State	RE	100	Path momentum time derivative	Composite Units
1026	FSUBK	Output	RCS			T/H State	RE	100	Derivative of esubk by flow rate	Composite Units
1027	RCS_PATH_UPDOWN	Partition					RE	400	Path flow direction dependent arrays	Partition
1028	P_NODE_UP	Output	RCS			T/H State	IN	100	Node currently upstream of path	Pointer
1029	P_NODE_DOWN	Output	RCS			T/H State	IN	100	RCS Node currently downstream of path	Pointer
1030	P_ELEV_UP	Output	RCS			T/H State	RE	100	Elevation of currently upstream end	Feet
1031	P_ELEV_DOWN	Output	RCS			T/H State	RE	100	Elevation of currently downstream end	Feet
1032	RCS_STEAM_GENERATOR	Partition					RE	16	Steam generator variables	Partition
1033	HEAT_SG	Output	SG	RCS		T/H State	RE	8	Steam generator heat transfer rates	Btu/sec
1034	RCS_PUMPS	Partition					RE	20	Main coolant pump variables	Partition
1035	SPEED_PUMP	Output	RCP	RCS		Pump Prop.	RE	4	Main coolant pump speeds	Shaft RPM
1036	HEAT_PUMP	Output	RCP	RCS		T/H State	RE	4	Main coolant pump heat rates	Btu/sec
1038	HEAD_PUMP	Output	RCP	RCS		Pump Prop.	RE	4	Main coolant pump heads	Feet
1039	DP_PUMP	Output	RCP	RCS		T/H State	RE	4	Main coolant pump pressure rises. How different from	Psid
1040	RCS_CORE	Partition					RE	80	Reactor core variables	Partition
1041	HEAT_CORE	Output	CORE	RCS		T/H State	RE		Total core-to-coolant heat transfer rate	Btu/sec
1042	FLOW_CORE_IN	Output	CORE	RCS		T/H State	RE		Core inlet flow rate (total minus all bypass flow).	Lbm/sec
1043	BORON_CORE	Output	CORE	RCS		Solutes	RE		Core average boron concentration	Parts/million
1044	LEVL_LIQ_VESSEL	Output	CORE	RCS		T/H State	RE		Collapsed liquid level in vessel downcomer	Feet
1045	LEVL_MIX_VESSEL	Output	CORE	RCS		T/H State	RE		Two-phase mixture level in vessel downcomer	Feet
1046	LEVL_MIX_CORE	Output	CORE	RCS		T/H State	RE		Two-phase mixture level in core	Feet
1047	SVOL_DOWNCOMER	Output	CORE	RCS		T/H State	RE	2, 10	Downcomer specific volumes at excore detectors	Ft^3/lbm
1048	BOUYANCY_CORE	Output	CORE	RCS		T/H State	RE		Core coolant buoyancy ratio	Fraction
1049	DP_LOSS_UPLEN	Output	CORE	RCS		T/H State	RE		Pressure loss in the inner vessel upper plenum, between N_BOT_UPLEN and N_TOP_UPLEN.	Psid
1050	RCS_Q_CEA_CORE	Output	CORE	RCS		T/H State	RE		Heat transfer rate from CEA node to core node	Btu/sec
1051	ENTH_QUAD_CORE	Output	CORE	RCS		T/H State	RE	4	Core inlet radial enthalpy distribution	Btu/lbm
1052	RCS_DELH_HLTILT	Output	CORE	RCS		T/H State	RE	4	Hot leg inlet delta enthalpy tilt	Btu/lbm
1053	RCS_Q_UHEAD_CORE	Output	CORE	RCS		T/H State	RE		Heat transfer rate u-head to core node	Btu/sec
1054	RCS_PRESSURIZER	Partition					RE	80	Pressurizer variables	Partition
1055	VOLT_HEATER	Output	PZR	RCS		Heater Prop.	RE	6	Pressurizer heater effective voltages in each heater bank.	Volts
1056	ADMI_HEATER	Output	PZR	RCS		Heater Prop.	RE	6	Pressurizer heater admittances per bank (=1/R)	Mho admittance
1057	HEAT_ELEC	Output	PZR	RCS		Heater Prop.	RE	6	Pressurizer heater electrical heat rates per bank.	Btu/sec
1058	ENGY_HEATER	Output	PZR	RCS		Heater Prop.	RE	6	Pressurizer heater stored heats per bank.	Btu
1059	TEMP_HEATER	Output	PZR	RCS		Heater Prop.	RE	6	Pressurizer heater temperature in each bank.	Degree F
1060	HEAT_HEATER	Output	PZR	RCS		T/H State	RE	6	Pressurizer heater-to-coolant heat rates per bank.	Btu/sec

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
1061	HEAT_PRZR	Output	PZR	RCS		T/H State	RE		Total pressurizer heater heat rate = Sum (HEAT_HEATER).	Btu/sec
1062	LEVL_PRZR_DP	Output	PZR	RCS		T/H State	RE		Pressure drop for pressurizer level instrument.	Feet
1063	TEMP_PRZR_REF	Input	PZR	RCS		T/H State	RE		Pressurizer reference leg temperature	Degree F
1064	TEMP_PRZR_SURGE	Output	PZR	RCS		T/H State	RE		Surge line water temperature	Degree F
1065	TEMP_PRZR_RTD	Output	PZR	RCS		T/H State	RE		Pressurizer rtd temperature = temp_liq(2) or temp_stm(2), depending upon whether the pressurizer water level is above or below the rtd level.	Degree F
1066	P_FLOW_SPRAY	Output	PZR	RCS		T/H State	RE		Pressurizer spray total flow rate = - P_FLOW(143)	Lbm/sec
1067	P_ENTH_SPRAY	Output	PZR	RCS		T/H State	RE		Pressurizer spray enthalpy	Btu/lbm
1068	P_BORON_SPRAY	Output	PZR	RCS		Solutes	RE		Pressurizer spray boron concentration	Parts/million
1069	P_FLOW_AUX_SPRAY	Output	PZR	RCS		T/H State	RE		Auxiliary spray flow rate	Lbm/sec
1070	P_ENTH_AUX_SPRAY	Output	PZR	RCS		T/H State	RE		Auxiliary spray flow enthalpy	Btu/lbm
1071	P_BORON_AUX_SPRAY	Output	PZR	RCS		Solutes	RE		Auxiliary spray flow boron concentration	Parts/million
1072	P_FLOW_BLEED	Output	PZR	RCS		T/H State	RE	4	Spray bleed flows from cold legs = P_FLOW(144,145).	Lbm/sec
1073	P_FLOW_RELIEF	Output	PZR	RCS		T/H State	RE		Total pressurizer relief flow rate. This is the combined line flow rate, from all sources, inclusive of flow to the QT and containment	Lbm/sec
1074	P_ENTH_RELIEF	Output	PZR	RCS		T/H State	RE		Pressurizer relief flow enthalpy. This is the combined discharge line flow enthalpy.	Btu/lbm
1075	P_SVOL_RELIEF	Output	PZR	RCS		T/H State	RE		Pressurizer relief flow specific volume. This is the combined discharge line flow specific volume.	Ft^3/lbm
1076	VIBR_VALVE_RELIEF	Output	PZR	RCS		Miscellaneous	RE	4	Array of pressurizer relief valve vibration signals. Used for display only.	Volts
1077	TEMP_VALVE_RELIEF	Output	PZR	RCS		T/H State	RE	3	Array of pressurizer relief valve exit temperatures.	Degree F
1078	P_NONC_PRZR_CONT	Output	PZR	RCS		Solutes	RE		Non-condensable flow from pressurizer to containment. This output parameter is calculated by CENTS from the corresponding valve open area and the critical flow tables, using the pressurizer pressure and fluid enthalpy at the exit location, and the non-condensable-fluid specific volume at the exit location. Reference 1, Section 4 12.	Lbm/sec
1079	P_NONC_PRZR_QT	Output	PZR	RCS	QT	Solutes	RE		Non-condensible flow, pressurizer to quench tank. This output parameter is calculated by CENTS from the corresponding valve open area and the critical flow tables, using the pressurizer pressure and fluid enthalpy at the exit location, and the non-condensable-fluid specific volume at the exit location. Reference 1, Section 4.12.	Lbm/sec
1080	P_FLOW_PRZR_QT	Output	PZR	RCS	QT	T/H State	RE		Pressurizer total flow rate to QT. Includes all safeties, PORVs, and vents.	Lbm/sec
1081	RCS_P_FLOW_PRZR_QT2	Output	PZR	RCS	QT	T/H State	RE		PORVs and safeties flow from pressurizer to Quench Tank. This flow to the QT does not include flow from the pressurizer vents, as does P_FLOW_PRZR_QT	Lbm/sec
1082	RCS_PRZR_PRES	Output	PZR	RCS		T/H State	RE		Pressurizer pressure (local variable). Same as PRESS(NODE_PRZR).	Psia
1083	P_ENTH_BLEED	Output	PZR	RCS		T/H State	RE	4	Spray bleed enthalpies from cold legs.	Btu/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
1084	VLV_PRZR_PRES_UP	Output	PZR	RCS		T/H State	RE		Upstream pressure at pressurizer relief valves.	Psia
1085	VLV_PRZR_PRES_DOWN	Output	PZR	RCS		T/H State	RE		Downstream pressure at pressurizer relief valves. With the QT model turned off, this variable is set equal to containment pressure.	Psia
1086	RCS_UPPER_HEAD	Partition					RE	25	Reactor vessel upper head variables	Partition
1087	P_FLOW_UHEAD_QT	Output	RCS	QT		T/H State	RE		Upper head to quench tank flow rate. This output parameter is calculated by CENTS from the corresponding valve open area and the critical flow tables, using the upper head pressure and fluid enthalpy at the exit location, and the non-condensable-fluid specific volume at the exit location.	Lbm/sec
1088	P_ENTH_UHEAD_QT	Output	RCS	QT		T/H State	RE		Upper head to quench tank flow enthalpy.	Btu/lbm
1089	P_FLOW_UHEAD_CONT	Output	RCS			T/H State	RE		Upper head to containment vent flow rate. This output parameter is calculated by CENTS from the corresponding valve open area and the critical flow tables, using the upper head pressure and fluid enthalpy at the exit location, and the non-condensable-fluid specific volume at the exit location.	Lbm/sec
1090	P_ENTH_UHEAD_CONT	Output	RCS			T/H State	RE		Upper head to containment vent enthalpy	Btu/lbm
1091	ENTH_UHEAD_TOP	Output	RCS			T/H State	RE		Enthalpy in upper head vent line. If the level in the UH is above elevation of the upper head relief valve / vent, then this variable equals ENTH_TOT( ). If not, then = ENTH_STM( ).	Btu/lbm
1092	SVOL_UHEAD_TOP	Output	RCS			T/H State	RE		Specific volume at upper head vent line. If the level in the UH is above elevation of the upper head relief valve / vent, then this variable equals SVOL_TOT( ). If not, then = SVOL_STM( ).	Ft^3/lbm
1097	P_NONC_UHEAD_CONT	Output	RCS			Solutes	RE		Non-condensible flow from upper head to containment. This output variable = quality of nonc * flow rate to containment.	Lbm/sec
1098	P_NONC_UHEAD_QT	Output	RCS			Solutes	RE		Non-condensible flow from upper head to the quench tank. This output variable = quality of nonc * flow rate to QT.	Lbm/sec
1099	RCS_UHEAD_PRES	Output	RCS			T/H State	RE		Upper head pressure (local variable).	Psia
1100	RCS_CEA_MULT	Output	RCS			Multiplier	RE	2	CEA paths k factor multipliers. Calculated by CENTS based on RCS_CEAIN_KTERM and the CEA position. See RCS_CEAIN_KTERM for detailed discussion	Dimensionless
1101	RCS_CEA_AV	Output	RCS			Dimension	RE		CEA average position, used in calculating RCS_CEA_MULT.	Feet
1102	RCS_QUENCH_TANK	Partition					RE	20	Quench tank variables	Partition
1103	PRES_QT	Output / Init	PZR	QT	RCS	T/H State	RE		Quench tank pressure. This output is calculated from the ideal gas law. Reference 1, Section 4.16 This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Psia
1104	ENTH_QT	Output	PZR	QT	RCS	T/H State	RE		Quench tank enthalpy. This output is used if-and-only-if the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Btu/lbm
1105	ENGY_QT	Output	PZR	QT	RCS	T/H State	RE		Quench tank liquid energy. This output is calculated from liquid mass * liquid enthalpy. Reference 1, Section 4.16. This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Btu

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimen-sions	Definition	Units
1106	LEVL_QT	Output	PZR	QT	RCS	T/H State	RE		Quench tank liquid level. This output is calculated by CENTS from the mass and specific volume of the liquid and the formulas for volume of a horizontal circular-cylinder volume. Reference 1, Section 4.16. This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Feet
1107	MASS_WAT_QT	Output / Init	PZR	QT	RCS	T/H State	RE		Mass of water in quench tank. This parameter is calculated by CENTS by dM/dt=Sum (Flow rates, W). Reference 1, Section 4.16.	Lbm
1108	MASS_GAS_QT	Output	PZR	QT	RCS	T/H State	RE		Mass of nitrogen in quench tank. This parameter is calculated by CENTS by dM(nc)/dt=Sum (Flow rates(nc), Wnc). Reference 1, Section 4.16. This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Lbm
1109	TEMP_QT	Output / Init	PZR	QT	RCS	T/H State	RE		Quench tank temperature. This parameter is an input required for initialization of the code. Thereafter, it is an output Reference 1, Section 4.16. As an output, it is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F)	Degree F
1110	TEMP_QT_SURGE	Output	PZR	QT	RCS	T/H State	RE		Quench tank in-surge temperature. This parameter is calculated by CENTS from the known flow rates into the QT and fluid conditions for those flow rates. Reference 1, Section 4.16.	Degree F
1111	RUPTURE_QT	Output / Init	PZR	QT	RCS	Flag	LO		Rupture disk ruptured when True. This flag is required as an input for initialization. Thereafter, it becomes an output. When the QT pressure exceeds the rupture pressure, CENTS sets this parameter to true. Reference 1, Section 4.16. This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	True False
1112	CONC_SOLU_QT	Output	PZR	QT	RCS	T/H State	RE	5	Solute concs in quench tank: B,H,I,Cs,Xe. These parameters are calculated by CENTS solving the concentration equation, d(XM)/dt=Sum(Wi * Xi). X=solute concentration, W=flow rate. Reference 1, Section 4.16. These outputs are used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F).	Composite Units
1113	P_NONC_QT_CONT	Output	PZR	QT	RCS	T/H State	RE		Quench tank to cont vent non-cond flow. This output is used iff the quench tank inputs are developed for a given plant basedeck and the QT model is "on" (MOD_OFF_QT=F). Reference 1, Section 4 16.	Lbm/sec
1128	RCS_SOLUTE	Partition					RE	1030	Variables for coolant solute concentrations	Partition
1129	RCS_P_SOLU	Output	RCS			Solutes	RE	50, 5	Non momentum paths solute concentrations	Composite Units

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
1130	RCS_P_BORON	Output	RCS			Solutes	RE	50	Non-momentum paths, boron concentration. This output parameter array is determined by CENTS as follows. For flow out of node through a non-momentum path, the boron concentration is the same as the upstream path. For flow into a node from a non-momentum path, the concentration is usually zero, except for charging, aux.spray and SIS flow. For these, the boron concentration is set by CHGS_RCS_BORON or SIS_RCS_BORON, which are both USER defined inputs. Reference 1, Sections 4.15 and 5 8.2.	Parts/million
1131	RCS_P_HYD	Output	RCS			Solutes	RE	50	Non momentum paths hydrogen. This output parameter array is determined by CENTS as follows. For flow out of node through a non-momentum path, the hydrogen concentration is the same as the upstream path. For flow into a node from a non-momentum path, the concentration is usually zero, except for charging and aux spray. For these, the hydrogen concentration is set by CHGS_RCS_HYD or RCS_P_HYD_AUX_SPRAY, which are both USER defined inputs. Reference 1, Sections 4.15 and 5 8.2.	Lbm/lbm
1132	RCS_P_IOD	Output	RCS			Solutes	RE	50	Non momentum paths iodine concentration. This output parameter array is determined by CENTS as follows. For flow out of node through a non-momentum path, the iodine concentration is the same as the upstream path. For flow into a node from a non-momentum path, the concentration is usually zero, except for charging and aux.spray. For these, the iodine concentration is set by CHGS_RCS_IOD or RCS_P_IOD_AUX_SPRAY, which are both USER defined inputs. Reference 1, Sections 4.15 and 5.8.2.	Microcurie/lbm
1133	RCS_P_PART	Output	RCS			Solutes	RE	50	Non momentum paths particulates concentration. This output parameter array is determined by CENTS as follows. For flow out of node through a non-momentum path, the particulates concentration is the same as the upstream path. For flow into a node from a non-momentum path, the concentration is usually zero, except for charging and aux.spray. For these, the hydrogen concentration is set by CHGS_RCS_PART or RCS_P_PART_AUX_SPRAY, which are both USER defined inputs. Reference 1, Sections 4.15 and 5 8 2.	Microcurie/lbm
1134	RCS_P_XEN	Output	RCS			Solutes	RE	50	Non momentum paths xenon concentration. This output parameter array is determined by CENTS as follows. For flow out of node through a non-momentum path, the Xenon concentration is the same as the upstream path. For flow into a node from a non-momentum path, the concentration is usually zero, except for charging and aux.spray. For these, the Xenon concentration is set by CHGS_RCS_XEN or RCS_P_XEN_AUX_SPRAY, which are both USER defined inputs. Reference 1, Sections 4.15 and 5 8.2.	Microcurie/lbm
1135	RCS_P_HYD_AUX_SPRAY	Output	RCS			Solutes	RE		Aux spray hydrogen concentration. This is set by CENTS equal to CHGS_RCS_HYD, since the water source for both charging and Aux spray are the same. Reference 1, Sections 4.15 and 5 8.2.	Lbm/lbm

Table G.1: Dictionary Listing

Index No.	Long Variable Name	Input / Output	System	System Alt. 1	System Alt. 2	Variable's Function	Type	Dimensions	Definition	Units
1136	RCS_P_IOD_AUX_SPRAY	Output	RCS			Solutes	RE		Aux spray iodine concentration. This is set by CENTS equal to CHGS_RCS_IOD, since the water source for both charging and Aux spray are the same. Reference 1, Sections 4.15 and 5.8.2.	Microcurie/lbm
1137	RCS_P_PART_AUX_SPRAY	Output	RCS			Solutes	RE		Aux spray particulate concentration. This is set by CENTS equal to CHGS_RCS_PART, since the water source for both charging and Aux spray are the same. Reference 1, Sections 4.15 and 5.8.2.	Microcurie/lbm
1138	RCS_P_XEN_AUX_SPRAY	Output	RCS			Solutes	RE		Aux spray xenon concentration. This is set by CENTS equal to CHGS_RCS_XEN, since the water source for both charging and Aux spray are the same. Reference 1, Sections 4 15 and 5 8 2.	Microcurie/lbm
1140	RCS_CONC_SOLU	Output	RCS			Solutes	RE	50, 5	Node solution concentrations. Reference 1, Sections 4.15 and 5 8.2.	Composite Units
1141	RCS_CONC_BORON	Output / Init	RCS			Solutes	RE	50	RCS Node boron concentrations This parameter array is both a CENTS calculated output and a USER adjusted input. For instance, RBINIT is used at initialization to set the boron concentration of all nodes to a given value. After initialization, RCS_CONC_BORON(I) = this initial value. If the USER wanted to adjust the boron in the pressurizer or RV UH nodes, then RCS_CONC_BORON (2),(4) could be re-established at x ppm. CENTS would then calculate any changes to x as the given transient progressed, thus reverting RCS_CONC_BORON to an output role. Reference 1, Sections 4.15 and 5 8 2	Parts/million
1142	RCS_CONC_HYD	Output / Init	RCS			Solutes	RE	50	RCS Node hydrogen concentrations. This parameter array is both a CENTS calculated output and a USER adjusted input. For instance, hyd. conc. = 0.0 at initialization. After initialization, RCS_CONC_HYD(I) = 0.0. If the USER wanted to adjust the hydrogen in the pressurizer or RV UH nodes for example, then RCS_CONC_HYD (2),(4) could be re-established at x lbm/lbm. CENTS would then calculate any changes to x as the given transient progressed, thus reverting RCS_CONC_HYD to an output role affected by transport of the hydrogen and releases from the Zr-water reaction model. Reference 1, Sections 4.15 and 5.8 2.	Lbm/lbm
1143	RCS_CONC_IOD	Output / Init	RCS			Solutes	RE	50	RCS Node iodine concentrations. This parameter array is both a CENTS calculated output and a USER adjusted input. For instance, RCS_DOSE_INIT_IOD is used at initialization to set the iodine concentration of all nodes to a given value. After initialization, RCS_CONC_IOD(I) = this initial value. If the USER wanted to adjust the iodine in the pressurizer or RV UH nodes as an example, then RCS_CONC_IOD (2),(4) could be re-established at x microC/lbm. CENTS would then calculate any changes to x as the given transient progressed, thus reverting RCS_CONC_IOD to an output role Reference 1, Sections 4 15 and 5.8.2.	Microcurie/lbm