6.0. INPUT-DATA PREPARATION

This chapter describes how to define the TRACIN-file input data for TRAC-M and how to do a restart calculation with TRCRST-file data from a previous calculation's TRCDMP-file data. The input TRACIN file and output LABIN, TRCMSG, TRCOUT, and TRCXTV files can be in SI or English units. The TRCDMP file is in SI units.

6.1. Input-Data Organization

The input-data TRACIN file is divided into eight major sections: main, countercurrent flow-limitation, material-properties, hydraulic-path steady-state initialization, control-parameter, radiation–enclosure, component, and timestep data. These data-block sections and their subsections are read in the listed order shown in Fig. 6-1.

Note: **Reflood Models.** The following specifications for file TRACIN are valid for both TRAC-M/F77 and TRAC-M/F90 for use in the core reflood model that was developed for TRAC-PF1/MOD2. If the user wishes to use the reflood model for multiple-quench fronts (simultaneous top-down and bottom-up reflood, Refs. 6-1 and 6-2), which is only in TRAC-M/F77, additional input specifications are required. These specifications are provided in Appendix M, which was adapted from Ref. 6-1. The optimization methodology that was developed as a part of the TRAC-M/F77 reflood effort also requires new input. These specifications are also provided in Appendix M, and in Ref. 6-1. Reference 6-1 should be consulted for additional information on the use of the optimization technique (including use of additional files).

Note: **Separation of Input Processing.** The planned separation of TRAC-M/F90 into input and computational engines, post-Version 3.0 (see Section 5.0.), will not affect the specifications for file TRACIN.

The main-data information block contains general parameters including title cards for problem ID and NAMELIST-variable, dump-restart, transient, steady-state, problem-size, problem-convergence criteria, and component identification-number parameter information. This data block is always present in the TRACIN file.

A special model exists in TRAC-M to allow the user to apply correlations for CCFL at specific locations. The user supplies the correlation constants and the locations where the CCFL model is to be evaluated. Alternatively, the values of the constants can be calculated by TRAC-M from thermodynamic properties and geometric data. The correlation data along with the CCFL option flag array must be present in the TRACIN file for calculations where countercurrent flow limitations are applied. The LCCFL array, containing the locations where the CCFL calculation is applied in a hydraulic component, is saved in the restart-data dump TRCDMP file; therefore, those components do not need to be included in the TRACIN file for a restart calculation.

1. Main Data
      Main-Data Cards 1 and 2
      Title Cards
      NAMELIST Data Cards
      Solubility-Parameters Card
      Main-Data Cards 3 to 7
      Component-List Card/s
2. Countercurrent Flow-Limitation Data
      Card Sets 1 to 4
3. Material-Properties Data
      Card Sets 1 to 3
4. Hydraulic-Path Steady-State Initialization Data
      Card Number 1
      Path Cards 1 to 3
5. Control-Parameter Data
      CSS-Controller Data Card
      Multipass Control-Parameter Evaluation Card/s
      Signal-Variable Data Card
      User-Defined Units-Label Data Card
      Control-Block Data Cards 1 to 6
      Trip Dimension Variables Card
      Trip Data Cards 1 to 5
      Trip-Signal-Expression Signal Cards 1 to 4
      Trip-Controlled-Trip Signal Cards 1 and 2
      Trip Setpoint-Factor Table Cards 1 and 2
      Trip-Initiated Restart-Dump and Problem-Termination Cards 1 and 2
      Trip-Initiated Timestep Data Cards 1 to 4
6. Radiation-Enclosure Data
7. Component Data
      BREAK Component Cards 1 to 10 and Card Sets 11 to 17
      FILL Component Cards 1 to 12 and Card Sets 13 to 20
      HTSTR (Heat Structure) ROD or SLAB Component Cards 1 to 26 and
       Card Sets 27 to 85
      PIPE Component Cards 1 to 8 and Card Sets 9 to 35
      PLENUM Component Cards 1 and 2 and Card Sets 3 to 13
      PRIZER (Pressurizer) Component Cards 1 to 5 and Card Sets 6 to 28
      PUMP Component Cards 1 to 15 and Card Sets 16 to 65
      SEPD (Separator) Component Cards 1 to 17 and Card Sets 18 to 79
      TEE Component Cards 1 to 15 and Card Sets 16 to 69
      TURB (Turbine) Component Cards 1 to 13 and Card Sets 14 to 39
      VALVE Component Cards 1 to 10 and Card Sets 11 to 38
      VESSEL Component Cards 1 to 6, Card Sets 7 to 11, Cards 12 to 14,
      Card Sets 15 to 16, Card 17, Card Sets 18 to 56, and Repeat-Level Card
8. Timestep Data
      Cards 1 and 2

Fig. 6-1.   TRAC-M input-data parameter categories in the TRACIN file.

The user has the option to input material-properties data when the TRAC-M internally defined material properties are inappropriate. New properties may be entered for materials that TRAC-M does not define. These properties must be included in the TRACIN file for all restarts because they are not written to the restart-data dump TRCDMP file.

Hydraulic-path, steady-state initialization data provide the user with a convenient way to input phasic temperature and velocity distribution solution estimates for a steady-state calculation. The known or estimated thermal-hydraulic condition and a major heat source or sink are specified at a location in each 1D flow-channel hydraulic path of the hydraulic-system model. At the beginning of the initialization stage of the calculation, TRAC-M uses this information to initialize the phasic temperatures and velocities throughout the system model in all hydraulic components for both single- and two-phase conditions.

Control-parameter data define the control-procedure parameters that are used to control the PWR-system model. These data include: CSS controllers, signal variables, control blocks, and trips as well as the order in which the last three control-parameter types are evaluated. For a CSS calculation, internally programmed proportional-integral (PI) controllers are selected by the user to adjust specific component actions to achieve desired steady-state values for selected system parameters. Signal variables define system-model parameters for control-block input, trip-signal definition, and component-action-table independent-variable definition. Control blocks are functional operators that operate on their input signals to produce an output signal. Their input signals are signal variables or the output signal from control blocks. A control block's output signal is used for the same applications as signal variables. Trips are dynamic ON-OFF switch controllers that provide a logic switch and specify when trip-controlled component actions are to be evaluated. The number of each control-parameter type is defined by the main data. When a smaller number of a particular control-parameter types are input-specified in TRACIN, the remainder comes from the TRCRST restart-data file. All CSS controller data must be reentered in the TRACIN file when a CSS calculation is restarted.

The radiation-enclosure data consist of a set of cards that define the individual enclosures for the optional thermal radiation heat-transfer model. Additional data for the model (radiative properties) are specified in the HTSTR component input.

Note: Thermal Radiation Heat-Transfer Model. Currently, in TRAC-M/F90, the thermal radiation heat-transfer model is not available. The model is available in TRAC-M/F77.

The component-data block is the main body of the input-data file. This block contains a detailed description of every hydraulic and heat-transfer component in the system model unless the calculation is reinitiated from a restart-data dump. For steady-state or transient restart calculations, this block contains only additional or modified components. The remainder of the component data are obtained from the restart TRCRST file. There is a component-data block in TRACIN unless all the component data are to be obtained from the restart file and only an "END" card is specified.

The timestep-data block specifies maximum and minimum timestep sizes, edit frequencies, and the end of the problem for specified time intervals. A new parameter has been added to control the timestep size to conserve convection heat-transfer energy between HTSTR and hydraulic components. This data block is always present in the TRACIN file.

All numeric input data are read into the code with either an E14.4 or I14 format statement by the READI, READR, and LOAD subroutines or as NAMELIST data. Standard Fortran statements are used for formatted and NAMELIST reads. Subroutines READI and READR read scalar data. The LOAD subroutine provides additional flexibility to read array data. Real-variable parameters are input with either SI units (NAMELIST variable IOINP = 0; default) or English units (IOINP = 1).

The user can create a TRACIN input-data file as FREE-format input or as TRAC-format input that is in strict accordance with the input specifications described in Section 6.3. If TRAC-format input is selected, all data and array loading operations must be entered in the card columns specified in Section 6.3. If FREE-format input is chosen, the input cards and the data on each card must adhere to the order specified in Section 6.3., but the data do not have to be entered in the specified columns. In addition to the obvious convenience of not counting columns, FREE-format input gives the TRAC-M user greater flexibility in using comments to document the input-data parameters, and TRAC-M provides better diagnostics from input-error checking. The FREE-format input option is discussed in detail in Section 6.5. The user has the option of outputting file LABIN in either SI units (NAMELIST variable IOLAB = 0, default) or English units (IOLAB = 1). LABIN is a FREE-format TRACIN file with the Fortran variable names of all input variables (defined in Section 6.3.) defined by comments. The following sections describe the dump/restart capability, input-data format specification in detail, LOAD subroutine read formats, FREE-format input option, NAMELIST format, and the TRAC-M output files.

6.2. Dump/Restart Capability

TRAC-M automatically generates a dump/restart data file named TRCDMP, which contains snapshots of the state of the modeled system at various times during the problem evaluation. Any one of these snapshots, called a data dump, may be used to initialize all or part of the modeled system for subsequent calculations. The times when dumps are generated are determined by several criteria. The user may specify a dump frequency time interval on the timestep data cards. A data dump will be generated whenever this time interval has elapsed since the last data dump. These data dumps are added sequentially to the end of the TRCDMP file. A data dump also may be initiated by the user with one or more designated trips. At the time the set status of any of those trips is set ON, a dump is output to the end of the TRCDMP file. This permits the restart of a problem when a trip-signal monitored particular event of interest occurs.

In addition to these user-specified data dumps, TRAC-M automatically generates data dumps at various times. A data dump is generated at the end of the initialization stage, at the end of the steady-state or transient calculation, and at intermediate points in the calculation based upon the central processing unit (CPU) time interval being greater than TDUMPINT since the last data dump. The last feature no longer generates data dumps because the data initialized value of TDUMPINT has been changed from 1800 s to 10^{10} s in subroutine TIMCHK.

To use the TRCDMP file to initialize a subsequent calculation at a specific data dump, the name of the file must be changed from TRCDMP to TRCRST. The timestep number of the particular data dump desired must be specified by DSTEP (Word 1 on Main-Data Card 3). A message containing each data dump's timestep number is sent to the output file TRCOUT whenever a data dump is output during a calculation. If the timestep number specified is negative, TRAC-M will use the last data dump with the largest timestep number and overwrites the negative value of DSTEP (Word 1 on Main-Data Card 3) with the timestep number taken from that data dump. Data retrieved from the selected data dump depend on the information that already has been provided by the TRACIN file. Any component not defined by the TRACIN file (as determined from the component numbers listed in the Main-Data IORDER array) is initialized from the restart data dump. Also, any signal variable, control block, and trip with an ID number that has not already been defined by the TRACIN file will be initialized with its defined state from the data dump.

The value of some input parameters cannot be changed in a restart calculation. These include NAMELIST variables IELV, IKFAC, ITHD, NEWRFD, NDIA1, NENCL, NFRC1, NFRC2, and ISOLUT (Word 3 on Main-Data Card 6). If any of their values are changed, TRAC-M will output an error message and abort the calculation.

6.3. TRAC-M Input-Data Format Specification

The TRAC-M input data are classified into eight general categories:

1. main,
2. countercurrent flow limitation,
3. material properties,
4. hydraulic-path, steady-state initialization,
5. control parameter,
6. radiation enclosure,
7. component, and
8. timestep.

The detailed format of the input-data parameters in each category follows.

6.3.1. Main Data
The main-data parameters are listed below in the order in which they are entered. This data block always must be supplied at the start of the TRACIN file.

Main-Data Card 1. (Free format) The first card of the TRACIN file serves as the free-format ON-OFF switch, indicating whether the cards that follow are in FREE or TRAC-M format. It must be included and must contain the string FREE (free format), TRAC (TRAC-M format), or both strings (FREE overrides TRAC). This card is in free format; up to 80 columns may be used; the control string/s and documentation may appear anywhere on the card.

Main-Data Card 2. (Format 5I14) NUMTCR, IEOS, INOPT, NMAT, ID2O

Columns	Variable	Description
1–14	NUMTCR	Number of title cards to be read (NUMTCR ≥ 1).
15–28	IEOS	Steam/noncondensable gas option. 0 = gas phase treated as a steam and noncondensable gas mixture throughout the modeled system; 1 = gas phase treated as noncondensable gas through- out the modeled system. Evaporation and condensation are inhibited.
29–42	INOPT	Specification for including or excluding NAMELIST group INOPTS input data after the title cards. 0 = NAMELIST group INOPTS input data omitted after the title cards; 1 = NAMELIST group INOPTS input data inserted after the title cards.
43–56	NMAT	Number of different materials for which heat-conduction-related properties will be input. The material-properties data are not passed through the dump/restart TRCDMP/TRCRST file and, hence, must be in the input-data TRACIN file for each restart.
57–70	ID2O	Option for fluid properties. 0 = H_2O; 1 = D_2O.

Title Card(s). (Format 20A4) NUMTCR (Word 1 on Main-Data Card 2) Cards are input.

Note: A minimum of one card is required.

Columns	Variable	Description
1–80	ACH	Problem title information.

NAMELIST Data Cards for Group INOPTS. (NAMELIST format.) This data section is included only if the variable INOPT = 1 (Word 2 on Main-Data Card 2). In this case, one or more of the NAMELIST variables described below may be specified with their variable name = value. The format of these data is not checked during preprocessing of FREE format data. Therefore, its data should be entered carefully to avoid fatal input errors. The data are entered in columns 2–80 on one or more cards, beginning with $INOPTS in columns 2 to 8, and are terminated with a "$END" character. The "$" may be replaced by an "&". A more detailed description of the format for NAMELIST input data is provided in Section 6.6. and in a FORTRAN manual. The following variables are included in the NAMELIST group INOPTS, and one or more of them are included in the NAMELIST data when INOPT = 1 (Word 2 on Main-Data Card 2). Variables omitted from the specified data retain their default value.

Variable	Value Range	Description	Default Value
ALP	0.0 To 1.0	Default value for gas volume fractions (-) (real format). Used when istopt = 1 or 2.	10^{20}
CCIF	> 0.0 kg m^{-4} (> 0.0 lb$_m$ ft^{-4})	Constant two-phase flow interfacial drag coefficient (kg m^{-4}, lb$_m$ ft^{-4}) (real format) if NIFSH = 1.	10^4 kg m^{-4} (1.90×10^2 lb$_m$ ft^{-4})
CFZ3	> 0.0	Default value for 3D loss coefficients (real format). Used when ISTOPT = 1 or 2.	10^{20}
CHM12, CHM22	> 0.0	Subcooled and two-phase multipliers, respectively, for choked-flow multiplier set 2 (real format).	1.0
CHM13, CHM23	> 0.0	Subcooled and two-phase multipliers, respectively, for choked-flow multiplier set 3 (real format).	1.0
CHM14, CHM24	> 0.0	Subcooled and two-phase multipliers, respectively, for choked-flow multiplier set 4 (real format).	1.0
CHM15, CHM25	> 0.0	Subcooled and two-phase multipliers, respectively, for choked-flow multiplier set 5 (real format).	1.0
CPUFLG	0 or 1	Option for eliminating CPU times from being output to files TRCMSG, TRCOUT, and the terminal so that a DIFF file comparison between TRAC-M versions will not include the CPU-time differences between calculations. 0 = no; 1 = yes.	0
DTSTRT	−1.0 or > 0.0 s	Initial timestep size/s (real format) when DTSTRT > 0.0.	-1.0
FDFHL	0.0 to 1.0	Multiplier used on the Forslund-Rohsenow film-boiling correlation in standard blowdown heat transfer. A value of 1.0 is fully on while 0.0 is fully off.	1.0
HD3	≥ 0.0 m (≥ 0.0 ft)	Default value for 3D hydraulic diameters (m, ft) (real format). Used when ISTOPT = 1 or 2.	10^{20} m (3.28× 10^{20} ft)
HSTN	> 0.0 K (> -4.5967 ×10^2 °F)	Default value for HTSTR temperatures (K, °F) (real format) in 3D components. Used when ISTOPT = 1 or 2.	10^{20} K, (1.8× 10^{20} °F)

Variable	Value Range	Description	Default Value
HTCWL	> 0.0 W m^{-2} K^{-1} (> 0.0 Btu ft^{-2} °F^{-1} h^{-1}	Constant wall to liquid heat-transfer coefficient (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) (real format) if ICONHT = 1.	10.0 W m^{-2} K^{-1} (1.76 Btu ft^{-2} °F^{-1} h^{-1})
HTCWV	> 0.0 W m^{-2} K^{-1} (> 0.0 Btu ft^{-2} °F^{1} h^{-1})	Constant wall to vapor heat-transfer coefficient (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) (real format) if ICONHT = 1.	10.0 W m^{-2} K^{-1} (1.76 Btu ft^{-2} °F^{-1} h^{-1})
IADDED	≥ 0	Option that adds a numerical-solution status-parameter message to the TRCMSG and TTY files. The status parameters are written every IADDEDth timestep.	0
IBLAUS	0 or 1	Apply the Blasius interfacial drag correlation in the lower plenum and downcomer of VESSEL components. 0 = no; 1 = yes.	0
ICDELT	0 or 1	Option that overrides the evaluation of DELT at the beginning of an initial calculation by defining DELT = DTMIN when ICDELT = 0. ICDELT = 1 forces DELT to be evaluated.	0
ICFLOW	0,1 or 2	Choked-flow model option. 0 = model turned off; 1 = model using default multipliers is turned on only at component junctions connected to a BREAK; 2 = model using optional multipliers (NAMELIST variables CHM12, CHM22; CHM13, CHM23; CHM14, CHM24; and CHM15, CHM25) is turned on at cell-edges indicated in the component input. (Note that this option requires additional array data for all one-dimensional hydro-dynamic components.)	1
ICONHT	0 or 1	Heat-transfer option. 0 = normal heat-transfer calculation; 1 = constant heat-transfer coefficients.	0

Variable	Value Range	Description	Default Value
IDIAG	0,1,2,3 or 4	This option is intended to generate additional information primarily for the code developer rather than the analyst. This additional information is described in more detail in the TRAC-P Programmer's Manual. The timestep interval during which additional information defined by IDIAG = 3 is output is defined by NAMELIST variables NSDL and NSDU. 0 = standard output; 1 = additional variables, including the stabilizer velocities, are output as part of the large edits written to the TRCOUT file; 2 = information from IDIAG = 1 plus diagnostics about reiterations due to flow reversals are output to the TRCMSG file for every timestep; 3 = information from IDIAG = 1 and 2 plus diagnostics about the temporal changes in gas volume fraction are output to the TRCMSG file. **Note:** the edit interval for the IDIAG = 3 diagnostics is from timestep NSDL to timestep NSDU; 4 = information from IDIAG = 1, 2, and 3 plus diagnostics about reiterations due to out-of-bounds gas volume fraction predictions are output to the TRCMSG file for every timestep. **Note:** The use of IDIAG > 0 will approximately double the size of the TRCOUT file; the use of IDIAG > 1 will greatly increase the size of the TRCMSG file.	0
IDIAGS	0 or 1	Option to select the additional variables written in a large edit to file TRCOUT for 1D hydraulic components when NAMELIST variable IDIAG > 0.0 = liquid and gas mass flows; 1 = ARLN and ARVN stabilizer-solution parameters replace the liquid and gas mass flows.	0

Variable	Value Range	Description	Default Value
IELV	0 or 1	Option that determines whether gravity (GRAV) terms or cell-centered elevations (ELEV) in meters are to be input in the component data. When this option is selected, ELEV (dimensioned NCELLS) or cell-centered elevations should be input for GRAV array data cards in all components. In addition, a BREAK elevation BELV (BREAK component Card Number 5), a FILL elevation FELV (FILL component Card Number 4), and a Vessel elevation shift SHELV (VESSEL component Card Number 13) are required. 0 = gravity terms must be input (default); 1 = cell-centered elevations must be input. **Note:** The value of IELV must not be changed when performing a restart calculation.	0
IGAS	1, 2, 3	Noncondensable-gas type option. 1 = air; 2 = hydrogen; 3 = helium (ideal gas).	1
IGEOM3	0 or 1	Option that determines, for all 3D vessel components, whether the mesh-cell interface flow areas between the downcomer and the inside of the vessel are to be set to zero. 0 = areas to be set to zero; 1 = the user enters the values of the flow-area fractions used.	0
IH2SRC	≥ 0	Option that sets the hydrogen source flag. If this parameter is nonzero, the hydrogen source flags, IGAS = 2 and NOAIR = 0 are set internally by TRAC-P.	0
IHOR	0, 1, 2 or 3	Wall-drag form option. 0 = uses dispersed drag only; 1 = uses stratified drag in one dimension if conditions are met; 2 = always uses stratified drag; 3 = turns off head gradient force.	1

Variable	Value Range	Description	Default Value
IKFAC	0 or 1	Option that defines whether additive loss coefficients (FRIC) or K factors are to be input in the component data. When this option is selected, K factors (dimensioned NCELLS+1) replace the FRIC array input cards in all components. To input K factors that depend on flow direction, include the NFRC1 or NFRC3 options. 0 = additive loss coefficients will be input; 1 = K factors will be input. **Note:** The value of IKFAC must not be changed when performing a restart calculation.	0
IMFR	1 or 3	Option that sends the VESSEL-component phasic mass flows to the TRCXTV file. 1 = sends phasic mass flows for axial direction only; 3 = sends the phasic mass flows in the theta, radial, and axial directions.	1
INLAB	0 or 3	Option that creates, during input-data processing, a new input-data file in free format named INLAB. All input-data values from file TRACIN are echoed to INLAB along with their variable names as comments contained between asterisks. 0 = file INLAB is not created; 3 = file INLAB is created.	0
INVAN	0 or 3	Option that selects either the T_{CHF} or T_{SAT} values for the inverted annular switch. 0 = T_{CHF} value is selected (all code assessment was performed with this option); 3 = T_{SAT} value is selected.	0
IOFFTK	0 or 1	Option that selects TEE component offtake model. 0 = model off; 1 = model on.	0
IOGRF	0 or 1	SI/English units flag for writing graphics data to file TRCXTV. 0 = SI units; 1 = English units.	0

Variable	Value Range	Description	Default Value
Note:		**XMGR5; TRAC-M/F90, Version 3.0.** In Version 3.0 of TRAC-M/F90 XMGR5 graphics postprocessing is only available by selecting NAMELIST-input variable IOGRF = 2, which creates file TRCXTV in XDR format. In this case file TRCXTV is in SI units. Future versions of TRAC-M/F90 will only support the XDR format, and will support both SI and English units. This format will be readable by both XMGR5 and a future version of XTV.	
IOINP	0 or 1	SI/English units flag for reading input data from file TRACIN. 0 = SI units; 1 = English units.	0
IOLAB	0 or 1	SI/English units flag for writing comment-labeled input data to file INLAB. 0 = SI units; 1 = English units.	0
IOOUT	0 or 1	SI/English units flag for echoing input and restart data, writing short and large edits to file TRCOUT, and writing calculative information to file TRCMSG and the terminal. 0 = SI units; 1 = English units.	0
IPOWR	–1, 0 or 1	Option that controls core-power initialization at its steady-state level during a steady-state calculation. See the Appendix on TRAC's control procedure in the TRAC-M/F90 Theory Manual for additional details. IPOWR = –1, turns on the core steady-state power (specified by variable RPOWRI, Word 1 an HTSTR Card Number 22) at time specified by NAMELIST variable TPOWR;	0

Variable	Value Range	Description	Default Value
		IPOWR = 0, turns on the core steady-state power at time based on built-in logic or at time TPOWR, whichever occurs first (the built-in logic checks that the fractional change in the coolant velocity per second is ≤ 0.1 in all hydraulic cells at the bottom of the core that are coupled to powered heat structures and requires the coolant velocity at these locations to be greater than a minimum numerically significant value);	
		IPOWR = 1, turns on the core steady-state power at the beginning of the steady-state calculation.	
IRESET	0 or 1	Option to reinitialize the energy error to zero at the start of a restart calculation. 0 = no (allow the energy error to accumulate from the previous calculation); 1 = yes.	0
ISOLCN	0 or 1	Solubility-parameters option. [Solubility parameters characterize the dissolved material that is followed by the solute tracker when ISOLUT = 1 (Word 3 on Main Card 6.).] **Warning** No input solubility parameters are saved on the dump/restart file; thus, these parameters must be input for each restart. 0 = use of default parameters for linear fit to solubility of orthoboric acid as a function of liquid temperature (default condition); 1 = input parameters for linear fit to solubility of solute as a function of liquid temperature. See Solubility-Parameters Card before Main-Data Card 3.	0

Variable	Value Range	Description	Default Value
ISSCVT	0 or 1	Option for evaluating the EPSS (Word 2 on Main Data Card 5) steady-state convergence test in a TRANSI = 1 (Word 2 on Main Data Card 4) transient calculation. 0 = no; 1 = yes.	0
ISTOPT	0, 1 or 2	Option that allows the user to input only once default values for certain parameters that are used to initialize data arrays for hydraulic components. The default parameter values also are input through the NAMELIST group INOPTS. The NAMELIST variables that can be assigned default values are ALP, CFZ3, HD3, HSTN, P, PA, QPPP,VL, VV, TL, TV, and TW. When ISTOPT= 1 or 2, the values of these variables are used to fill the corresponding arrays in all hydraulic components except PRIZERs and VALVEs. This option can be used for both steady-state and transient calculations.	0

0 = off;
1 = on.
   Those component (excluding PRIZER and VALVES) arrays, for which default values are included in the NAMELIST data, are filled with the default value. All cards that would contain data for the defaulted arrays must be omitted from the input-data file;
2 = on.
   Those component (excluding PRIZER and VALVE) arrays, for which default values are included in the NAMELIST data, are filled with the default value. Cards containing data for the defaulted arrays must remain in the input-data file but are overridden by the default value.

Variable	Value Range	Description	Default Value
ITHD	0 or 1	Option for inputting heat-transfer diameters through variables HDRI and HDRO (Words 3 and 4 on Card Number 4) for HTSTR components. When ITHD = 0, the mesh-cell hydraulic diameters are used for the heat-transfer diameters. 0 = no; 1 = yes. **Note:** The value of ITHD must not be changed when performing a restart calculation.	0
IUNLAB	≥ 0 and ≤ 100	Option for inputting user-defined units-name labels required for defining the units of control block or trip-signal-expression parameters. 0 = no; >0 = yes. **Note:** User-defined units-name label data is not written to the TRCDMP file and not read from the TRCRST file, so the user needs to input the user-defined units-name label data to the TRACIN file for all (initial and restart) TRAC-M calculations.	0
IUNOUT	0 or 1	Option for writing SI/English units to file TRCOUT. 0 = no; 1 = yes.	1
MHTLI	0 or 1	Option for input specifying wall-to-liquid heat-transfer multiplicative design factors for the inner surface of all HTSTR components. 0 = no; 1 = yes.	0
MHTLO	0 or 1	Option for input specifying wall-to-liquid heat-transfer multiplicative design factors for the outer surface of all HTSTR components. 0 = no; 1 = yes.	0

Variable	Value Range	Description	Default Value
MHTVI	0 or 1	Option for input specifying wall-to-gas heat-transfer multiplicative design factors for the inner surface of all HTSTR components. 0 = no; 1 = yes.	0
MHTVO	0 or 1	Option for input specifying wall-to-gas heat-transfer multiplicative design factors for the outer surface of all HTSTR components. 0 = no; 1 = yes.	0
MWFL	0 or 1	Option for input specifying wall-to-liquid wall-friction multiplicative design factors. 0 = no; 1 = yes. **Note:** Additional array input is required by the PIPE, PRIZER, PUMP, SEPD, TEE, TURB, VALVE, and VESSEL components when MWFL = 1.	0
MWFV	0 or 1	Option for input specifying wall-to-gas wall-friction multiplicative design factors. 0 = no; 1 = yes. **Note:** Additional array input is required by the PIPE, PRIZER, PUMP, SEPD, TEE, TURB, VALVE, and VESSEL components when MWFV = 1.	0
NDIA1	1 or 2	Option used to input the heat-transfer diameter as well as the hydraulic diameter (HD), for all 1D hydraulic components for the evaluation of the wall heat-transfer coefficient. When NDIA1 = 2, the dimension of the HD array is doubled to 2× (NCELLS+1). The HD-array data must be defined with NCELLS+1 values for the hydraulic diameter that end with an "e" followed by another record with NCELLS+1 values for the heat-transfer diameter that end with an "e".	1

Variable	Value Range	Description	Default Value
		1 = only hydraulic diameters are input; 2 = hydraulic and heat-transfer diameters are input. **Note:** The value of NDIA1 must not be changed when performing a restart calculation.	
NENCL	≤–1, 0, ≥1	Total number of radiation enclosures in the radiation heat-transfer model. NENCL ≥ 1 acts as an option flag to turn the model on. Specifying NENCL ≤–1 is an input convenience for the user to turn the model off and not require the removal of radiation-model input data (which allows easy comparison of results with and without the radiation heat-transfer model). **Note:** NENCL must not be changed when performing a restart calculation.	0
NEWRFD	0 or 1	This option when turned on will activate the reflood model for HTSTR components coupled to VESSEL components when internal tests are satisfied. 0 = off; 1 = on. **Note:** NEWRFD must not be changed when performing a restart calculation.	0
NFRC1	1 or 2	This option can be used to require input of forward and reverse loss coefficients for all 1D components. When it is set to 2, the dimension of the FRIC array is doubled to 2 × (NCELLS + 1). The input data must be defined to provide two consecutive arrays of loss coefficients, each dimensioned NCELLS + 1. Each array is in LOAD format and must be terminated with an "E." The first array provides loss coefficients that are used with positive velocities, and the second array provides loss coefficients that are used with negative velocities. To input these coefficients as K factors, use the IKFAC option. 1 = FRIC loss coefficients (default); 2 = FRIC and RFRIC two-way loss coefficients.	1

Variable	Value Range	Description	Default Value
		Note: NFRC1 must not be changed when performing a restart calculation.	
NFRC3	1 or 2	This option can be used to require input of forward and reverse loss coefficients for all 3D vessel components. When it is set to 2, input must be augmented to include the additional reverse loss coefficients. The variables CFZL-T, CFZL-Z, CFZL-R, CFZV-T, CFZV-Z and CFZV-R are input as before to provide forward (positive velocity) loss coefficients. This block of input is immediately followed by a corresponding block containing the reverse loss coefficients CFRL-T, CFRL-Z, CFRL-R, CFRV-T, CFRV-Z, and CFRL-R. To input these coefficients as standard K factors, use the IKFAC option. Note: NFRC3 must not be changed when performing a restart calculation.	1
NHTSTR	≥ 0	Number of HTSTR components input (must be defined when NHTSTR > 0) after the hydraulic-component data.	0
NIFSH	0 or 1	Interfacial shear option. 0 = normal interfacial-shear calculation; 1 = constant interfacial-shear coefficients.	0
NLT	≥1	Number of hydraulic-component loops.	10
NOAIR	0 or 1	Option that controls the calculation of noncondensable-gas partial pressure in hydraulic components. 0 = noncondensable-gas partial pressures solved for (this is less efficient when there is no noncondensable-gas in the system); 1 = noncondensable-gas partial pressures are not solved for (the noncondensable-gas partial-pressure array PA must be input with a value of 0.0 when NOAIR = 1). Note: TRAC-M sets PA to 0.0 when ALP is 0.0.	1

Variable	Value Range	Description	Default Value
NOSETS	0, 1 or 2	Flag for evaluating the SETS3D equations for all vessel components. 0 = do not evaluate the SETS3D equations during the first timestep, but thereafter begin evaluating them when the timestep size exceeds 0.8 times the VESSEL-component material-Courant limit. Stop evaluating them when the timestep size falls below 0.75 times the VESSEL-component material-Courant limit; 1 = do not evaluate the SETS3D equations; 2 = evaluate the SETS3D equations every timestep.	2
NRSLV	−1, 0 or 1	Axial-direction conduction heat-transfer calculation numerics in all HTSTR components having IAXCND = 1. 0 = explicit numerics; 1 = implicit numerics. **Note:** NRSLV must be 0 if ITTC = 1 (Word 3 on Card Number 2) for modeling an external thermocouple in a HTSTR component.	0
NSDL	≥ −1	The first timestep number in the range NSDL to NSDU at which a short edit and additional diagnostics are printed to the TRCOUT file and IDIAG = 3 diagnostics are printed to the TRCMSG file for every timestep in the range NSDL to NSDU. −1 = no additional output edits; ≥0 = short edits and additional diagnostics at the selected timesteps NSDL to NSDU. **Note:** The diagnostics include information on what is controlling the timestep size, the value of the largest ratio of iterate pressure change to total pressure (VARERM), and the differences between the basic and stabilizer macroscopic densities.	−1

Variable	Value Range	Description	Default Value
NSDU	≥ –1	The last timestep number in the range NSDL to NSDU at which a short edit and additional diagnostics are printed to the TRCOUT file and IDIAG = 3 diagnostics are printed to the TRCMSG files for every timestep in the range NSDL to NSDU. –1 = no additional output edits; ≥0 = short edits and additional diagnostics at the selected timesteps NSDL to NSDU.	–1
NSEND	≥ –1	Parameter used to stop the calculation at timestep NSEND. This parameter is useful for setting the boundaries for runs that might bog down with small timesteps. –1 = off; ≥0 = on.	–1
NSPL	≥ –1	The first timestep number in the range NSPL to NSPU at which a large edit is printed to the TRCOUT file for every timestep in the range NSPL to NSPU. –1 = no additional large edits; ≥0 = large edits at the selected timesteps NSPL to NSPU. **Note:** Additional information may be included on all large edits if IDIAG > 0.	–1
NSPU	≥ –1	The last timestep number in the range NSPL to NSPU at which a large edit is printed to the TRCOUT file for every timestep in the range NSPL to NSPU. –1 = no additional large edits; ≥0 = large edits at the selected timesteps NSPL to NSPU.	–1
NVGRAV	0 or 1	Option for user-specified orientation of 3D vessel components relative to the gravity-vector direction. 0 = gravity vector is in the negative z-direction of the vessel component; 1 = general orientation defined through input for each vessel component.	0

Variable	Value Range	Description	Default Value
NVPOW	≥ 0	Number of VESSEL components in the input and restart data files that are coupled to powered HTSTR components [used to dimension array storage].	1
P	1.0 Pa to 4.5×10^7 Pa (1.45×10^{-4} psia to 6.53×10^3 psia)	Default value for the initial pressures (Pa, psia) (real format). Used when ISTOPT = 1 or 2.	10^{20} Pa (1.45×10^{16} psia)
PA	0.0 Pa to 4.5×10^7 Pa (0.0 psia to 6.53×10^3 psia)	Default value for the initial noncondensable-gas partial pressures (Pa, psia) (real format). PA > P is invalid. Used when ISTOPT = 1 or 2.	10^{20} Pa (1.45×10^{16} psia)
QPPP	≥ 0.0	Default value for the heat-source distribution (–) in the walls of 1D hydraulic components (real format). Used when ISTOPT = 1 or 2. If this array is filled with the same nonzero constant, a uniform heat-source distribution results.	10^{20}
TIMDL	–1.0, ≥ 0.0 s	Time (s) to begin the debug printout over the time range TIMDL to TIMDU (real format). –1.0 = off; $\geq$0.0 s = on.	–1.0
TIMDU	–1.0, ≥ 0.0 s	Time (s) to end the debug printout over the time range TIMDL to TIMDU (real format). –1.0 = off; $\geq$0.0 s = on.	–1.0
TL	2.7315×10^2 K to 7.1395×10^2 K ($32.0°$F to $8.2544 \times 10^2°$F)	Default value for the initial liquid temperatures (K, °F) (real format). Used when ISTOPT = 1 or 2.	10^{20} K (1.8×10^{20} °F)

Variable	Value Range	Description	Default Value
TPOWR	≥ 0.0 s	Time (s) at which the steady-state power is set on under the control of NAMELIST variable IPOWR (real format).	10^{30} s

Note: Detailed Timestep-Size Diagnostics. Currently, in TRAC-M/F90 (Version 3.0), the option to obtain detailed diagnostic information on the timestep-size control for a calculation, via NAMELIST variables TSDLS, TSDLT, TSDUS, and TSDUT, is not available. The option is available in TRAC-M/F77.

Variable	Value Range	Description	Default Value
TSDLS	−1 or >0	First timestep (integer format) in which detailed timestep-diagnostic information on the logic used to evaluate the timestep size is output to file TRCMSG. Timestep backups that occur during the course of timestep TSDLS will be a part of that information. −1 = no timestep-size diagnostics; >0 = timestep-size diagnostics from timestep TSDLS to timestep TSDUS. **Note:** Both timesteps TSDLS to TSDUS and problem times TSDLT to TSDUT can be used to provide timestep-diagnostic information.	−1
TSDLT	−1.0 or ≥0.0	Starting problem time (real format) at which detailed timestep-diagnostic information on the logic used to evaluate the timestep size is output to file TRCMSG. −1.0 = no timestep-size diagnostics; ≥0.0 = timestep-size diagnostics from problem time TSDLT to problem time TSDUT.	−1.0
TSDUS	−1 or >0	Last timestep (integer format) in which detailed timestep-diagnostic information on the logic used to evaluate the timestep size is written to file TRCMSG. −1 = no timestep-size diagnostics; >0 = timestep-size diagnostics from timestep TSDLS to timestep TSDUS.	−1

Variable	Value Range	Description	Default Value
TSDUT	−1.0 or ≥0.0	Ending problem time (real format) at which detailed timestep-diagnostic information on the logic used to evaluate the timestep size is written to file TRCMSG. −1.0 = no timestep-size diagnostics; ≥0.0 = timestep-size diagnostics from problem time TSDLT to problem time TSDUT.	−1.0
TV	2.7315×10^2 K to 3.0000×10^3 K (32.0 °F to 4.9403×10^3 °F)	Default value for the initial vapor temperatures (K, °F) (real format). Used when ISTOPT = 1 or 2.	10^{20} K (1.8×10^{20} °F)
TW	> 0.0 K (> -459.7 °F)	Default value for the initial wall temperatures (K, °F) (real format). Used when ISTOPT = 1 or 2.	10^{20} K (1.8×10^{20} °F)
VL	$|VL| < 10^4$ m s^{-1} (3.28×10^4 ft s^{-1})	Default value for the initial liquid velocities (m s^{-1}, ft s^{-1}) (real format). Used when ISTOPT = 1 or 2.	10^{20} m s^{-1} (3.28×10^{20} ft s^{-1})
VV	$|VV| < 10^4$ m s^{-1} (3.28×10^4 ft s^{-1})	Default value for the initial vapor velocities (m s^{-1}, ft s^{-1}) (real format). Used when ISTOPT = 1 or 2.	10^{20} m s^{-1} (3.28×10^{20} ft s^{-1})

Solubility-Parameters Card. (Format 4E14.4) CNTLMN, CNMIN, CNTLMX, CNMAX

Note: If ISOLCN = 0 in the NAMELIST data, skip to Main-Data Card 3

Columns	Variable	Description
1–14	CNTLMN	Minimum liquid temperature (K, °F) to use linear fit.
15–28	CNMIN	Solubility concentration ratio (kg(solute) kg^{-1} (liquid), lb$_m$ (solute) lb$_m^{-1}$(liquid) when liquid temperature is at or below CNTLMN.
29–42	CNTLMX	Maximum liquid temperature (K, °F) to use linear fit.
43–56	CNMAX	Solubility concentration ratio (kg(solute) kg^{-1} (liquid), lb$_m$ (solute) lb$_m^{-1}$ (liquid) when liquid temperature is at or above CNTLMX.

Main-Data Card 3. (Format I14,E14.4) DSTEP, TIMET

Columns	Variable	Description
1–14	DSTEP	Timestep number of the TRCDMP-file data dump to be read from the TRCRST file for a restart calculation. If DSTEP is less than zero, the last data dump found will be used. Input DSTEP = 0 for an initial calculation where all the input data is defined by the TRACIN file.
15–28	TIMET	Problem start time (s). If DSTEP or TIMET is less than zero, the time obtained from the retrieved data dump overrides the TIMET input value.

Main-Data Card 4. (Format 5I14) STDYST, TRANSI, NCOMP,NJUN, IPAK

Columns	Variable	Description
1–14	STDYST	Steady-state calculation indicator. 0 = no steady-state calculation; 1 = generalized steady-state (GSS) calculation; 2 = CSS calculation; 3 = GSS calculation with hydraulic-path steady-state initialization (HPSSI); 4 = CSS calculation with HPSSI; 5 = static-check steady-state (SSS) calculation (checks to see if zero flow can be achieved with the pumps turned off and no heat transfer).
15–28	TRANSI	Transient calculation indicator. 0 = no transient calculation; 1 = transient calculation.
29–42	NCOMP	Total number of hydraulic and HTSTR components.
43–56	NJUN	Total number of junctions between hydraulic components.
57–70	IPAK	Water-packing option (suggested value = 1). 0 = off; 1 = on.

Main-Data Card 5. (Format 2E14.4) EPSO, EPSS

Columns	Variable	Description
1–14	EPSO	Convergence criterion for the outer-iteration pressure calculation (suggested value = 1.0×10^{-4}).
15–28	EPSS	Convergence criterion for the steady-state calculation (suggested value = 1.0×10^{-4}).

Main-Data Card 6. (Format 5I14) OITMAX, SITMAX, ISOLUT, NCONTR, NCCFL

Columns	Variable	Description
1–14	OITMAX	Maximum number of outer iterations for pressure calculation (suggested value = 10).
15–28	SITMAX	Maximum number of outer iterations for steady-state calculation (suggested value = 10).
29–42	ISOLUT	Solute-tracking option (for example, orthoboric acid solute in liquid coolant). ISOLUT must not be changed when performing a restart calculation. 0 = off; 1 = on.
43–56	NCONTR	Number of CSS controllers (NCONTR $\geq$ 1 when STDYST = 2 or 4; NCONTR = 0 when STDYST $\neq$ 2 and $\neq$ 4).
57–70	NCCFL	Number of countercurrent flow-limitation parameter sets to be input.

Main-Data Card 7. (Format 5I14) NTSV, NTCB, NTCF, NTRP, NTCP

Columns	Variable	Description
1–14	NTSV	Number of signal variables from input and the restart file (NTSV $\geq$ 0) (used to dimension variable storage).
15–28	NTCB	Number of control blocks from input and the restart file (NTCB $\geq$ 0) (used to dimension variable storage).
29–42	NTCF	Total number of table entries for the tabular control blocks from input and the restart file (NTCF $\geq$ 0) (used to dimension variable storage).
43–56	NTRP	Number of trips from input and the restart file (NTRP $\geq$ 0) (used to dimension variable storage).
57–70	NTCP	Number of passes made each timestep through the control-parameter evaluation of signal variables, control blocks, and trips (NTCP $\geq$ 0) (two or more passes may be needed when the signal or set status of a trip is a signal-variable or control-block input parameter or when a control procedure contains an implicit control-block evaluation loop).

Component-List Card(s). [Format 5(3X,I11)] (IORDER(I), I = 1, NCOMP) Load Format.

Variable	Dimension	Description
IORDER	NCOMP	Component ID numbers. All component identification numbers (input variable NUM on card number 1 of each component input) are listed in LOAD format. The list can be in any order.

6.3.2. Countercurrent Flow-Limitation Data.

If NCCFL = 0 (Word 5 on Main-Data Card 6), do not input Card Sets 1 to 3 and Card Number 4 (arrays CBETA, CCFLM, CCFLC and Card Number 4).

Card Set 1. (Format 5E14.4) (CBETA (I), I = 1, NCCFL). Load Format.

Variable	Dimension	Description
CBETA	NCCFL	Bankoff interpolation constant for interpolating between Wallis characteristic length dimension to Kutateladze characteristic length dimension. CBETA is used in the following equation, OMEGA = $D^{(1.0-CBETA)} \times L^{CBETA}$, where OMEGA is the length scale used in the Bankoff nondimensional volumetric fluxes Hg * & Hf *, D is the hydraulic diameter which is the Wallis scaling parameter, and L is the Kutateladze scaling parameter. CBETA = 0.0 yields Wallis scaling; CBETA = 1.0 yields Kutateladze scaling; CBETA < 0.0 implies that the complete Bankoff correlation will be input to calculate CBETA as a function of geometry and thermodynamic properties.

Card Set 2. (Format 5E14.4) (CCFLM(I), I = 1, NCCFL). Load Format.

Variable	Dimension	Description
CCFLM	NCCFL	The slope for the CCFL correlation. Default is 1.07 if CBETA is < 0.0 and 1.0 if CBETA is ≥ 0. The general form of the correlation for CBETA ≥ 0 is, $\sqrt{Hg^*}$ + CCFLM × $\sqrt{Hf^*}$ = CCFLC. The general form of the correlation for CBETA < 0.0 is, $\sqrt{Hg^*}$ + $\sqrt{Hf^*}$ = CCFLM + CCFLC × AMIN1(BOND,CTRANS).

Card Set 3. Format [5(E14.4)] (CCFLC(I), I = 1, NCCFL). Load Format.

Variable	Dimension	Description
CCFLC	NCCFL	The constant for the CCFL correlation. See the general form of the correlation given above. Default is 0.00433 if CBETA < 0.0 and 1.0 if CBETA ≥ 0.

For each CBETA(I) < 0.0, the following input is required to calculate CBETA based on Bankoff's correlation.

Card Number 4. (Format I14,4E14.4) NHOLES, TP, GAMMA, DIAH, CTRANS.

Variable	Dimension	Description
1–14	NHOLES	Number of holes in the perforated plate.
15–28	TP	Plate thickness (m, ft).
29–42	GAMMA	Ratio of open-plate flow area to total-plate flow area.
43–56	DIAH	Diameter of one hole (m, ft).
57–70	CTRANS	Bond number above which the CCFL constant is independent of Bond number. See the general formulation give above for Bankoff's correlation (default is 200.0).

6.3.3. Material-Properties Data

If the TRAC-M internally defined material properties are inappropriate, the user may input his own data. Material-properties data are required when NMAT > 0 (Word 4 on Main-Data Card 2). For each new material, the user must provide a unique material identifier (MATB > 50), the number of data-point sets provided for each material (PTBLN ≥ 2), and the data tables that specify the material properties (ρ, cp, k, and ε) as a function of temperature (T). Linear interpolation is used to obtain property values for wall temperatures intermediate to those specified by the input tables. Extrapolation is not allowed (an error message results). The material-properties tables are not included in the dump; therefore, the tables must be included in TRACIN for a restart run.

Card Set 1. [Format 5(3X,I11)] [MATB(I), I = 1, NMAT]. Load Format.

Variable	Dimension	Description
MATB	NMAT	New material identifiers, which require MATB(I) ≥ 50, I = (1, NMAT). These are the material ID numbers used in the component input to reference the input material properties instead of the built-in properties.

Card Set 2. [Format 5(3X,I11)] (PTBLN(I), I = 1, NMAT). Load Format.

Variable	Dimension	Description
PTBLN	NMAT	Number of data-point sets provided for each of NMAT materials; material MATB(I) consists of PTBLN(I) data-point sets, where PTBLN(I) ≥ 2.

Card Set 3. Input NMAT data tables, one for each material (MATB(I), I = 1, NMAT).

Data Table I. [Format 5(3X,E11.4)] [PRPTB(J), J = 1, 5 × PTBLN(I)]. Load Format.

Variable	Dimension	Description
PRPTB(I)	5*PTBLN(I)	The material-properties data for material MATB(I), each point of which consists of the five variables in order T, ρ, C_p, k, and ε [where T is the temperature (K, °F), ρ is the density (kg m^{-3}, lb$_m$ ft^{-3}), C_p is the specific heat (W s kg^{-1} K^{-1}, Btu lb$_m^{-1}$ °F^{-1}), k is the thermal conductivity (W m^{-1} K^{-1}, Btu ft^{-1} °F^{-1} h^{-1}), and is the emissivity (–)]. Each material MATB(I) consists of PTBLN(I) points with the values of T increasing monotonically. The table array appears as T_1, ρ_1, C_{p1}, k_1, ε_1, T_2, ρ_2, C_{p2}, k_2, ε_2, T_3,...., $T_{PTBLN(I)}$, $\rho_{PTBLN(I)}$, $C_{pPTBLN(I)}$, $k_{PTBLN(I)}$, $\varepsilon_{PTBLN(I)}$. At least two points are required for each material, and the temperature range of the table must bound the range of application. Extrapolation is not allowed.

6.3.4. Hydraulic-Path Steady-State Initialization Data.

If STDYST = 3 or 4 (Word 1 on Main-Data Card 4), input Card Number 1 and NPATHS of Path Card Numbers 1, 2, and 3 (if NTPI = 0).

Card Number 1. (Format 3I14) NPATHS, NFPI, NTPI

Columns	Variable	Description
1–14	NPATHS	Number of 1D hydraulic paths in the system model. The internal-junction interface between the main and side tubes of SEPD and TEE components defines the starting or ending interface of a 1D hydraulic path. The internal-junction interface of SEPD and TEE components and the junction interfaces of PLENUM and VESSEL components define the path end of a 1D hydraulic path. A user-defined hydraulic-path connection interface within a 1D hydraulic component or at a junction between two 1D hydraulic components provides a connection point for two hydraulic paths.

15–28	NFPI	PMVL and PMVV flow-parameter input option. 0 = liquid and vapor mass flows; 1 = liquid and vapor velocities.
29–42	NTPI	Total and noncondensable-gas pressure input option. 0 = specify pressures on Path Card Number 3 and use these pressures to define the pressure for all mesh cells in the hydraulic path; 1 = get pressures from the donor cell of the thermal-hydraulic condition location IDCLOC in the component data and use these pressures to define the pressures for all mesh cells of the hydraulic path; 2 = get pressures from each mesh cell of the component data for the hydraulic path.

Input a Path Card Number 1, 2, and 3 (if NTPI = 0) for each hydraulic path N for N = 1 to NPATHS.

Note: Potential hydraulic paths that are appropriately defined by the component data do not need to be specified (for example, the emergency-coolant system side-leg channel with stagnant coolant).

Path Card Number 1. Format 5I14) IDCINF, IDCOUF, IDCLOC, IDCPWI, IDCPWO

Columns	Variable	Description
1–14	IDCINF	Hydraulic path N inflow location number defined by the composite value (component ID number)* 1000 + interface number where its thermal-hydraulic condition is donor-cell convected through the mesh-cell interface (except for VESSEL-component source connections where the thermal-hydraulic condition is assumed donored from the 1D cell). Make the composite value negative if the location is on the side tube of a SEPD or TEE component and either IDCINF or IDCOUF must define the SEPD or TEE internal-junction interface number NCELL1+2. Each PLENUM-component junction interface must be defined by IDCINF or IDCOUF of a hydraulic path.

15–28	IDCOUF	Hydraulic path N outflow location number defined by the composite value (component ID number)* 1000 + interface number where its thermal-hydraulic condition is donor-cell convected through the mesh-cell interface (except for VESSEL-component source connections where the thermal-hydraulic condition is assumed donored from the 1D cell). Make the composite value negative if the location is on the side tube of a SEPD or TEE component and either IDCINF or IDCOUF must define the SEPD or TEE internal-junction interface number NCELL1+2. Each PLENUM-component junction interface must be defined by IDCINF or IDCOUF of a hydraulic path].
29–42	IDCLOC	Hydraulic path N thermal-hydraulic condition location number defined by the composite value (component ID number)*1000 + interface number where the defined thermal-hydraulic condition is donor-cell convected through the mesh-cell interface. Make the composite value negative if the location is on the side tube of a SEPD or TEE component. In this case, the interface location must be the SEPD or TEE internal-junction interface defined by IDCINF or IDCOUF while IDCLOC has a special defining form where instead its interface number is the JCELL cell number on the main tube of the SEPD or TEE component. IDCLOC must be defined the same as IDCINF or IDCOUF for a PLENUM-component junction interface. The donor cell's thermal-hydraulic parameters are defined on Path Card Numbers 2 and 3. Don't define interface IDCLOC within the heat source or sink cell range from IDCPWI to IDCPWO.
43–56	IDCPWI	Hydraulic path N inflow location number defined by the composite value (component ID number)* 1000 + cell number for the first cell in the hydraulic-path flow direction having heat-transfer to or from it. Input 0 if there is no heat source or sink in the hydraulic path that needs to be considered.
57–70	IDCPWO	Hydraulic path N outflow location number defined by the composite value (component ID number)* 1000 + cell number for the last cell in the hydraulic-path flow direction having heat-transfer to or from it. Input 0 if there is no heat source or sink in the hydraulic path that needs to be considered.

Path Card Number 2. (Format 5E14.4) PMVL, PMVV, PTL, PTV, PPOWER

Columns	Variable	Description
1–14	PMVL	Initial liquid mass flow (kg s^{-1} or lb$_m$ h^{-1}) when NFPI = 0 (Word 2 on Card Number 1) or velocity (m s^{-1} or ft s^{-1}) when NFPI=1 at the IDCLOC interface of hydraulic path N.
15–28	PMVV	Initial vapor mass flow (kg s^{-1} or lb$_m$ h^{-1}) when NFPI = 0 (Word 2 on Card Number 1) or velocity (m s^{-1} or ft s^{-1}) when NFPI=1 at the IDCLOC interface of hydraulic path N.
29–42	PTL	Initial liquid temperature (K or °F) in the donor cell of the IDCLOC interface of hydraulic path N [input 0.0 K or –459.67°F to specify the saturation temperature based on the vapor pressure].
43–56	PTV	Initial vapor temperature (K or °F) in the donor cell of the IDCLOC interface of hydraulic path N (input 0.0 K or –459.67°F to specify the saturation temperature based on the vapor pressure).
57–70	PPOWER	Total heat-transfer power to [PPOWER(n) > 0.0] or from [PPOWER(n) < 0.0] all mesh cells between and including location numbers IDCPWI and IDCPWO (W or Btu h^{-1})(input 0.0 W or 0.0 Btu h^{-1} if there is no heat source or sink in the hydraulic path such that IDCPWI = 0 and IDCPWO = 0).

Path Card Number 3. (Format 2E14.4) PP, PPA

Note: Input Path Card Number 3 if NTPI = 0 (Word 3 on Card Number 1).

Columns	Variable	Description
1–14	PP	Total pressure (Pa or psia) that is defined to be constant over all mesh cells of hydraulic path N.
15–28	PPA	Noncondensable-gas pressure (Pa or psia) that is defined to be constant over all mesh cells of hydraulic path N.

6.3.5. Control-Parameter Data

Parameters and procedures that are used to control PWR-system operation are specified through control-parameter data. CSS controllers, signal variables, control blocks, and

trips are defined along with a multipass procedure for evaluating the later three at the start of each timestep.

6.3.5.1. CSS controller data. When STDYST = 2 or 4 (Word 1 on Main-Data Card 4), a CSS calculation is performed using NCONTR ≥ 1 (Word 4 on Main-Data Card 6) controllers that are specified by CSS controller data. These controllers are internally programmed PI controllers that adjust specific parameter actions to achieve desired steady-state values for specific monitored parameters. Transient-calculation control procedures for some of these component actions are specified in the component input data; however, these CSS controllers override those procedures and control their parameter actions during the CSS calculation. Four types of controllers are available to the TRAC-M user (the type 4 controller for the STGEN hydraulic component has been eliminated along with the STGEN component):

- **Type 1 Controller:** A type 1 controller adjusts a PUMP component's rotational speed (rad s^{-1}, rpm) to achieve a desired coolant mass flow (kg s^{-1}, lb$_m$ h^{-1}) through the PUMP. The desired coolant mass flow is specified initially in the PUMP component data at the PUMP interface by the input coolant mass flow (NMPCSS = -1) or velocity (NMPCSS = 0), which is summed over the liquid and vapor coolant.

- **Type 2 Controller:** A type 2 controller adjusts a VALVE component's flow-area fraction (–) to achieve a desired pressure (Pa, psia) in the mesh cell upstream of the VALVE interface (NMPCSS = 1) or a desired coolant mass flow (kg s^{-1}, lb$_m$ h^{-1}) through the VALVE (NMPCSS = 2). The desired pressure is the input upstream-cell pressure or the input pressure in the lower-numbered cell adjacent to the VALVE interface if the initial velocity is zero. The desired mass flow, which is determined from the input velocity at the VALVE interface, is summed over the liquid and vapor coolant. These desired parameter values are specified initially in the VALVE component data.

- **Type 3 Controller:** A type 3 controller adjusts: a PUMP component's rotational speed (rad s^{-1}, rpm) (NAPCSS = –1), a VALVE component's flow-area fraction (–) (NAPCSS = 0), or a FILL component's mass flow (kg s^{-1}, lb$_m$ h^{-1}) with a direct-equality controller that defines mass flow out of (NAPCSS = 1) or into (NAPCSS = 2) the FILL. This achieves a desired coolant mass flow at the FILL junction that equals the coolant mass flow at interface location NMPCSS elsewhere in the modeled system. The monitored mass flow at location NMPCSS, specified initially by the velocity in its component data, can vary during the CSS calculation.

- **Type-5 Controller:** A type-5 controller adjusts with a factor (–) a HTSTR component's (a) inner or outer surface coupled hydraulic-channel pressure; (b) inner, outer, or both surface heat-transfer areas (heat-transfer coefficients); (c) inner, outer, or both surface nodes or all nodes of the entire wall thermal conductivities; or (d) both surface heat-transfer areas (heat-transfer coefficients) and all nodes of the entire wall thermal conductivities. This is done to achieve a desired single-phase coolant temperature (K,°F) or two-phase gas volume fraction (–) at location NMPCSS defined (a) initially in the component data for NMPCSS > 1000, (b) by a signal variable with ID 0 <

NMPCSS < 1000, or (c) by a control block with ID NMPCSS < 0. If this controller adjusts a coupled hydraulic-channel pressure, a similar adjustment is applied to all the hydraulically coupled VALVE-component upstream pressures that are controlled by a type 2 CSS controller and all break pressures.

The monitored-parameter location number NMPCSS at a component location for the last three controller types is a composite value that is defined by

Location number NMPCSS = (component number) × 1000 + (cell or interface number).

For a type-5 controller, NMPCSS also can be defined by a signal variable with ID number $0 < NMPCSSD \leq 1000$ or by a control block with ID number NMPCSS < 0.

The desired steady-state value for the monitored parameter is specified initially in input as part of the component data at the PUMP interface, VALVE interface, or NMPCSS location. For a type-5 controller, its signal-variable value is evaluated in the first timestep based on the input parameters of the modeled system, or its control-block value is specified in one of two ways: by the control-block input value of CBCON2 ≠ 0 or by its evaluation in the first timestep based on the input parameters of the modeled system.

When restarting a CSS calculation, the CSS-Controller Cards need to be reinput in the TRACIN file. These cards must be input in the same order as in the original TRACIN file. If a composite number or a signal variable defines the monitored parameter NMPCSS, its desired value cannot be changed when performing the restart. Because of this limitation, the type-5 controller also allows the user to specify the monitored parameter by a control block. The control block's desired value can be changed during a restart by reinputting the control block that defines NMPCSS and defining its CBCON2 with the new desired value.

Each of the NCONTR (Word 4 on Main-Data Card 6) controllers is specified by the TRAC-M user with four (controller types 1 and 2) or five (controller types 3 and 5) values on the following card.

CSS-Controller Card. (Format I14,2E14.4,2I14) NUMCSS, AMNCSS, AMXCSS, NMPCSS, NAPCSS

Columns	Variable	Description
1–14	NUMCSS	Component number whose parameter action is adjusted by the CSS controller.
15-28	AMNCSS	Minimum value to which the parameter action can be adjusted by the CSS controller (units based on NMPCSS and NAPCSS defining the controller type).
29-42	AMXCSS	Maximum value to which the parameter action can be adjusted by the CSS controller (units based on NMPCSS and NAPCSS defining the controller type).

43–56	NMPCSS	Monitored-parameter number that is defined for each CSS controller type as follows:
		For controller type 1, the desired mass flow through the PUMP is defined by its input-specified initial liquid plus gas mass flow (NMPCSS = –1) or velocity (NMPCSS = 0) at the pump-impeller interface,
		For controller type 2, the desired upstream pressure (NMPCSS = 1) or liquid plus gas mass flow through the VALVE interface (NMPCSS = 2) is defined by its input-specified initial value,
		For controller type 3, the desired liquid plus gas mass flow is defined each timestep during the calculation at interface-location number NMPCSS,
		For controller type 5, the desired single-phase coolant temperature or two-phase coolant gas volume fraction is defined by its input-specified initial value at composite cell-location number NMPCSS ≥ 1000, by signal variable with ID number 0 < NMPCSS < 1000, or by control block with ID number NMPCSS < 0.

57–70	NAPCSS	Adjusted-parameter number that is defined for the last two controller types as follows:
		For controller type 1, NAPCSS is not used;
		For controller type 2, NAPCSS is not used;
		For controller type 3, adjusts the PUMP's impeller rotational speed (NAPCSS = –1), the VALVE flow-area fraction (NAPCSS = 0), the mass flow out of a FILL (NAPCSS = 1), or the mass flow into a FILL (NAPCSS = 2);
		For controller type 5, adjusts with a factor the HTSTR component's:
		inner-surface coupled hydraulic-channel pressure (NAPCSS = 5),
		outer-surface coupled hydraulic-channel pressure (NAPCSS = 6),
		inner-surface heat-transfer area (heat-transfer coefficient) (NAPCSS = 7),
		outer-surface heat-transfer area (heat-transfer coefficient) (NAPCSS = 8),
		both surface heat-transfer areas (heat-transfer coefficients) (NAPCSS = 9),
		inner-surface node thermal conductivity (NAPCSS = 10),
		outer-surface node thermal conductivity (NAPCSS = 11),

both surface node thermal conductivities (NAPCSS = 12),
all nodes of the entire wall thermal conductivities (NAPCSS = 13), or
both surface heat-transfer areas (heat-transfer coefficients) and all nodes of the entire wall thermal conductivities (NAPCSS = 14).

6.3.5.2. Multipass control-parameter evaluation. Control parameters are evaluated in the following order: signal variables, control blocks, and trips. If a signal variable is to be evaluated after a control block or a trip or a control block is to be evaluated after a trip, two or more evaluation passes through the three control-parameter types are needed. For NTCP ≥ 2 evaluation passes (Word 5 on Main-Data Card 7), the following Control-Parameter List Cards are input to define the subrange of parameters to be evaluated for each control-parameter type during each evaluation pass.

Control-Parameter List Cards. [Format 5(3X,I11)] ISV1(i), ISV2(i), ICB1(i), ICB2(i), ITP1(i), ITP2(i), i = (1, NTCP).

Load Format (Indicated columns are only suggested; instead, the user may wish to input each of the NTCP pass parameters on a set of two or three cards with the remaining fields on a card skipped by using an "s").

Columns	Variable	Description
4–14	ISV1(1)	The smallest signal-variable ID number evaluated during the first control-parameter evaluation pass [1 ≤ ISV1(1)].
18–28	ISV2(1)	The largest signal-variable ID number evaluated during the first control-parameter evaluation pass [ISV1(1) ≤ ISV2(1); input ISV2(1) = 0 if no signal variables are to be evaluated during the i = 1 first pass].
32–42	ICB1(1)	The smallest (in absolute value) control-block ID number evaluated during the first control-parameter evaluation pass [ICB1(1) ≤ –1].
46–56	ICB2(1)	The largest (in absolute value) control-block ID number evaluated during the first control-parameter evaluation pass [ICB2(1) ICB1(1); input ICB2(1) = 0 if no control blocks are to be evaluated during the i = 1 first pass].
60–70	ITP1(1)	The smallest (in absolute value) trip ID number evaluated during the first control-parameter evaluation pass [1 ≤ |ITP1(1)|].

4–14	ITP2(1)	The largest (in absolute value) trip ID number evaluated during the first control-parameter evaluation pass [$\|ITP1(1)\| \leq \|ITP2(1)\|$; input ITP2(1) = 0 if no trips are to be evaluated during the i = 1 first pass].
18-28	ISV1(2)	The smallest signal-variable ID number evaluated during the second control-parameter evaluation pass [$1 \leq ISV1(2)$].
32-42	ISV2(2)	Etc.

6.3.5.3. Signal-variable data. Signal-variable data are specified when NTSV > 0 (Word 1 on Main-Data Card 7). Signal variables define directly the input parameters for control blocks, the parameters for trip signals, the independent variable parameter for component-action tables, and the component action. Either NTSV or fewer signal variables are input. When fewer than NTSV signal variables are input, conclude the data with a card having parameter IDSV set to 0 (0 must be entered explicitly if the free-format option is used). The remaining signal variables (for a total of NTSV) are obtained from the restart file. They are the signal variables on the restart file whose IDSV ID numbers differ from those defined here on input. After all signal-variable data are read from input and obtained from the restart file, the signal variables are reordered with their ID numbers increasing monotonically. Each signal variable is defined by the following card.

Signal-Variable Card. (Format 5I14) IDSV, ISVN, ILCN, ICN1, ICN2

Columns	Variable	Description
1–14	IDSV	Signal-variable ID number ($1 \leq IDSV \leq 9900$) (signal variables used to define a trip-signal expression require that $1 \leq IDSV \leq 399$).
15–28	ISVN	Signal-variable parameter number ($-104 \leq ISVN \leq 104$). Refer to Table 6-1 for a list of the signal-variable parameter numbers vs their parameter descriptions. The numerical sign of ISVN (for ISVN $\neq$ 0) specifies how the parameter is defined. When $0 \leq ISVN \leq 104$, the signal variable is the parameter value. When $-101 \leq ISVN \leq -65$ or $-40 \leq ISVN \leq -21$ and ICN1 and ICN2 are both nonzero, the signal variable is the difference between the parameter values at cell locations $\|ICN1\|$ or $\|ICN2\|$. When $-104 \leq ISVN \leq -1$ and either ICN1 or ICN2 or both are zero, the signal variable is the change in the parameter value over the previous time-step. Signal-variable parameter units are defined based on the absolute value of ISVN.

29–42	ILCN	The component number ($18 \leq	\mathrm{ISVN}	\leq 54$ or $57 \leq	\mathrm{ISVN}	\leq 104$), or the trip ID number ($55 \leq	\mathrm{ISVN}	\leq 56$) of the signal-variable parameter. The variable ILCN is not used when $1 \leq	\mathrm{ISVN}	\leq 17$. For ISVN = 0, the problem time parameter becomes the previous or current timestep size by defining ILCN = –1 or +1, respectively.
43–56	ICN1	The cell, interface, or node number of the first location in component ILCN where the signal-variable para-meter is defined when $20 \leq	\mathrm{ISVN}	\leq 40$ or $65 \leq \mathrm{ISVN} \leq 101$ or ISVN = 104.
57–70	ICN2	The cell, interface, or node number of the second location in component ILCN where the signal-variable parameter is defined when $20 \leq \mathrm{SVN} \leq 40$ or $65 \leq \mathrm{ISVN} \leq 101$ or ISVN = 104.

For the VESSEL, TEE (side tube), or HTSTR components, cells $|\mathrm{ICN1}|$ and $|\mathrm{ICN2}|$ are defined by a composite number. For the VESSEL, the composite number is the horizontal-plane cell number times 1000 plus the axial level number; for the TEE side tube, it is the total number of primary-side cells plus the secondary-side cell number; for the HTSTR, it is the node number times 1000000 plus the ROD or SLAB element number times 1000 plus the axial node-row number. Refer to Sec 2.4.3 of the TRAC-P Theory Manual for further information on defining cell and interface location composite numbers.

The numerical signs of ICN1 and ICN2 are used for defining the signal-variable value. For $21 \leq \mathrm{ISVN} \leq 40$, $65 \leq \mathrm{ISVN} \leq 101$, or ISVN = 104, the signal variable is

1. the parameter value in cell $|\mathrm{ICN1}|$ when ICN2 = 0 or in cell $|\mathrm{ICN2}|$ when ICN1 = 0;
2. the maximum parameter value between cells $|\mathrm{ICN1}|$ and $|\mathrm{ICN2}|$ when ICN1 > 0 and ICN2 > 0;
3. the minimum parameter value between cells $|\mathrm{ICN1}|$ and $|\mathrm{ICN2}|$ when ICN1 < 0 and ICN2 < 0; and
4. the volume-averaged parameter value between cells $|\mathrm{ICN1}|$ and $|\mathrm{ICN2}|$ when ICN1 and ICN2 are of opposite signs.

When ISVN = –104, $-101 \leq \mathrm{ISVN} \leq -65$, or $-40 \leq \mathrm{ISVN} \leq -21$ and both ICN1 and ICN2 are nonzero, the signal variable is the difference between the parameter value in cells $|\mathrm{ICN1}|$ and $|\mathrm{ICN2}|$ (that is, the parameter value in cell $|\mathrm{ICN1}|$ minus the parameter value in cell $|\mathrm{ICN2}|$). If either ICN1 or ICN2 is zero when $-104 \leq \mathrm{ISVN} \leq -1$, the signal variable is the change in the parameter value in cell $|\mathrm{ICN2}|$ or $|\mathrm{ICN1}|$ over the previous timestep.

TABLE 6-1
SIGNAL-VARIABLE PARAMETERS

Signal-Variable Parameter Number	Defined For	Parameter Description	Input Location Numbers
0	Global	Problem time (s)	−1 (dto), 0(time), 1(dt)
1–17		Undefined	
18	HS	Reactor power (W, Btu/hr)	Component
19	HS	Reactor-power period (s)	Component
20	1D,3D	Liquid level (m, ft)	Component, Cell1, Cell2
21	1D,3D	Cell pressure (Pa, psia)	Component, Cell1, Cell2
22	1D,3D	Cell gas temperature (K, °F)	Component, $Cell_1$, $Cell_2$
23	1D,3D	Cell liquid temperature (K, ×°F)	Component, Cell1, $Cell_2$
24	ID	Slab inner-surface temperature (K, °F)	Component, $Cell_1$, $Cell_2$
25	HS	Slab/rod surface temperature (K, °F)	Component, $Nrow_1$, $Nrow_2$
26	HS	Slab/rod temperature (K, °F)	Component, $Nrow_1$, $Nrow_2$
27	1D,3D	Cell gas volume fraction	Component, $Cell_1$, $Cell_2$
28	3D	Y θ-face gas mass flow (kg/s, lb_m/hr)	Component, $Iface_1$, $Iface_2$
29	1D,3D	Z-face gas mass flow (kg/s, lbm/hr)	Component, $Iface_1$, $Iface_2$
30	3D	XR-face gas mass flow (kg/s, lb_m/hr)	Component, $Iface_1$, $Iface_2$
31	3D	Y θ-face liquid mass flow (kg/s, lb_m/hr)	Component, $Iface_1$, $Iface_2$
32	1D,3D	Z-face liquid mass flow (kg/s, lb_m/hr)	Component, $Iface_1$, $Iface_2$
33	3D	XR-face liquid mass flow (kg/s, lb_m/hr)	Component, $Iface_1$, $Iface_2$
34	3D	YÐ θ-face gas velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
35	1D,3D	Z-face gas velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$

TABLE 6-1 (cont)
SIGNAL-VARIABLE PARAMETERS

Signal-Variable Parameter Number	Defined For	Parameter Description	Input Location Numbers
36	3D	XR-face gas velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
37	3D	Y θ-face liquid velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
38	1D,3D	Z-face liquid velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
39	3D	XR-face liquid velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
40	1D,3D	Boron concentration (kg/m^3)	Component, $Cell_1$, $Cell_2$
41	1D	Pump rotational speed (rad/s, rpm)	Component
42	1D	Valve flow-area fraction	Component
43	1D	Valve stem position	Component
44	HS	Neutron multiplication constant $k_{eff} = 1 + \Delta k_{prog} + \Delta_{kfdbk}$	Component
45	HS	Programmed Δk_{prog}	Component
46	HS	Feedback Δk_{fdbk}	Component
47	HS	Fuel-temperature feedback Δk_{Tf}	Component
48	HS	Coolant-temperature feedback Δk_{Tc}	Component
49	HS	Gas-volume-fraction feedback Δk_α	Component
50	HS	Solute concentration-ratio feedback Δk_{Bm}	Component
51	HS	Core density·volume·power^{powexp} – averaged fuel temperature (K, °F)	Component
52	HS	Core density·volume·power^{powexp} – averaged coolant temperature (K, °F)	Component
53	HS	Core volume·power^{powexp} – averaged gas volume fraction	Component

TABLE 6-1 (cont)
SIGNAL-VARIABLE PARAMETERS

Signal-Variable Parameter Number	Defined For	Parameter Description	Input Location Numbers
54	HS	Core density·volume·power^{powexp} – averaged solute concentration ratio (kg_{sol}/kg_{liq}, $lb_{m\text{-}sol}/lb_{m\text{-}liq}$) or (ppm)	Component
55	Global	Trip-signal value	Trip ID
56	Global	Trip set-status value	Trip ID
57	HS	Prompt-fission power (W, Btu/hr)	Component
58	HS	Decay-heat power (W, Btu/hr)	Component
59	HS	Average slab/rod maximum surface temperature (K, °F)	Component
60	HS	Additional slab/rod maximum surface temperature (K, °F)	Component
61	1D	Pump head (m^2/s^2, $lb_f\text{-}ft/lb_m$)	Component
62	1D	Pump torque ($Pa\text{-}m^3$, $lb_f\text{-}ft$)	Component
63	1D	Pump momentum source (Pa, psia)	Component
64	1D	Valve hydraulic diameter (m, ft)	Component
65	3D	Y θ-face hydraulic diameter (m, ft)	Component, $Iface_1$, $Iface_2$
66	1D,3D	Z-face hydraulic diameter (m, ft)	Component, $Iface_1$, $Iface_2$
67	3D	XR-face hydraulic diameter (m, ft)	Component, $Iface_1$, $Iface_2$
68	3D	Y θ-face mix. mass flow (kg/s, lb_m/s)	Component, $Iface_1$, $Iface_2$
69	1D,3D	Z-face mixture mass flow (kg/s, lb_m/s)	Component, $Iface_1$, $Iface_2$
70	3D	XR-face mixture mass flow (kg/s, lb_m/s)	Component, $Iface_1$, $Iface_2$
71	3D	Y θ-face mixture average velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
72	1D,3D	Z-face mixture average velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$

TABLE 6-1 (cont)
SIGNAL-VARIABLE PARAMETERS

Signal-Variable Parameter Number	Defined For	Parameter Description	Input Location Numbers
73	3D	XR-face mixture average velocity (m/s, ft/s)	Component, $Iface_1$, $Iface_2$
74	1D,3D	Cell gas density (kg/m^3, lb_m/ft^3)	Component, $Cell_1$, $Cell_2$
75	1D,3D	Cell liquid density (kg/m^3, lb_m/ft^3)	Component, $Cell_1$, $Cell_2$
76	1D,3D	Cell mixture density (kg/m^3, lb_m/ft^3)	Component, $Cell_1$, $Cell_2$
77	1D,3D	Cell air density (kg/m^3, lb_m/ft^3)	Component, $Cell_1$, $Cell_2$
78	1D,3D	Cell air mass (kg/m^3, lb_m/ft^3)	Component, $Cell_1$, $Cell_2$
79	1D,3D	Cell air pressure (Pa, psia)	Component, $Cell_1$, $Cell_2$
80	1D,3D	Cell air internal energy (W-s/kg, Btu/lb_m)	Component, $Cell_1$, $Cell_2$
81	1D,3D	Cell gas internal energy (W-s/kg, Btu/lb_m)	Component, $Cell_1$, $Cell_2$
82	1D,3D	Cell liquid internal energy (W-s/kg, Btu/lb_m)	Component, $Cell_1$, $Cell_2$
83	1D,3D	Cell saturation temperature based on vapor saturation pressure (K, °F)	Component, $Cell_1$, $Cell_2$
84	1D,3D	Cell saturation temp. based on total pressure (K, °F)	Component, $Cell_1$, $Cell_2$
85	1D,3D	Cell gas specific heat (W-s/kg-K, Btu/lbm-°F)	Component, $Cell_1$, $Cell_2$
86	1D,3D	Cell liquid specific heat (W-s/kg-K, Btu/lbm-°F)	Component, $Cell_1$, $Cell_2$
87	1D,3D	Cell latent heat of vaporization (W-s/kg, Btu/lb_m)	Component, $Cell_1$, $Cell_2$
88	1D,3D	Total surface heat loss to the gas (W, Btu/hr)	Component, $NCell_1$, $NCell_2$

TABLE 6-1 (cont)
SIGNAL-VARIABLE PARAMETERS

Signal-Variable Parameter Number	Defined For	Parameter Description	Input Location Numbers
89	1D,3D	Total surface heat loss to the liquid (W, Btu/hr)	Component, $NCell_1$, $NCell_2$
90	1D,3D	Cell gas/liquid interfacial heat flow (W, Btu/hr)	Component, $Cell_1$, $Cell_2$
91	HS	ROD/SLAB gas HTC $(W/m^2\text{-}K, Btu/ft^2\text{-}°F\text{-}hr)$	Component, $NCell_1$, $NCell_2$
92	HS	ROD/SLAB liquid HTC $(W/m^2\text{-}K, Btu/ft^2\text{-}°F\text{-}hr)$	Component, $Ncell_1$, $Ncell_2$
93	1D	Cell SLAB gas HTC $(W/m^2\text{-}K, Btu/ft^2\text{-}°F\text{-}hr)$	Component, $Cell_1$, $Cell_2$
94	1D	Cell SLAB liquid HTC $(W/m^2\text{-}K, Btu/ft^2\text{-}°F\text{-}hr)$	Component, $Cell_1$, $Cell_2$
95	1D,3D	Cell interfacial area x gas HTC $(W/K, Btu/hr\text{-}°F)$	Component, $Cell_1$, $Cell_2$
96	1D,3D	Cell interfacial area x liquid HTC $(W/K, Btu/hr\text{-}°F)$	Component, $Cell_1$, $Cell_2$
97	3D	Y Θ-face interfacial drag Ci $(kg/m^4, lb_m/ft^4)$	Component, $Iface_1$, $Iface_2$
98	1D,3D	Z-face interfacial drag Ci $(kg/m^4, lb_m/ft^4)$	Component, $Iface_1$, $Iface_2$
99	3D	XR-face interfacial drag Ci $(kg/m^4, lb_m/ft^4)$	Component, $Iface_1$, $Iface_2$
100	1D,3D	Cell solid-solute concentration $(kg/m^3, lb_m/ft^3)$	Component, $Cell_1$, $Cell_2$
101	1D,3D	Cell vapor generation rate $(kg/m^3\text{-}s, lb_m/ft^3\text{-}hr)$	Component, $Cell_1$, $Cell_2$
102	1D,HS	Total inner surface heat loss (W, Btu/hr)	Component
103	1D,HS	Total outer surface heat loss (W, Btu/hr)	Component
104	1D,3D	Cell mixture temperature (K, °F)	Component, $Cell_1$, $Cell_2$

6.3.5.4. User-defined units-name label data. When one or more of the NAMELIST variables IOGRF, IOINP, IOLAB, and IOOUT [for input/output (I/O) of data with SI/English units] is nonzero such that IOALL = |IOGRF| + |IOINP| + |IOLAB| + |IOOUT| ≠ 0, the TRAC-M user is required to input the units-name labels of selected user-defined control-block and trip parameters. When IOALL = 0, the TRAC-M user does not input the units-name labels of these parameters. This allows previous input-data files to be used without modification. Because TRAC-M then does not know the units of these user-defined parameters, TRAC-M performs no units conversion on these parameters and outputs the symbol * when their units symbol is to be output (when NAMELIST variable IOOUT=1). Table 6-2 shows the units-name labels (leftmost column beginning with the letters LU) defined in TRAC, which the user may use to define the units of these parameters. If the units of some user-defined control-block or trip parameters cannot be defined by this internal set, the user must then input the additionally required units-name labels.

TABLE 6-2
UNITS NAMES FOR CONTROL-BLOCK AND TRIP PARAMETERS AND THEIR SI, AND ENGLISH UNITS AND SI TO ENGLISH CONVERSION FACTORS AND SHIFTS

Units Name	SI Units	English Units	Factor	Shift
lunounit	(-)	(-)	1.00000000e+00	0.00000000e+00
lutime	(s)	(s)	1.00000000e+00	0.00000000e+00
lutemp	(k)	(f)	1.80000000e+00	-4.59670000e+02
lutempd	(k)	(f)	1.80000000e+00	0.00000000e+00
lulength	(m)	(ft)	3.28083990e+00	0.00000000e+00
luarea	(m2)	(ft2)	1.07639104e+01	0.00000000e+00
luvolume	(m3)	(ft3)	3.53146667e+01	0.00000000e+00
luvel	(m/s)	(ft/s)	3.28083990e+00	0.00000000e+00
luacc	(m/s2)	(ft/s2)	3.28083990e+00	0.00000000e+00
lupumphd	(m2/s2)	(lbf*ft/lbm)	3.34552563e-01	0.00000000e+00
luvolflw	(m3/s)	(gpm)	1.58503222e+04	0.00000000e+00
luspvol	(m3/kg)	(ft3/lbm)	1.60184634e+01	0.00000000e+00
lumass	(kg)	(lbm)	2.20462262e+00	0.00000000e+00
lumassfw	(kg/s)	(lbm/hr)	7.93664144e+03	0.00000000e+00
lumfwrat	(kg/s2)	(lbm/s2)	2.20462262e+00	0.00000000e+00
lumassfx	(kg/m2/s)	(lbm/ft2/hr)	7.37338117e+02	0.00000000e+00
luvapgen	(kg/m3/s)	(lbm/ft3/hr)	2.24740658e+02	0.00000000e+00
luden	(kg/m3)	(lbm/ft3)	6.24279606e-02	0.00000000e+00
luddendt	(kg/m3/k)	(lbm/ft3/f)	3.46822003e-02	0.00000000e+00
luidrag	(kg/m4)	(lbm/ft4)	1.90280424e-02	0.00000000e+00
lupressa	(pa)	(psia)	1.45037738e-04	0.00000000e+00
lupressd	(pa)	(psid)	1.45037738e-04	0.00000000e+00
luprsrat	(pa/s)	(psi/s)	1.45037738e-04	0.00000000e+00
luminert	(kg*m2)	(lbm*ft2)	2.37303604e+01	0.00000000e+00
lutorque	(pa*m3)	(lbf*ft)	7.37562149e-01	0.00000000e+00
lubtork	(pa*m3*s/rad)	(lbf*ft/rpm)	7.72373277e-02	0.00000000e+00
luctork	(pa*m3*s2/r2)	(lbf*ft/rpm2)	8.08827404e-03	0.00000000e+00
lupower	(w)	(btu/hr)	3.41214163e+00	0.00000000e+00
lupowrat	(w/s)	(btu/hr/s)	3.41214163e+00	0.00000000e+00
lulinhts	(w/m)	(btu/ft/hr)	1.04002077e+00	0.00000000e+00
luheatfx	(w/m2)	(btu/ft2/hr)	3.16998331e-01	0.00000000e+00
luvolhts	(w/m3)	(btu/ft3/hr)	9.66210912e-02	0.00000000e+00

Units Name	SI Units	English Units	Factor	Shift
luthcond	(w/m/k)	(btu/ft/f/hr)	5.77789317e-01	0.00000000e+00
luhtc	(w/m2/k)	(btu/ft2/f/h)	1.76110184e-01	0.00000000e+00
luihttf	(w/k)	(btu/f/hr)	1.89563424e+00	0.00000000e+00
luenergy	(w*s)	(btu)	9.47817120e-04	0.00000000e+00
luspener	(w*s/kg)	(btu/lbm)	4.29922614e-04	0.00000000e+00
luspheat	(w*s/kg/k)	(btu/lbm/f)	2.38845897e-04	0.00000000e+00
lurtime	(1/s)	(1/s)	1.00000000e+00	0.00000000e+00
lurtemp	(1/k)	(1/f)	5.55555556e-01	0.00000000e+00
lurmass	(1/kg)	(1/lbm)	4.53592370e-01	0.00000000e+00
lurpress	(1/pa)	(1/psi)	6.89475729e+03	0.00000000e+00
luspeed	(rad/s)	(rpm)	9.54929659e+00	0.00000000e+00
luradacc	(rad/s2)	(rpm/s)	9.54929659e+00	0.00000000e+00
luangle	(rad)	(deg)	5.72957795e+01	0.00000000e+00
luburnup	(mwd/mtu)	(mwd/mtu)	1.00000000e+00	0.00000000e+00
luenfiss	(mev/fiss)	(mev/fiss)	1.00000000e+00	0.00000000e+00
lugapgas	(g-moles)	(g-moles)	1.00000000e+00	0.00000000e+00
lurtmsq	(1/k2)	(1/f2)	3.08641975e-01	0.00000000e+00

Namelist variable IUNLAB (default value is 0) is the user-defined number of these additional labels. When IUNLAB > 0, input IUNLAB of the following cards to define the additional unit-name labels. User-defined units-name label data are not written to the TRCDMP file and not read from the TRCRST file so the user needs to input the user-defined units-name label data to the TRACIN file for all (initial and restart) TRAC-P calculations.

User-Defined Units-Name Label Card. (Format 6X, A8, 1X, A13, 1X, A13, 2E14.4)
LULABEL, LUNITSI, LUNITENG, UFACTOR, USHIFT

Columns	Variable	Description
1–14	LULABEL	Units-name label beginning with the letters LU followed by one to six nonblank characters (for example, the user might choose the units-name label LUDPDT for the derivative of pressure with respect to temperature, dP/dT).
15–28	LUNITSI	The SI-units symbol associated with the units-name label that begins with the letters LU followed by 1 to 11 nonblank characters. TRAC-P internally removes the LU prefix (required for preinput processing of character-string data) in defining the SI-units symbol for I/0 (for example, LUPA/K defines the SI-units symbol for the derivative of pressure with respect to temperature, dP/dT).

Columns	Variable	Description
29–42	LUNITENG	The English-units symbol associated with the units-name label, which begins with the letters LU followed by 1 to 11 nonblank characters. TRAC-P internally removes the LU prefix in defining the English-units symbol for I/0 (for example, LUPSID/F defines the English-units symbol for the derivative of pressure with respect to temperature, dP/dT).
43–56	UFACTOR	The factor value for converting a parameter value in SI units to its value in English units where Parameter(SI) * UFACTOR + USHIFT = Parameter(English) (for example, UFACTOR = 8.05765E-05 (PSID×K)/(PA×°°F) = 1.450377 E-04 PSID/PA divided by 1.8°F/K for the derivative of pressure with respect to temperature, dP/dT).
57–70	USHIFT	The shift value for converting a parameter value in SI units to its value in English units where Parameter(SI) * UFACTOR + USHIFT = Parameter(English) (for example, USHIFT = 0.0 PSID/°F for the derivative of pressure with respect to temperature, dP/dT, because pressure and temperature are both difference values rather than absolute values).

6.3.5.5. Control-block data. Control-block data are defined when NTCB > 0 (Word 2 on Main-Data Card 7). Control blocks are mathematical functions that operate on 0 to 3 input parameters defined by signal variables and control blocks. The control-block output signal defines an input parameter for control blocks, a parameter for trip signals, the independent-variable parameter for component-action tables, and the component action directly. Either NTCB or fewer control blocks are input. When fewer than NTCB control blocks are input, conclude the data with a blank card or a card having a 0 defining the first input parameter, IDCB (0 must be entered explicitly if the free-format option is used). The remaining control blocks (for a total of NTCB) are obtained from the restart file. They are the control blocks on the restart file whose IDCB ID numbers differ from those defined on input. After all control-block data are read from input and obtained from the restart file, the control-blocks are reordered with the absolute value of their ID numbers (the value of –IDCB) increasing monotonically. Each control block is defined by the following two cards. When the control block is a tabular function of 1, 2, or 3 independent variables (ICBN = 101 or 102), additional Card Number 3 data cards are needed to define the function table. When the control block is a PI or PID controller (ICBN = 200 or 201), an additional Card Number 4 is needed.

Control-Block Cards.

Card Number 1. (Format 5I14) IDCB, ICBN, ICB1, ICB2, ICB3

Columns	Variable	Description
1–14	IDCB	Control-block ID number ($-9900 \leq IDCB \leq -1$).
15–28	ICBN	Control-block operation number ($1 \leq ICBN \leq 61$, $100 \leq ICBN \leq 102$, or $200 \leq ICBN \leq 201$). Refer to Table 6-3 for the list of control-block operation numbers and the mathematical description of the operation each performs.
29–42	ICB1	ID number for the first input parameter to the control block. ICB1 > 0 defines a signal-variable parameter; ICB1 < 0 defines a control-block output parameter.
43–56	ICB2	ID number for the second input parameter to the control block. ICB2 > 0 defines a signal-variable parameter; ICB2 < 0 defines a control-block output parameter. For ICBN = 100 or 101, ICB2 is the number of entry pairs in the control block's function table.
57–70	ICB3	ID number for the third input parameter to the control block. ICB3 > 0 defines a signal-variable parameter; ICB3 < 0 defines a control-block output parameter.

TABLE 6-3
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
1	Absolute value	XOUT = G * ABS(X1).	X1				
2	Arccosine	XOUT = G * ACOS(X1), units label should be angle = (rad, deg) for XOUT.					
3	Add	XOUT = G * (X1 + X2).	X1	X2			
4	Integerizer	XOUT = G* FLOAT(IFIX(X1)).	X1				
5	Logical "and"	XOUT = G IF((L1.EQ.1.0) .AND.(L2.EQ.1.0)); = 0.0 otherwise.	L1	L2			
6	Arcsine	XOUT = G * ASIN(X1), units label should be angle = (rad, deg) for XOUT.	X1				
7	Arctangent	XOUT = G * ATAN(X1), units label should be angle = (rad, deg) for XOUT.	X1				
8	Arctangent 2	XOUT = G * ATAN(X1,X2), units label should be angle = (rad, deg) for XOUT.	X1	X2			
9	Constant	XOUT = G * C1.					
10	Cosine	XOUT = G * COS(X1), units label should be angle = (rad, deg) for X1.	X1				
11	Dead band, dead zone, or dead space	XOUT = G * (X1 – C2) IF(X1.GT.C2); = G * (X1 – C1) IF(X1.LT.C1); or = 0.0 otherwise.	X1				

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
12	Derivative	$XOUT = G * (dX1/dt)$.	X1 (X2)				
13	Double integrator with XOUT limited	$XOUT = G * \int[\int X1dt + X2]dt + XOUT$, X1 and (X2) are reset to 0.0 if XOUT is against a limit and the sign of X1 does not change. $X1 = 0.0, X2 = 0.0$, and $XOUT = 0.0$ initially. X2 is $\int X1dt$ summed over all previous timesteps. $C1 = 0.0$ or 1.0 is the polynomial order for approximating the time dependence of X1 and its integral.	X1	(X2)	(X3)		
14	Divide	$XOUT = G * X1 / X2$.	X1	X2			
15	Logical "exclusive or"	$XOUT = G$ IF(L1+L2).EQ.1.0); $= 0.0$ otherwise.	L1	L2			
16	Logical "equivalent"	$XOUT = G$ IF(L1.EQ.L2); $= 0.0$ otherwise.	L1	L2			
17	Exponentiate	$XOUT = G * EXP(X1)$.	X1				
18	Logical "flip-flop"	$XOUT = G$ or 0.0, flip-flop output value that changes state whenever L1 changes state (only if L3 = 1.0).	L1	(L2)	L3		
19	Gate	$XOUT = G * X1$ IF(L2.EQ.1.0); $= 0.0$ IF(L2.EQ.0.0).	X1	L2			
20	Greater than or equal to	$XOUT = G$ IF(X1.GE.X2); $= 0.0$ otherwise.	X1	X2			

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
21	Greater than	XOUT = G IF(X1.GT.X2); = 0.0 otherwise.	X1	X2			
22	Input switch	XOUT = G * X1 IF(L3.EQ.1.0); = G * X2 IF(L3.EQ.0.0).	X1	X2	L3		
23	Integrate	XOUT = G * ∫X1dt + XOUT, XOUT = 0.0 initially. X1 is not reset to 0.0 when XOUT is against its limits. C1 = 0.0 or 1.0 is the polynomial order for approximating the time dependence of X1.	X1			C1	(C2)
24	Integrate with mode control	XOUT = 0.0 IF((L2+L3).EQ. 0.0), reset mode; = XOUT IF((L2+L3).EQ.1.0), hold mode; or = G * ∫X1dt + XOUT IF((L2+L3).EQ.2.0), integrate mode. C1 = 0.0 or 1.0 is the polynomial order for approximating the time dependence of X1.	X1	L2	L3	C1	(C2)
25	Logical "inclusive or"	XOUT = 0.0 IF((L1+L2).EQ. 0.0); = G otherwise.	L1	L2			

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input 1	2	3	Block[c] Const. 1	2
26	First-order lag	XOUT = XO, where XO is the problem time-domain output from the Laplace transform operator $(G * X1(s)+C1 * XO(t = 0))/(C1*s +1)$ operating on the X1(t) input function X1(s) in the Laplace transform s domain; that is, XO(t) is the solution of the first-order differential equation $C1 * dX0/dt + XO = G * X1$ in time where $C1 \geq 0.0$ and G is a constant gain factor. XO is initialized to $G * X1$ at $t = 0$.	X1			C1	
27	Logic delay	XOUT = 0.0 IF((L1.EQ.0.0).OR.(TIME.GT.(C1+C2))); = G IF((L1.EQ.1.0).AND.(TIME.LE.(C1+ C2))), where (C2) is the time when L1 switches from 0.0 to 1.0.	L1	(L2)		L1	(L2)
28	Logic general-purpose counter	XOUT = 0.0 IF(L3.EQ.0.0), reset mode; = G times the number of times L1 has changed state since enabled (when L3 = 1.0), count mode.	L1	(L2)	L3		

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input 1	2	3	Block[c] Const. 1	2
29	Logic input switch	XOUT = G * L1 IF(L3.EQ.1.0); = G * L2 IF(L3.EQ.0.0).	L1	L2	L3		
30	Lead-lag transfer function	XOUT = XO, where XO is the problem time-domain output from the Laplace trans-form operator $(G * X1(s) * (C1 * s + 1) + C2 * XO (t = 0) - C1 * G * X1(t = 0))/(C2 *s + 1)$ operating on the X1(t) input function X1(s) in the Laplace transform s domain; that is, XO(t) is the solution of the first-order differential equation $C2 * dXO/dt + XO = G * (C1 * dX1/dt + X1)$ where $C1 \geq 0.0$, $C2 \geq 0.0$, and G is a constant gain factor. XO is initialized to G * X1 at t = 0.	X1	(X2)		C1	C2
31	Limited integrator	XOUT = G * ½X1dt + XOUT, X1 is set to 0.0 if XOUT is against a limit and the sign of X1 does not change; XOUT = 0.0 initially. C = 0.0 or 1.0 is the poly-nomial order for approximating the time dependence of X1.	X1			C1	(C2)

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
32	Natural logarithm	XOUT = G * ALOG(X1).	X1				
33	Less than or equal to	XOUT = G IF(X1.LE.X2); = 0.0 otherwise.	X1	X2			
34	Less than	XOUT = G IF(X1.LT.X2); = 0.0 otherwise.	X1	X2			
35	Maximum of two signals	XOUT = G * AMAX1(X1,X2).	X1	X2			
36	Maximum during trans-ient signals	XOUT = G * AMAX1(X1, XOUT).	X1				
37	Minimum of two	XOUT = G*AMIN1(X1,X2).	X1	X2			
38	Minimum during transient	XOUT = G * AMIN1(X1,XOUT).	X1				
39	Multiply	XOUT = G * X1 * X2.	X1	X2			
40	Logical "not and"	XOUT = 0.0 IF((L1+L2).EQ. 2.0); = G otherwise.	L1	L2			
41	Logical "not equal"	XOUT = G IF(L1.NE.L2); = 0.0 otherwise.	L1	L2			
42	Logical "not inclusive or"	XOUT = G IF((L1+L2).EQ.0.0);= 0.0 otherwise.	L1	L2			
43	Logical "not" or negation	XOUT = G IF(L1.EQ.0.0); = 0.0 IF(L1.EQ.1.0).	L1				
44	Positive difference	XOUT = G * (X1 – X2) IF(X1.GT.X2); = 0.0 otherwise.	X1	X2			
45	Quantizer	XOUT = G * FLOAT (IFIX(X1+ 0.5)) IF(X1.GE.0.0); = G * FLOAT (IFIX(X1 – 0.5)) IF(X1.LT.0.0).	X1				

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input 1	2	3	Block[c] Const. 1	2
46	Ramp	XOUT = G * (TIME – C1) IF(TIME.GT.C1); = 0.0 otherwise.				C1	
47	Random number generator	XOUT = G * RANF where 0.0.LE.RANF.LE.1.0 IF(TIME.GE.C1); = 0.0 otherwise.				C1	
48	Sign function	XOUT = G * |X1| IF(X2.GE.0.0); = –G * |X1| IF(X2.LT.0.0).	X1	X2			
49	Sine	XOUT = G * SIN(X1), units label should be angle = (rad, deg) for X1.	X1				
50	Sign inversion	XOUT = – G * X1.	X1				
51	Second-order transfer function	XOUT = XO, where XO is the problem time-domain output from the Laplace transform operator (G * X1(s) + C1 * XO(t = 0) + C2 * (s * XO(t = 0) + dXO/dt(t = 0)))/(C2 * s * s + C1 * s + 1) operating on the X1(t) input function X1(s) in the Laplace transform s domain that is, XO(t) is the second-order differferential equation C2 * d(dXO/dt)/dt + C1 * dXO/dt + XO = G * X1 where C1 ≥ 0.0, C2 ≥ 0.0, and G is a constant gain factor. XO is initialized to G * X1 at t = 0.	X1	(X2)	(X3)	C1	C2

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
52	Square root	XOUT = G * SQRT(X1).	X1				
53	Step	XOUT = G IF(TIME.GE.C1); = 0.0 otherwise.				C1	
54	Subtract	XOUT = G * (X1 – X2).	X1	X2			
55	Tangent	XOUT = G * TAN(X1), units label should be angle = (rad, deg) for X1.	X1				
56	Sum constant	XOUT = G * (X1 + C1).	X1			C1	
57	Sum three	XOUT = G * (X1 + X2 + X3).	X1	X2	X3		
58	Variable limiter	XOUT = G * X2 IF(X1.GT.X2), at upper limit; = G * X3 IF (X1.LT.X3), at lower limit; or = G * X1 otherwise between limits.	X1	X2	X3		
59	Weighted summer	XOUT = G * (C1*X1 + C2*X2).	X1	X2		C1	C2
60	Exponential	XOUT = G * (X1**X2), where X1 > 0.	X1	X2			
61	Zero-order hold	XOUT = G * X1 IF(L2.EQ.1.0); = XOUT otherwise.	X1	X2			
100	Time delay	XOUT = G * X1, where X1 is evaluated at the time the control block is input IF(TIME.LE. C1); = G * X1(TIME– C1) otherwise [X1(TIME–C1) is evaluated at time (TIME–C1)]. The variable n is the number of storage table pairs for saving values of X1 over the last C1 seconds. X1 is stored at intervals of approximately C1/ (n–1) s; the control	X1	n	(X3)	C1	

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
		block will use linear inter-polation to obtain the desired value of X1(TIME–C1).					
101	Function of one independent variable	$XOUT = G * f_n(X1)$. The variable n is the number of function table pairs of values to be input.	X1	n	(X3)	(C1)	
102	Function of two or three independent variables	$XOUT = G * f(X1,X2,X3)$. The variable n is the composite number $10000.0 \times N_1 + 100.0 \times N_2 + N_3$, where $N_1 =$ number of X1 values $(2 \le N_1 \le 99)$, $N_2 =$ number of X2 values $(2 \le N_2 \le 99)$, and $N_3 =$ number of X3 values $(2 \le N_3 \le 99)$. Input zero for X3 and N_3 for a tabular function of two independent variables. Input the function table in the following order: the N_1 values of X1, the N_2 values of X2, the N_3 values of X3, and the $[N_1 * N_2 * \max(1,N_3)]$ function values.	X1	X2	X3	n	(C2)

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input			Block[c] Const.	
			1	2	3	1	2
200	PI Controller	$XOUT = A = A_O + \Delta A$ in Fig. 6-2, where $X1 =$ ID number of F, $X2 =$ ID number of F_d when F_d is an input parameter rather than a constant value; $C1 = F_d$, a constant value; $C2 = A_o$, the initial XOUT; $G = (\Delta A / \Delta F)_{est}$; $XMIN = A_{min}$; and $XMAX = A_{max}$. A third input-data card is required to specify $\Delta t_d > 0.0$ and $\tau \geq 0.0$. Refer to Fig. 6-2 for a schematic of the functional form of this control block.	X1	X2		C1	C2

TABLE 6-3 (cont)
CONTROL-BLOCK FUNCTION OPERATIONS

No.	Control-Block Name	Control-Block Mathematical Operation[a]	Block[b,c] Input 1	2	3	Block[c] Const. 1	2
201	PID Controller	$XOUT = A = A_o + \Delta A$ in Fig. 6-3, where $X1 = $ ID number of F; $X2 = $ ID number of F_d when F_d is an input parameter rather than a constant value, $C1 = F_d$, a constant value; $C2 = A_o$, the initial XOUT; $G = (\Delta A / \Delta F)$; $XMIN = A_{min}$; and $XMAX = A_{max}$. A third input-data card is required to specify $\Delta t_d > 0.0$, $\tau \geq 0.0$, and $0.0 \leq Wt \leq 1.0$. Refer to Fig. 6-3 for a schematic of the functional form of this control block.	X1	X2	(X3)	C1	C2

[a] XOUT appearing on the right-hand side of the defining equation indicates its value from the previous evaluation. G is a constant gain factor applied to the operation result. XOUT appearing on the left-hand side of the defining equation is constrained by constant lower and upper limits, XMIN and XMAX, in defining the control-block XOUT output value.

[b] An "X" parameter indicates a continuous value variable; an "L" parameter indicates a logical (or discrete) parameter only having a value of 0.0 or 1.0.

[c] Variables enclosed in parentheses are not input variables but are used internally by the control block for data storage.

$$\Delta A_{PI} = (\Delta A/\Delta F)_{est} \left[\Delta F + (1/\Delta t_d) \int \Delta F dt\right]$$
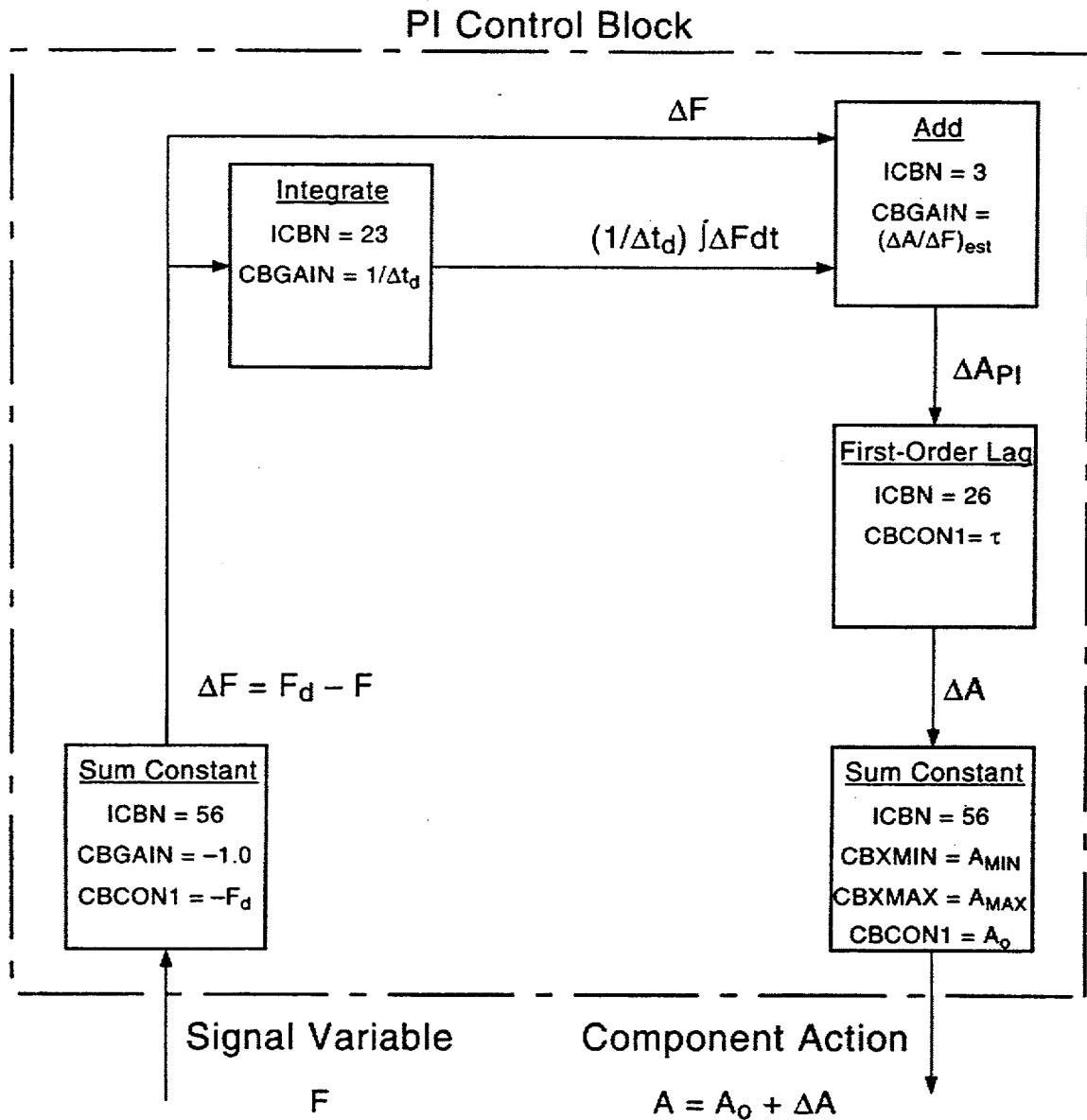
PI Control Block

Fig. 6-2.   Proportional plus integral controller diagram.

Proportional + Integral + Derivative (PID) Controller

$$\Delta A_{PID} = (\Delta A/\Delta F)_{est} \left[\Delta F + (1/\Delta t_d) \int \Delta F dt + \overline{\Delta t_d \, (d\Delta F/dt) + \Delta F}\right]$$

PID Control Block

Sum Three
ICBN = 57
CBGAIN = $(\Delta A/\Delta F)_{est}$

ΔF

Integrate
ICBN = 23
CBGAIN = $1/\Delta t_d$

$(1/\Delta t_d) \int \Delta F dt$

$\overline{\Delta t_d \, (d\Delta F/dt) + \Delta F}$

Derivative
ICBN = 12
CBGAIN = Δt_d

Wt. Summer
ICBN = 59
CBCON1 = Wt
CBCON2 = 1−Wt

ΔA_{PID}

$\Delta t_d \, (d\Delta F/dt)$

1   2

Add
ICBN = 3

ΔF

First-Order Lag
ICBN = 26
CBCON1= τ

$\Delta F = F_d - F$

Sum Constant
ICBN = 56
CBGAIN = −1.0
CBCON1 = $-F_d$

ΔA

Sum Constant
ICBN = 56
CBXMIN = A_{MIN}
CBXMAX = A_{MAX}
CBCON1 = A_o

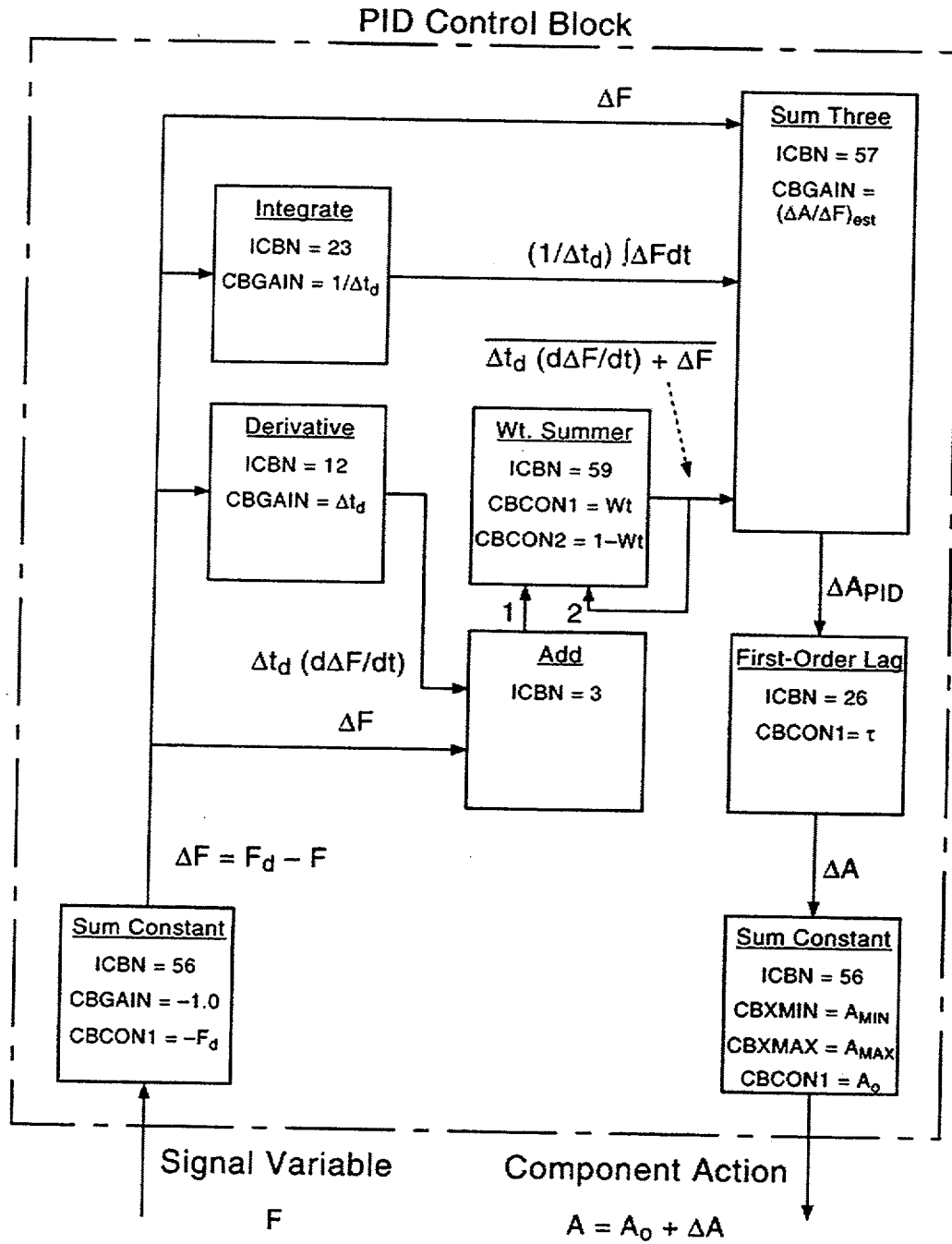Signal Variable
F

Component Action
$A = A_o + \Delta A$

Fig. 6-3.   Proportional plus integral plus derivative controller diagram.

Card Number 2. Format 5A14) LUGAIN, LUXMIN, LUXMAX, LUCON1, LUCON2

Note: If |IOGRF|+|IOINP|+|IOLAB|+|IOOUT| ≠ 0 (NAMELIST variables), input Card Number 2. See Table 6-2 for a list of unit names and their SI and English units, and SI to English conversion factors and shifts for these control-block parameters.

Columns	Variable	Description
1–14	LUGAIN	Units-name label of the control-block gain factor.
15-28	LUXMIN	Units-name label of the control-block minimum value of its output parameter (also defines the units of the control-block output parameter).
29–42	LUXMAX	Units-name label of the control-block maximum value of its output parameter (also defines the units of the control-block output parameter).
43–56	LUCON1	Units-name label of the control-block first constant.
57–70	LUCON2	Units-name label of the control-block second constant.

Card Number 3. (Format 5E14.4) CBGAIN, CBXMIN, CBXMAX, CBCON1, CBCON2

Note: If CBGAIN, CBXMIN, and CBXMAX are defined to be zero or defined with blank fields in TRAC-M format, TRAC-P internally defines CBGAIN = 1.0, CBXMIN = -1.0×10^{20}, and CBXMAX = 1.0×10^{20}.

Columns	Variable	Description
1–14	CBGAIN	Control-block gain factor (*).
15–28	CBXMIN	Control-block minimum value of its output parameter (*).
29–42	CBXMAX	Control-block maximum value of its output parameter (*).
43–56	CBCON1	Control-block first constant. For ICBN=102, CBCON1 is a composite number defining the number of values to be input for the function table (*).
57–70	CBCON2	Control-block second constant is required input for the ICBN = 11, 30, 51, 59, 200, and 201 control-block functions. XOUT is initialized by TRAC-P to its initial evaluated value for control-block functions ICBN = 11 and 59. For the Laplace-transform function control blocks, ICBN = 26, 30, and 51, XOUT is initialized to CBGAIN * XIN(ICB1). For the PI- and PID-controller function control blocks, ICBN = 200 and 201, XOUT is initialized to the CBCON2 value. For all other control-block function ICBN values, XOUT is initialized to its initial evaluated value when CBCON2 is 0.0 or defined by a blank field. Otherwise, XOUT is initialized to the nonzero input specified CBCON2 value.

Card Number 4. (Format 4A14) LUYTAB, (LUXTAB(I), I = 1, II

Note: If ICBN = 101 or 102 (Word 2 on Control-Block Data Card 1) and IOALL = |IOGRF| + |IOINP| + |IOLAB| + |IOOUT| ≠ 0 (NAMELIST variables), input Card Number 4. If ICBN = 101, II = 1; if ICBN=102, II = 3. See Table 6-2 for a list of units-name labels, their SI and English units symbols, and their SI to English conversion factors and shifts for these control-block function table parameters.

Columns	Variable	Description
1–14	LUYTAB	Units-name label of the control-block table dependent-variable values.
15–28	LUXTAB(1)	Units-name label of the control-block table first independent-variable values.
29–42	LUXTAB(2)	Units-name label of the control-block table second independent-variable values.
43–56	LUXTAB(3)	Units-name label of the control-block table third independent-variable values.

Card Set 5. CBFTAB(I), I = (1, N) Load Format

Note: If ICBN = 101 or 102 (Word 2 on Control-Block Data Card 1), input Card Set 5.

Variable	Dimension	Description
CBFTAB	ICB2 × 2	Control-block function table data (*,*); input N values where N = 2 × ICB2 for ICBN = 101 or N = $N_1 + N_2 + N_3$ + [$N_1 \times N_2 \times$ max $(1,N_3)$] for ICBN = 102 where CBCON1 = 10000.0 × N_1 + 100.0 × N_2 + N_3 (refer to Table 6-3 for additional information about the defining form of these control blocks).

Card Number 6. (Format 3E14.4) CBDT, CBTAU, CBWT

Note: If ICBN = 200 or 201 (Word 2 on Control-Block Data Card 1), input Card Number 6.

Columns	Variable	Description
1–14	CBDT	The Δt_d time constant (s) for removal of PI-controller or PID-controller error (where convergence of the form $\Delta F(t) = \Delta F_o \times \exp [(t_o - t)/\Delta t_d]$ is assumed).

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| 15–28 | CBTAU | The τ time constant (s) for the first-order lag function operation. |
| 29–42 | CBWT | The first constant Wt value (–) for the weighted summing function operation when ICBN = 201. |

6.3.5.6. Trip data. Trip data are defined when NTRP > 0 (Word 4 on Main-Data Card 7). There are 7 categories of trip-input data. The first category, Trip-Dimension Variables Card, is always input when NTRP > 0. The five variables on this card and NTRP define the variable storage required for the remaining 6 trip-input data categories. In each remaining category, none, part, or all of the data can be input. Any data that are not input are obtained from the restart file.

Trip-Dimension Variables Card. (Format 5I14) NTSE, NTCT, NTSF, NTDP,NTSD

Columns	Variable	Description
1–14	NTSE	The number of different signal-expression trip signals from input and the restart file (NTSE ≥ 0) (used to dimension variable storage).
15–28	NTCT	The number of different trip-controlled trip signals from input and the restart file (NTCT ≥ 0) (used to dimension variable storage).
29–42	NTSF	The number of different set-point factor tables referenced by trips from input and the restart file (NTSF ≥ 0) (used to dimension variable storage).
43–56	NTDP	The number of trips from input and the restart file that generate a restart dump and possible problem termination when they are set ON (NTDP ≥ 0) (used to dimension variable storage).
57–70	NTSD	The number of trip-controlled timestep data sets from input and the restart file that are used for timestep and edit control when their defined trips are set ON (NTSD ≥ 0) (used to dimension variable storage).

Trip-Defining Variables Cards. Input from 0 to NTRP (Word 4 on Main-Data Card 7) of the following card set. If fewer than NTRP card sets are input, conclude these data with a blank card or a card with a 0 for the first input parameter IDTP (0 must be entered explicitly if the free-format option is used). The remaining trips that have trip IDTP ID numbers different from those input will be obtained from the restart file.

Card Number 1. (Format 5I14) IDTP, ISRT, ISET, ITST, IDSG

Columns	Variable	Description
1–14	IDTP	The trip ID number ($1 \leq |IDTP| \leq 9999$). Negative trip ID numbers have their trip set status evaluated during both the steady-state and transient calculations. Positive trip ID numbers have their trip set status evaluated only during the transient calculation with the input value of the trip set status, ISET, used throughout the steady-state calculation.
15–28	ISRT	The signal-range type number. Over the value range of the trip signal, the signal-range type number ISRT defines either two (ISRT = ±1 or ±2) or three (ISRT = ±3, ±4, or ±5) subranges with different set-status labels (ON$_{Reverse}$, OFF, or ON$_{Forward}$). Refer to Table 6-4 for a description of these subranges and their delimiting setpoint values for the ten possible values of ISRT ($1 \leq |ISRT| \leq 5$).
29–42	ISET	The initial trip set-status number (only used during steady state when IDTP > 0). $-1 = $ ON$_{Reverse}$; $0 = $ OFF; $1 = $ ON$_{Forward}$.
43–56	ITST	The trip-signal type number. ±1 = signal-variable trip, ±2 = signal-expression trip, or ±3 = trip-controlled trip. Defining the ITST value negative eliminates writing trip-status changes to the output files (when the trip-signal criterion is met and when the trip set status is changed).
57–70	IDSG	The ID number for the trip-signal variable when ITST = ±1 (IDSG > 0 corresponds to IDSV in the signal-variable data and IDSG < 0 corresponds to IDCB in the control-block data), trip-signal expression when ITST = ±2 (IDSG corresponds to IDSE in the trip-signal-expression data that follow), or trip-controlled trip signal when ITST = ±3 (IDSG corresponds to IDTN in the trip-controlled trip data that follow).

Card Number 2. (Format A14) LUTRPSIG

Note: If ITST = ±2 (signal-expression trip) and IOALL = |IOGRF| + |IOINP| + |IOLAB| + |IOOUT| ≠ 0 (NAMELIST variables), input Card Number 2. See Table 6-2 for a list of units-name labels, their SI and English units symbols, and their SI to English conversion factors and shifts for the trip-signal and trip-signal setpoint parameters.

Columns	Variable	Description
1–14	LUTRPSIG	Units-name label of the trip signal and trip-signal setpoints.

Card Number 3. (Format 4E14.4) SETP(I), I = (1, NSP)

Variable	Dimension	Description
SETP	NSP	The trip-signal setpoint values (*) shown as $S_{\#}$ (where # = I) in the Table 6-4 definition of ISRT (Word 2 on Trip-Defining Variables Card 1). For ISRT = ±1 or ±2, NSP = 2; for ISRT = ±3, ±4, or ±5, NSP = 4. The setpoint values must satisfy SETP(1) < SETP(2) when ISRT = ±1 or ±2 or SETP(1) < SETP(2) < SETP(3) < SETP(4) when ISRT = ±3, ±4, or ±5. [Caution: For trip-controlled trips with real-value trip signals that have discrete integer values (0.0, 1.0, 2.0, etc.), the setpoint values should be midway between the two trip-signal values that change the trip's set status. Because of numerical roundoff when set-status values assigned to the trip signal are summed or multiplied, it is better to have the trip signal cross the setpoint value rather than reach and equal it to satisfy the set-status change criterion. For example, use S_1 = 0.4 and S_2 = 0.6 rather than S_1 = 0.0 and S_2 = 1.0 when the trip signal goes from 0.0 to 1.0 or 1.0 to 0.0 and changes the trip's set status.]

Card Number 4. (Format 4E14.4) DTSP(I), I = (1, NSP)

Variable	Dimension	Description
DTSP	NSP	The setpoint delay times (s) after the trip signal crosses the setpoint value to when the trip set status is changed. For ISRT = ±1 or ±2, NSP = 2; for ISRT = ±3, ±4, or ±5, NSP = 4.

TABLE 6-4
TRIP SIGNAL-RANGE TYPES

ISRT Signal-Range Type Number	Trip Signal-Range Diagram With Subrange Set Status					
1	$ON_{Forward}$ $\|$ S_1 $\|$ S_2 OFF					Trip Signal
2	OFF $\|$ S_1 $\|$ S_2 $ON_{Forward}$					Trip Signal
3	$ON_{Forward}$ $\|$ S_1 $\|$ S_2 OFF $\|$ S_3 $\|$ S_4 $ON_{Reverse}$					Trip Signal
4	OFF $\|$ S_1 $\|$ S_2 $ON_{Forward}$ $\|$ S_3 $\|$ S_4 OFF					Trip Signal
5	$ON_{Forward}$ $\|$ S_1 $\|$ S_2 OFF $\|$ S_3 $\|$ S_4 $ON_{Forward}$					Trip Signal

Making ISRT negative changes $ON_{Forward}$ to $ON_{Reverse}$ and $ON_{Reversee}$ to $ON_{Forward}$

ISRT Signal-Range Type Number	Description of How the Trip Set Status Is Changed
1	When $ON_{Forward}$, trip is set to OFF when the trip signal $\geq S_2$. When OFF, trip is set to $ON_{Forward}$ when the trip signal $\leq S_1$.
2	When OFF, trip is set to $ON_{Forward}$ when the trip signal $\geq S_2$. When $ON_{Forward}$, trip is set to OFF when the trip signal $\leq S_1$.
3	When $ON_{Forward}$, trip is set to OFF when trip signal $\geq S_2$ and $< S_4$. When $ON_{Forward}$, trip is set to $ON_{Reversee}$ when the trip signal $\geq S_4$. When OFF, the trip is set to $ON_{Forward}$ when the trip signal $\leq S_1$. When OFF, trip is set to $ON_{Reversee}$ when the trip signal $\geq S_4$. When $ON_{Reversee}$, trip is set to OFF when the trip signal $\leq S_3$ and $> S_1$. When $ON_{Reversee}$, trip is set to $ON_{Forward}$ when the trip signal $\leq S_1$.
4	When OFF (left), trip is set to $ON_{Forward}$ when signal $\geq S_2$ and $< S_4$. When $ON_{Forward}$, trip is set to OFF when the trip signal $\leq S_1$ and $\geq S_4$. When OFF (right), trip is set to $ON_{Forward}$ when signal $\leq S_3$ and $> S_1$.
5	When $ON_{Forward}$ (left), trip is set to OFF when the trip signal $\geq S_2$ and $< S_4$. When OFF, trip is set to $ON_{Forward}$ when the trip signal $\leq S_4$ or $\geq S_4$. When $ON_{Forward}$ (right), the trip is set to OFF when signal $\leq S_3$ and $> S_1$.

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Card Number 5. (Format 4I14) IFSP(I), I = (1, NSP)

Variable	Dimension	Description
IFSP	NSP	The setpoint factor-table ID numbers. The variable IFSP(I) corresponds to IDFT defined on the Trip Setpoint Factor-Table Card Number 1 that follows. Input IFSP(I) = 0 when no setpoint factor is to be applied to SETP(I); that is, the setpoint value remains constant during the problem. For ISRT = ±1 or ±2, NSP = 2; for ISRT = ±3, ±4, or ±5, NSP = 4.

Trip-Signal-Expression Signal Cards. Input the following card data for each different IDSG trip-signal ID number of trips with ITST = ±2 that are input.

Note: If none of the trip input has ITST = ±2 (Word 4 on Trip-Defining Variables Card Number 1), do not input the Trip-Signal-Expression Signal Cards.

Card Number 1. (Format 3I14) IDSE, INSE, INCN

Columns	Variable	Description
1–14	IDSE	The trip-signal-expression signal ID number. This number corresponds to IDSG (Word 5 on Trip-Defining Variables Card 1) for one or more of the input trips having ITST = ±2 (1 ≤ |IDSE| < 9999).
15–28	INSE	The number of subexpressions defining the trip-signal expression (1 ≤ INSE ≤ 10).
29–42	INCN	The number of different constants referenced in the subexpressions defining the trip-signal expression (0 ≤ INCN ≤ 5).

Card Number 2. (Format 3I14) ISE(I,J), I = (1, 3)

Note: Input INSE (Word 2 on Card Number 1) cards of Card Number 2 to define the J = (1, INSE) arithmetic sub-expressions.

Columns	Variable	Description
1–14	ISE(1,J)	The arithmetic-operator ID number of the Jth arithmetic subexpression (see Table 6-5).
15–28	ISE(2,J)	The first argument ID number of the Jth arithmetic subexpression.

Columns	Variable	Description
29–42	ISE(3,J)	The second argument ID number of the Jth arithmetic subexpression.

The first and second argument ID numbers define values that, when operated on by the arithmetic operator, give a value to their Jth arithmetic subexpression. There are four forms for the value of the first and second argument ID numbers. Their values are

1. a signal-variable or control-block output value evaluated each timestep when their ID number is a signal-variable ID number $1 \leq IDSV \leq 399$ (Word 1 of the Signal-Variable Card) or a control-block ID number $-9999 \leq IDCB \leq -1$ (Word 1 of Control-Block Data Card 1);

2. a signal-variable value evaluated initially and at timesteps when the trip controlled by this signal expression is set to $ON_{Reverse}$ or $ON_{Forward}$ when their ID number is a signal-variable ID number IDSV plus 400 ($400 < IDSV + 400 < 800$);

3. a constant input on Card Number 3 that follows when its ID number is the ith subscript of SCN(I) plus 800 ($800 < I + 800 < 806$); or

4. the value of an earlier subexpression J ($0 < j < J \leq INSE$) when their ID number is J plus 900 ($900 < J + 900 < 910$).

Example: The signal expression,

$$\max \left(\sqrt{(IDSV = 5) + (IDSV = 33)}, 1.0 \times 10^{-10} \right),$$

would be input as

1	5	33
5	901	801
6	902	802

where SCN(1) = 0.5, SCN(2) = 1.0×10^{-10}, INCN = 2, and INSE = 3.

Card Number 3. (Format 5A14) LSCN(I), I = (1, INCN)

Note: If INCN > 0 (Word 3 on Card Number 1) or IOALL = $|IOGRF| + |IOINP| + |IOLAB| + |IOOUT| \neq 0$ (NAMELIST variables), input Card Number 3. See Table 6-2 for a list of units-name labels, their SI and English units symbols, and their SI to English conversion factors and shifts for the trip signal-expression constants.

Variable	Dimension	Description
LSCN	INCN	The units-name labels of the constants used to evaluate the subexpressions.

TABLE 6-5
ARITHMETIC-OPERATOR ID NUMBERS OF THE
Jth ARITHMETIC SUBEXPRESSION

ID Number	Operator	Arithmetic Subexpression
1	Addition	(First argument ID number value) + (Second argument ID number value)
2	Subtraction	(First argument ID number value) − (Second argument ID number value)
3	Multiplication	(First argument ID number value) * (Second argument ID number value)
4	Division	(First argument ID number value) / (Second argument ID number value)
5	Exponentiation	(First argument ID number value) * (Second argument ID number value)
6	Maximum value	MAX [(First argument ID number value), (Second argument ID number value)]
7	Minimum value	MIN [(First argument ID number value), (Second argument ID number value)]
8	Absolute value	ABS (first argument ID number value)

Card Number 4. ((Format 5E14.4) SCN(I), I = (1, INCN)

Note: If INCN > 0 (Word 3 on Card Number 1), input Card Number 4.

Variable	Dimension	Description
SCN	INCN	The constants used to evaluate the subexpressions.

Trip-Controlled-Trip Signal Cards. Input the following card data for each different IDSG trip-signal ID number of trips having ITST = ±3 that are input.

Note: If none of the trips being input have ITST = ±3 (Word 4 on Trip-Defining-Variables Card Number 1), do not input the Trip-Controlled-Trip Signal Cards.

Card Number 1. (Format 2I14) IDTN,INTN

Columns	Variable	Description
1–14	IDTN	The trip-controlled-trip signal ID number. This number corresponds to IDSG (Word 5 on Trip-Defining-Variables Card Number 1) for one or more of the input trips that have ITST = ±3 ($1 \leq |IDTN| \leq 9999$).
15–28	INTN	The number of trip ID numbers whose ISET set-status values (Word 3 on Trip-Defining Variables Card Number 1) are summed (IDTN > 0) or multiplied (IDTN < 0) to evaluate this trip-controlled-trip signal ($2 \leq INTN \leq 10$).

Card Number 2. (Format 5I14) ITN(I), I = (1, INTN)

Variable	Dimension	Description
ITN	INTN	The trip ID numbers whose ISET set-status values are summed (IDTN > 0) or multiplied (IDTN < 0) to evaluate this trip-controlled-trip signal.

Trip Setpoint-Factor Table Cards. Input the following card data for each different setpoint factor-table ID number, IFSP(I), defined in the input trips.

Note: If all the trips have constant trip-signal set points because IFSP(I) = 0 (Trip-Defining Variables Card Number 4) was input for all the setpoints, do not input the Trip Setpoint-Factor Table Cards.

Card Number 1. (Format 3I14) IDFT, IDSG, INFT

Columns	Variable	Description
1–14	IDFT	The setpoint-factor table ID number. This number corresponds to IFSP(I) (Trip-Defining Variables Card Number 4) for one or more trip setpoints.

Columns	Variable	Description
15–28	IDSG	The signal-variable or control-block ID number defining the setpoint-factor table independent variable. This number corresponds to one of the ID numbers in the list of signal variables (IDSG > 0) or control blocks (IDSG < 0), either from input or from the restart file.
29–42	INFT	The number of setpoint-factor table entry pairs ($2 \leq$ INFT ≤ 10).

Card Number 2. (Format 5E14.4) FT(I), I = (1, 2 × INFT)

Variable	Dimension	Description
FT	2 × INFT	Setpoint factor-table data (*,–); input INFT table-defining data pairs having the following form (table-independent variable value associated with parameter ID number IDSG and its setpoint-factor value).

Trip-Initiated Restart-Dump and Problem-Termination Cards.

Note: If NTDP = 0 (Word 4 on the Trip-Dimension Variables Card), do not input the Trip-Initiated Restart-Dump and Problem-Termination Cards.

Card Number 1. (Format I14) NDMP

Columns	Variable	Description
1–14	NDMP	The total number of trips from the input file and the restart dump that generate a restart dump and possible problem termination when any one of the trips is set to $ON_{Reverse}$ or $ON_{Forward}$ ($0 \leq$ NDMP $\leq$ NTDP).

Card Number 2. (Format 5I14) IDMP(I), I = (1, NDMP)

Note: The input deck defines NDMP trip ID numbers, and the NTDP-NDMP remaining trip ID numbers will be obtained from the restart file. If NDMP = 0, do not input Card Number 2 because all NTDP trip ID numbers will be obtained from the restart file.

Variable	Dimension	Description
IDMP	NDMP	The absolute value of the trip ID numbers that generate a restart data dump when any one of the trips is set to $ON_{Reverse}$ or $ON_{Forward}$. If IDMP(I) is given a negative sign, problem termination will occur after the restart data dump is generated.

Trip-Initiated Timestep Data Cards. Input from zero to NTSD of the following card set. If fewer than NTSD sets are input, conclude these data with a blank card or a card having an integer zero defining the first parameter, NDID (a zero must be entered if the free-format option is used). The remaining Card Sets will be obtained from the restart file.

Note: If NTSD = 0 (Word 5 on the Trip-Dimension Variables Card), do not input the Trip-Initiated Timestep Data card set.

Card Number 1. (Format 2I14) NDID, NTID

Columns	Variable	Description
1–14	NDID	The ID number for the following set of trip-initiated timestep data.
15–28	NTID	The number of trip ID numbers that initiates the use of this timestep data set when any one of the trips is set to $ON_{Reverse}$ or $ON_{Forward}$ ($1 \leq NTID \leq 5$).

Card Number 2. (Format 5I14) ITID(I), I = (1, NTID)

Variable	Dimension	Description
ITID	NTID	The trip ID numbers that initiate use of this timestep data set when any one of the trips is set to $ON_{Reverse}$ or $ON_{Forward}$.

Card Number 3. (Format 4E14.4) DTMIN, DTMAX, DTEND, DTSOF

Columns	Variable	Description
1–14	DTMIN	The minimum timestep size (s).
15–28	DTMAX	The maximum timestep size (s).
29–42	DTEND	The problem time interval (s) during which these timestep data are used.
43–56	DTSOF	The next timestep DTSOF (s) (when DTSOF > 0.0) or the factor –DTSOF (–) to be applied to the existing timestep (when DTSOF < 0.0) in defining the timestep to be used at the start of the DTEND (Word 3 above) time interval when implementing these special timestep data.

Card Number 4. (Format 4E14.4) EDINT, GFINT, DMPIT, SEDINT

Columns	Variable	Description
1–14	EDINT	Long-print edit interval (s).
15–28	GFINT	Graphics edit interval (s).
29–42	DMPIT	Restart-dump edit interval (s).
43–56	SEDINT	Short-print edit interval (s).

Timestep data on Cards 3 and 4 replace the timestep data defined later in Section 6.3.9. for a time interval DTEND (Word 3 on Trip-Initiated Timestep Data Card 3) after any one of the timestep data set assigned trip is set to $ON_{Reverse}$ or $ON_{Forward}$. This timestep data can be replaced by this or any other trip-controlled timestep data if any trip assigned to that timestep data set is set to $ON_{Reverse}$ or $ON_{Forward}$ before the time interval DTEND of this set ends.

6.3.6. Radiation-Enclosure Data

The radiation heat-transfer model in HTSTR components requires that NAMELIST variable NENCL have a nonzero value whose absolute value defines the number of radiation enclosures. For each enclosure, the number of surfaces involved in radiation exchange is defined. Each surface corresponds to a node on either the inner or outer surface of a HTSTR component. Each HTSTR must model a single ROD or SLAB element by defining NCRX and NRODS = 1. Radiative properties (such as the surface emissivities, geometric view factors, and average path lengths) are input specified as part of the HTSTR component data.

Note: If NAMELIST variable NENCL = 0, do not input the Radiation-Enclosure Data card set.

Note: Thermal Radiation Heat Transfer Model. Currently, in TRAC-M/F90 (Version 3.0), the thermal radiation heat transfer model is not available. The model is available in TRAC-M/F77.

Radiation-Enclosure Data Cards. Input |NENCL| of the following card for the initial calculation only where all input data is defined by the TRACIN file.

Card Number 1. (Format 4I14) IENCLI, ITFACI, ITZI, INPMF

Columns	Variable	Description
1–14	IENCLI	Radiation-enclosure ID number (–).
15–28	ITFACI	Number of faces in the radiation enclosure (–).
29–42	ITZI	Number of levels in the radiation enclosure (–).

Columns	Variable	Description
43–56	INPMF	Intervening medium participation flag. 0 = medium does not participate; 1 = medium participates.

6.3.7. Component Data

NCOMP (Word 3 on Main-Data Card 4) or fewer sets of component-data cards are input. The sets may be input in any order provided that all the HTSTR components (with ROD and SLAB elements) are input last. The component input is concluded with an "end" card as discussed in Sec. 6.3.8. If fewer than NCOMP sets are input, the remaining components are initialized (input) from the TRCRST restart-data file. The format of each set depends on the component type. The following is the input format for the different component types. All velocities are positive in the direction of ascending cell number. Most of the array data variables are read in by the LOAD subroutine described in Section 6.4. Additional information on preparing component input data can be found in Section 4.0. where the component models are described. All tables that are entered as pairs of numbers (x,y) must be supplied in ascending order of the x independent variable.

Each component requires a junction number, JUN#, for each of its connecting points. A junction is the connection point between two components. A pipe requires two junction numbers, one for each end. A unique junction number must be assigned to each connecting point and referenced by both components to be connected. For example, if two pipes are joined, then the junction numbers of the connecting end of each pipe must be the same. No component may "wrap around" and connect to itself and no junction may have only one component connected to it. The boundary-condition single-junction BREAK or FILL components are used to end a component line that is not a loop. In the following input description, the asterisk (*) indicates units of the defined variable and the hyphen (–) indicates a dimensionless quantity.

Note: A BREAK component cannot be connected to a FILL, PLENUM, or VESSEL component junction.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–5	TYPE	Component type (BREAK left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq NUM \leq 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14) JUN1, IBTY, ISAT, IOFF

Columns	Variable	Description
1–14	JUN1	Junction number to which the BREAK is connected.
15–28	IBTY	BREAK-type option.

0 = no tables input and not a Generalized BREAK (see IBTY = 6);

1 = input pressure table;

2 = input pressure and temperature tables;

3 = input above tables plus gas volume-fraction table;

4 = input above tables plus noncondensable-gas partial-pressure table;

5 = input above tables plus solute-to-coolant mass-ratio table [requires ISOLUT = 1 (Word 3 on Main-Data Card 6)];

6 = Generalized-BREAK fluid parameters defined individually by a signal variable or control block (see Card Number 9). **Note:** this option is not under direct control by trip ID number IBTR (Word 1 on Card Number 3) and the rate of change of the fluid parameters is not constrained by RBMX (Word 3 on Card Number 5).

Columns	Variable	Description
29–42	ISAT	BREAK temperature table use options.

0 = use TIN or single table for liquid and gas temperatures;

1 = use TIN or table for liquid and set gas to T_{sat};

2 = use TIN or table for gas and set liquid to T_{sat};

3 = set liquid and gas to T_{sat};

Columns	Variable	Description

4 = use separate tables or separate signal variables and control blocks for the liquid and gas;

5 = set liquid and gas to input-specified offsets from T_{sat} (see Card Number 3).

For IBTY = 6 (Word 2 on Card Number 2), ISAT= 1, 2, and 3 has same effect (liquid and/or gas temperature set to T_{sat}). ISAT = 0 or 4 behave as follows: user can have TIN, signal variable, or control block for liquid and/or gas temperature, depending on values of IBTLSV and IBTVSV (see Card Number 9).

| 43–56 | IOFF | The BREAK fluid-state option (defines the fluid state when the BREAK table's controlling-trip is OFF after being ON) [define IOFF when IBTR ≠ 0 or 6 (Word 1 on Card Number 3); Set IOFF = 0 for BREAK-type options IBTY = 0 or 6 (Word 2 on Card Number 2)]. |

0 = the last BREAK table's interpolated fluid state is held constant;

1 = define the initial fluid state;

2 = input the pressure to be used, but maintain the fluid condition that existed when the trip was set OFF;

3 = input a complete fluid-state definition for when the controlling trip is OFF after being ON.

Card Number 3. (Format 2E14.4) DELTL, DELTV

Note: If ISAT ≠ 5 (Word 3 on Card Number 2), do not input Card Number 3.

Columns	Variable	Description
1–14	DELTL	Liquid temperature (K, °F) offset from the BREAK-fluid saturation temperature. The BREAK-cell liquid temperature is set to T_{sat} + DELTL where DELTL is positive or negative valued.
15–28	DELTV	Gas temperature (K, °F) offset from the BREAK-fluid saturation temperature. The BREAK-cell gas temperature is set to T_{sat} + DELTV where DELTV is positive or negative valued.

Card Number 4. (Format 5I14) IBTR, IBSV, NBTB, NBSV, NBRF

Note: If IBTY = 0 (Word 2 on Card Number 2), do not input Card Number 4. If IBTY = 6, Card Number 4 should be input with 0 input for its 5 fields.

Columns	Variable	Description
1–14	IBTR	The trip ID number that controls evaluation of the BREAK table ($|IBTR| \leq 9999$). Input IBTR = 0 if there is no trip control or if IBTY = 6 (Word 2 on Card Number 2).

15–28	IBSV	The BREAK-table abscissa-coordinate variable ID number that defines the independent-variable parameter for the IBTY = 1 to 5 tables. IBSV > 0 defines the ID number for a signal-variable parameter; IBSV < 0 defines the ID number for a control-block output parameter. Input IBSV = 0 if IBTY = 6 (Word 2 on Card Number 2).
29–42	NBTB	The number of BREAK-table pairs (defined by the absolute value of NBTB) for break options IBTY = 1 to 5. NBTB > 0 defines the independent-variable form to be the IBSV parameter value; NBTB < 0 defines the independent-variable form to be the sum of the change in the IBSV parameter over the last timestep times the trip set-status value ISET (when the BREAK table is trip controlled, IBTR ≠ 0); NBTB = 0 (for IBTY = 1 only) defines the BREAK pressure to be the IBSV parameter value. Input NBTB = 0 if IBVTY = 6 (Word 2 on Card Number 2).
43–56	NBSV	The rate-factor table abscissa-coordinate variable ID number. NBSV > 0 defines the ID number for a signal-variable parameter; NBSV < 0 defines the ID number for a control-block output parameter; NBSV = 0 when NBRF ≠ 0 defines the difference between the trip signal and the setpoint value that turns the trip OFF (when the BREAK table or tables are trip controlled).
57–70	NBRF	The number of rate-factor table pairs (defined by the absolute value of NBRF). The rate factor is applied as a factor to the independent variable of the BREAK table or tables when the rate factor is defined. No rate factor is defined when NBSV and NBRF are both zero. NBRF > 0 defines the rate-factor table abscissa coordinate to be the sum of the NBSV parameter value; NBRF < 0 defines it to be the change in the NBSV parameter over the last timestep times the trip set-status value ISET (when the BREAK table is trip controlled, IBTR ≠ 0); NBRF = 0 defines the rate factor to be the NBSV parameter value.

Card Number 5. (Format 5E14.4) DXIN, VOLIN, ALPIN, TIN, PIN

Columns	Variable	Description
1–14	DXIN	Cell length (m, ft) (generally defined to be the same as its neighboring cell in the adjacent component). Used to define the BREAK-cell flow area, VOLIN/DXIN, and used in stratified-flow calculations.
15–28	VOLIN	Volume (m^3, ft^3) of the BREAK cell. Used to define the BREAK-cell flow area, VOLIN/DXIN, and used in stratified-flow calculations.
29–42	ALPIN	Initial gas volume fraction (–) at the BREAK.
43–56	TIN	Initial mixture temperature (K, °F) at the BREAK.
57–70	PIN	Initial pressure (Pa, psia) at the BREAK.

Card Number 6. (Format 5E14.4) PAIN, CONCIN, RBMX, POFF, BELV

Columns	Variable	Description
1–14	PAIN	Initial noncondensable-gas partial pressure (Pa, psia) at the BREAK.
15–28	CONCIN	Solute mass to liquid-coolant mass ratio at the BREAK [kg(solute) kg^{-1}(liquid), lb_m(solute) lb_m^{-1}(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).
29–42	RBMX	Maximum rate of change of the BREAK pressure (Pa s^{-1}, psia s^{-1}) [0.0 Pa s^{-1} (0.0 psia s^{-1}) ≤ RBMX]. RBMX is not used when IBTY = 6 (Word 2 on Card Number 2).
43–56	POFF	Pressure (Pa, psia) at the BREAK when the controlling-trip is set OFF after being ON. POFF is used only when IBTY ≠ 0 or 6 (Word 2 on Card Number 2), IBTR ≠ 0 (Word 1 on Card Number 4) and IOFF ≥ 2 (Word 4 on Card Number 2).
57–70	BELV	BREAK cell-centered elevation (m, ft) (used only to compute GRAV when IELV = 1).

Card Number 7. (Format 5E14.4) ALPOFF, TLOFF, TVOFF, PAOFF, CONOFF

Note: If IBTY = 0 or 6 (Word 2 on Card Number 2), IBTR = 0 (Word 1 on Card Number 4), or IOFF ≠ 3 (Word 4 on Card Number 2), do not input Card Number 7.

Columns	Variable	Description
1–14	ALPOFF	BREAK gas volume fraction (–) when the controlling-trip is set OFF after being ON (used only when IBTY ≥ 3).
15–28	TLOFF	BREAK liquid temperature (K, °F) when the controlling-trip is set OFF after being ON (used only when IBTY ≥ 2).
29–42	TVOFF	BREAK gas temperature (K, °F) when the controlling-trip is set OFF after being ON (used only when IBTY ≥ 2).
43–56	PAOFF	BREAK noncondensable-gas partial pressure (Pa, psia) when the controlling-trip is set OFF after being ON (used only when IBTY ≥ 4).
57–70	CONOFF	BREAK solute mass to liquid-coolant mass ratio [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)] when the controlling-trip is set OFF after being ON. Used only when IBTY = 5 and requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Number 8. (Format 5E14.4) PSCL, TLSCL, TVSCL, PASCL, CONSCL

Note: If IBTY = 0 or 6 (Word 2 on Card Number 2) or NBTB = 0 (Word 3 on Card Number 4), do not input Card Number 8.

Columns	Variable	Description
1–14	PSCL	Pressure scale factor (–). The dependent variable in the pressure table PTB is multiplied by this factor to obtain absolute pressure (Pa, psia) (used only when IBTY ≥ 1).
15–28	TLSCL	Liquid-temperature scale factor (–). The dependent variable in the liquid-temperature table TLTB is converted to absolute liquid temperature (K, °R), multiplied by this factor to obtain the absolute liquid temperature (K, °R), and converted back to SI/English units liquid temperature (K, °F) (used only when IBTY ≥ 2).

29–42	TVSCL	Gas-temperature scale factor (–). The dependent variable in the vapor-temperature table TVTB is converted to absolute gas temperature (K, °R), multiplied by this factor to obtain the absolute gas temperature (K, x°R), and converted back to SI/English units gas temperature (K, °F) (used only when IBTY $\geq$ 2 and ISAT = 4).
43–56	PASCL	Noncondensable-gas partial pressure scale factor (–). The dependent variable in the noncondensable-gas partial pressure table PATB is multiplied by this scale factor to obtain the absolute noncondensable-gas partial pressure (Pa, psia) (used only when IBTY $\geq$ 4).
57–70	CONSCL	Solute mass to liquid-mass ratio scale factor (–). The dependent variable in the solute mass to liquid-mass ratio table CONCTB is multiplied by this scale factor to obtain the absolute ratio value [kg(solute) kg^{-1} (liquid), lb$_m$ (solute) lb$_m^{-1}$ (liquid)]. Used only when IBTY = 5 and requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Number 9. (Format 5I14) IBPSV, IBTLSV, IBTVSV, IBASV, IBPASV

Note: If IBTY $\neq$ 6 (Word 2 on Card Number 2), do not input Card Number 9.

Columns	Variable	Description
1–14	IBPSV	Signal variable or control-block ID number defining the BREAK pressure.
15–28	IBTLSV	Signal variable or control-block ID number defining the BREAK liquid temperature.
29–42	IBTVSV	Signal variable or control-block ID number defining the BREAK gas temperature.
43–56	IBASV	Signal variable or control-block ID number defining the BREAK gas volume fraction.
57–70	IBPASV	Signal variable or control-block ID number defining the BREAK noncondensable gas partial pressure.

Card Number 10. (Format 1I14) IBCNSV

Note: If IBTY ≠ 6 (Word 2 on Card Number 2), do not input Card Number 10.

Columns	Variable	Description
1-14	IBCNSV	Signal variable or control-block ID number defining the BREAK solute-to-coolant mass ratio. Used only if ISOLUT = 1 (Word 3 on Main-Data Card 6).

BREAK Array Cards. Seven sets of cards, one set for each of the following array variables. Use LOAD format.

Note: If IBTY = 0 or 6 (Word 2 on Card Number 2), or NBTB = 0 (Word 3 on Card Number 4), do not input the BREAK Array Cards.

Note: Each array has its element values defined by a Card Set of one or more cards.

Card Set 11.

Variable	Dimension	Description
PTB	2 × |NBTB|	BREAK pressure vs independent-variable-form table [(*,Pa), (*, psia)]. Input |NBTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IBSV (Word 2 on Card Number 4), pressure].

Card Set 12. If IBTY < 2 or IBTY = 6 (Word 2 on Card Number 2), do not input Card Set 12 (array TLTB).

Variable	Dimension	Description
TLTB	2 × |NBTB|	BREAK liquid temperature vs independent-variable-form table [(*, K), (*,°F)]. Input |NBTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IBSV (Word 2 on Card Number 4), liquid temperature].

Card Set 13. If IBTY < 2 or IBTY = 6 (Word 2 on Card Number 2) or ISAT ≠ 4 (Word 3 on Card Number 2), do not input Card Set 13 (array TVTB).

Variable	Dimension	Description
TVTB	2 × |NBTB|	BREAK gas temperature vs independent-variable-form table [(*, K), (*, F)]. Input |NBTB| (Word 3 on Card Number 4) table-defining data pairs having the fol-lowing form [independent-variable form defined by IBSV (Word 2 on Card Number 4), gas temperature].

Card Set 14. If IBTY < 3 or IBTY = 6 (Word 2 on Card Number 2), do not input Card Set 14 (array ALPTB).

Variable	Dimension	Description
ALPTB	$2 \times |NBTB|$	BREAK gas volume-fraction vs independent-variable-form table (*,–). Input $|NBTB|$ (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IBSV (Word 2 on Card Number 4), gas volume fraction].

Card Set 15. If IBTY < 4 or IBTY = 6 (Word 2 on Card Number 2), do not input Card Set 15 (array PATB).

Variable	Dimension	Description
PATB	$2 \times |NBTB|$	BREAK noncondensable-gas partial pressure vs independent-variable-form table [(*, Pa), (*, psia)]. Input $|NBTB|$ (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IBSV (Word 2 on Card Number 4), noncondensable-gas partial pressure].

Card Set 16. If IBTY ¦ 5 (Word 2 on Card Number 2), do not input Card Set 16 (array CONCTB).

Variable	Dimension	Description
CONCTB	$2 \times |NBTB|$	BREAK solute mass to liquid coolant-mass ratio vs independent-variable-form table [{*, kg(solute) kg^{-1} (liquid)}, {*, lb$_m$(solute) lb$_m^{-1}$(liquid)}]. Input $|NBTB|$ (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IBSV (Word 2 on Card Number 4) and the ratio of solute mass to liquid mass]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 17. If NBRF = 0 (Word 5 on Card Number 4), do not input Card Set 17 (array RFTB).

Variable	Dimension	Description
RFTB	$2 \times |$NBRF$|$	Rate-factor table (*,−) for the BREAK function table's independent-variable form defined by IBSV (Word 2 on Card Number 4). Input $|$NBTB$|$ (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NBSV (Word 4 on Card Number 4) and the rate factor to be applied to the BREAK function table's independent variable].

6.3.7.1. FILL component.

Note: A FILL component cannot be connected to a BREAK, PLENUM or VESSEL component junction.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–4	TYPE	Component type (FILL left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq$ NUM ≤ 999).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 3I14) JUN1, IFTY, IOFF

Columns	Variable	Description
1–14	JUN1	Junction number to which the FILL is connected.
15–28	IFTY	FILL-type option. 1 = constant velocity; 2 = constant mass flow; 3 = constant generalized state; (temperatures, pressures, void, fraction, solute ratio are specified) 4 = velocity vs independent-variable form table; 5 = mass flow vs independent-variable form table; 6 = generalized state vs independent-variable form table; 7 = constant velocity until the controlling trip is set ON then velocity vs independent-variable form table; 8 = constant mass flow until the controlling trip is set ON, then mass flow vs independent-variable form table; 9 = constant generalized state until the controlling trip is set ON, then generalized state vs independent-variable form table; 10 = Generalized-state parameters defined individually by a signal variable or control block.
29-42	IOFF	FILL fluid-state option (defines the fluid state when the fill-table controlling trip is OFF after being ON) [define IOFF when IFTY = 7, 8, or 9 (Word 2 on Card Number 2)]. 0 = the last FILL-table interpolated fluid state is held constant; 1 = define the initial fluid state; 2 = input the velocity [IFTY = 7 or 9 (Word 2 on Card Number 2)] or mass flow (IFTY = 8) to be used, but maintain the fluid condition that existed when the trip was set OFF; or 3 = input a generalized fluid-state definition (IFTY = 9 only).

Card Number 3. (Format 5I14) IFTR, IFSV, NFTB, NFSV, NFRF

Note: If IFTY < 4 (Word 2 on Card Number 2), do not input Card Number 3.

Columns	Variable	Description
1–14	IFTR	The trip ID number for controlling the evaluation of the FILL table for FILL-type options IFTY = 7, 8, or 9 (Word 2 on Card Number 2) ($\mid$IFTR$\mid$ $\leq$ 9999). Input IFTR = 0 when IFTY < 7 or IFTY = 10 (Word 2 on Card Number 2).
15–28	IFSV	The FILL-table abscissa-coordinate variable ID number that defines the independent-variable parameter in the IFTY = 4 to 9 (Word 2 on Card Number 2) tables. IFSV > 0 defines the ID number for a signal-variable parameter; IFSV < 0 defines the ID number for a control-block output parameter. Input IFSV = 0 if IFTY = 10 (Word 2 on Card Number 2).
29–42	NFTB	The number of FILL-table data pairs (defined by the absolute value of NFTB) for FILL options IFTY = 4 to 9 (Word 2 on Card Number 2). NFTB > 0 defines the independent-variable form to be the IFSV parameter; NFTB < 0 defines the independent-variable form to be the sum of the change in the IFSV parameter over the last timestep times the trip set-status value ISET [when the FILL is trip controlled, IFTR $\neq$ 0 (Word 1 on Card Number 3) and IFTY = 7, 8, or 9 (Word 2 on Card Number 2)]. NFTB = 0 defines the FILL velocity or mass flow to be the IFSV parameter. Input NFTB = 0 if IFTY = 10 (Word 2 on Card Number 2).
43–56	NFSV	The rate-factor table abscissa-coordinate variable ID number. NFSV > 0 defines the ID number for a signal-variable parameter; NFSV < 0 defines the ID number for a control-block output parameter; NFSV = 0 (when NFRF $\neq$ 0) defines the difference between the trip signal and the setpoint value that turns the trip OFF when the FILL table is trip contro
57–70	NFRF	The number of rate-factor table data pairs (defined by the absolute value of NFRF). The rate factor is applied as a factor to the FILL-table independent variable when the rate factor is defined. No rate factor is defined when NFSV and NFRF are both zero. NFRF > 0 defines the rate-factor table abscissa coordinate to be the NFSV parameter; NFRF < 0 defines it to be the sum of the change in the NFSV parameter over the last timestep times the trip set-status value ISET [when the FILL is trip controlled, IFTR = 0 (Word 1 on Card Number 3) and IFTY = 7, 8, or 9 (Word 2 on Card Number 2)]. NFRF = 0 defines the rate factor to be the NFSV parameter.

Card Number 4. (Format 4E14.4) TWTOLD, RFMX, CONCIN, FELV

Columns	Variable	Description
1–14	TWTOLD	The fraction (–) of the previous FILL fluid state that is averaged with the FILL-table-defined state to determine the FILL fluid state for this timestep ($0.0 \leq$ TWTOLD <1.0; it is suggested that a value of 0.0 be used). To avoid hydrodynamic instabilities, a value as large as 0.9 may be needed when the FILL table depends on a parameter (such as the adjacent component pressure) that couples strongly to the FILL velocity or a parameter that varies rapidly with time.
15–28	RFMX	The maximum rate of change of FILL velocity (m s^{-2}, ft s^{-2}) or FILL mass flow (kg s^{-2}, lb$_m$ s^{-2}) [0.0 m s^{-2} or 0.0 kg s^{-2} (0.0 ft s^{-2} or 0.0 lb$_m$ s^{-2}) $\leq$ RFMX]. For FILL-type option IFTY = 10 (Word 2 on Card Number 2), RFMX is not used.
29–42	CONCIN	The initial solute mass to liquid-coolant mass ratio [{*, kg(solute) kg^{-1}(liquid)}, {*, lb$_m$(solute) lb$_m$$^{-1}$(liquid)}] in the FILL composition. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).
43–56	FELV	FILL cell-centered elevation (m, ft) (used only to compute GRAV array when NAMELIST variable IELV = 1).

Card Number 5. (Format 5E14.4) DXIN, VOLIN, ALPIN, VLIN, TLIN

Columns	Variable	Description
1–14	DXIN	Cell length (m, ft) (generally defined to be the same as its neighboring cell in the adjacent component).
15–28	VOLIN	Cell volume (m^3, ft^3) (generally defined to be the same as its neighboring cell in the adjacent component).
29–42	ALPIN	Initial gas volume fraction (–) used for positive flow out of the fill.
43–56	VLIN	Initial liquid velocity (m s^{-1}, ft s^{-1}) (a positive value indicates flow into the adjacent component; a negative value indicates flow from the adjacent component) [used for fill options IFTY = 1, 3, 7 or 9 (Word 2 on Card Number 2)].
57–70	TLIN	Initial liquid temperature (K, °F) used for positive flow out of the fill.

Card Number 6. (Format 5E14.4) PIN, PAIN, FLOWIN, VVIN, TVIN

Columns	Variable	Description
1–14	PIN	Initial FILL pressure (Pa, psia).
15–28	PAIN	Initial FILL noncondensable-gas partial pressure (Pa, psia).
29–42	FLOWIN	Initial coolant mass flow (kg s^{-1}, lb$_m$ h^{-1}) (a positive value indicates flow into the adjacent component; a negative value indicates flow from the adjacent component) [used for FILL-type options IFTY = 2 or 8 (Word 2 on Card Number 2)].
43–56	VVIN	Initial gas velocity (m s^{-1}, ft s^{-1}) (a positive value indicates flow into the adjacent component; a negative value indicates flow from the adjacent component) [used for FILL-type options IFTY = 3 or 9 (Word 2 on Card Number 2)].
57-70	TVIN	Initial gas temperature (K, °F) used for positive flow out of the FILL [used for FILL options IFTY = 3 or 9 (Word 2 on Card Number 2)].

Card Number 7. (Format 4E14.4) FLWOFF, VLOFF, VVOFF, ALPOFF

Note: If IFTY < 7, IFTY = 10, or IOFF < 2 (Words 2 and 3 on Card Number 2), do not input Card Number 7.

Columns	Variable	Description
1–14	FLWOFF	Coolant mass flow (kg s^{-1}, lb$_m$ h^{-1}) when the controlling trip is set OFF after being ON [used when IFTY = 8 (Word 2 on Card Number 2)].
15–28	VLOFF	Liquid velocity (m s^{-1}, ft s^{-1}) [IFTY = 9 (Word 2 on Card Number 2)] or coolant-mixture velocity (IFTY = 7) when the controlling trip is set OFF after being ON (used when IFTY = 7 or 9).
29–42	VVOFF	Gas velocity (m s^{-1}, ft s^{-1}) when the controlling trip is set OFF after being ON [used when IFTY = 9 and IOFF = 3 (Words 2 and 3 on Card Number 2)].
43–56	ALPOFF	Gas volume fraction (–) for positive flow out of the FILL when the controlling trip is set OFF after being ON [used when IFTY = 9 and IOFF = 3 (Words 2 and 3 on Card Number 2)].

Card Number 8. (Format 5E14.4) TLOFF, TVOFF, POFF, PAOFF, CONOFF

Note: If IFTY ≠ 9 or IOFF ≠ 3 (Words 2 and 3 on Card Number 2), do not input Card Number 8.

Columns	Variable	Description
1–14	TLOFF	Liquid temperature (K, °F) for positive flow out of the FILL when the controlling trip is set OFF after being ON.
15–28	TVOFF	Gas temperature (K, °F) for positive flow out of the FILL when the controlling trip is set OFF after being ON.
29–42	POFF	FILL pressure (Pa, psia) when the controlling trip is set OFF after being ON.
43–56	PAOFF	FILL noncondensable-gas partial pressure (Pa, psia) when the controlling trip is set OFF after being ON.
57–70	CONOFF	Solute mass to the liquid-coolant mass ratio [kg (solute) kg^{-1} (liquid), lb_m (solute) lb_m^{-1} (liquid)] when the controlling trip is set OFF after being ON. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Number 9. Format 2E14.4) VMSCL, VVSCL

Note: IFTY < 4 or IFTY = 10 (Word 2 on Card Number 2) or NFTB = 0 (Word 3 on Card Number 4), do not input Card Number 9.

Columns	Variable	Description
1–14	VMSCL	Mixture-velocity [IFTY = 4 or 7 (Word 2 on Card Number 2)], liquid-velocity [IFTY = 6 or 9], or mixture mass-flow (IFTY = 5 or 8) scale factor (–). The dependent variable in table VMTB is multiplied by this factor to obtain the absolute mixture velocity, liquid velocity, or mixture mass flow.
15–28	VVSCL	Gas-velocity scale factor (–). The dependent variable in fill table VVTB is multiplied by this factor to obtain the absolute gas velocity [used when IFTY = 6 or 9 (Word 2 on Card Number 2)].

Card Number 10. (Format 5E14.4) TLSCL, TVSCL, PSCL, PASCL, CONSCL

Note: If IFTY ≠ 6 and IFTY ≠ 9 (Word 2 on Card Number 2), do not input Card Number 10

Columns	Variable	Description
1–14	TLSCL	Liquid-temperature scale factor (–). The dependent variable in table TLTB is converted to absolute liquid temperature (K, °R), multiplied by this factor to obtain the absolute liquid temperature (K, °R), and converted back to SI/English units liquid temperature (K, °F).
15–28	TVSCL	Gas-temperature scale factor (–). The dependent variable in table TVTB is converted to absolute gas temperature (K, R), multiplied by this factor to obtain the absolute gas temperature (K, °R), and converted back to SI/English units gas temperature (K, °F).
29–42	PSCL	Pressure scale factor (–). The dependent variable in table PTB is multiplied by this factor to obtain absolute pressure (Pa, psia).
43–56	PASCL	Noncondensable-gas partial-pressure scale factor (–). The dependent variable in table PATB is multiplied by this factor to obtain absolute air partial pressure (Pa, psia).
57-70	CONSCL	Solute mass to liquid-coolant mass ratio scale factor (–). The dependent variable in table CONCTB is multiplied by this factor to obtain the absolute solute mass to liquid-coolant mass ratio. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Number 11. (Format 5I14) IFMLSV, IFMVSV, IFTLSV, IFTVSV, IFASV

Note: If IFTY ≠ 10 (Word 2 on Card Number 2), do not input Card Number 11.

Columns	Variable	Description
1–14	IFMLSV	Signal variable or control-block ID number defining the liquid mass flow (kg s^{-1}, lb$_m$ s^{-1}).
15–28	IFMVSV	Signal variable or control-block ID number defining the gas mass flow (kg s^{-1}, lb$_m$ s^{-1}).
29–42	IFTLSV	Signal variable or control-block ID number defining the liquid temperature (K, °F).
43–56	IFTVSV	Signal variable or control-block ID number defining the gas temperature (K, °F).
57-70	IFASV	Signal variable or control-block ID number defining the gas volume fraction (–).

Card Number 12. (Format 3I14) IFPSV, IFPASV, IFCNSV

Note: If IFTY ≠ 10 (Word 2 on Card Number 2), do not input Card Number 12.

Columns	Variable	Description
1–14	IFPSV	Signal variable or control-block ID number defining the fluid pressure (Pa, psia).
15–28	IFPASV	Signal variable or control-block ID number defining the partial pressure of the noncondensable gas (Pa, psia).
29–42	IFCNSV	Signal variable or control-block ID number defining the solute mass to the liquid-coolant mass ratio (–). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

FILL Array Cards. Nine sets of cards, one set for each of the following array variables. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Note: If IFTY < 4 or IFTY = 10 (Word 2 on Card Number 2) or NFTB = 0 (Word 3 on Card Number 4), do not input the FILL Array Cards.

Card Set 13.

Variable	Dimension	Description
VMTBV (IFTY = 4, 7, 6, or 9) or VMTBM (IFTY = 5 or 8)	$2 \times |NFTB|$	Mixture velocity [(*, m s^{-1}), (*, ft s^{-1})] [IFTY = 4 or 7 (Word 2 on Card Number 2)], liquid velocity [(*, m s^{-1}), (*, ft s-1)] [IFTY = 6 or 9], or mixture mass flow [(*, kg s^{-1}), (*, lb$_m$ h^{-1})] (IFTY = 5 or 8) vs independent-variable-form table. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 3); mixture velocity, liquid velocity, or mixture mass flow].

Card Sets 14 to 19. If IFTY ≠ 6 and IFTY ≠ 9 (Word 2 on Card Number 2), do not input Card Sets 14 to 19 (arrays VVTB, TLTB, TVTB, ALPTB, PTB, and PATB).

Variable	Dimension	Description
VVTB	2 × |NFTB|	Gas-velocity vs independent-variable-form table [(*, m s^{-1}), (*, ft s^{-1})]. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), gas velocity].
TLTB	2 × |NFTB|	Liquid-temperature vs independent-variable-form table [(*, K), (*, °F)]. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), liquid temperature].
TVTB	2 × |NFTB|	Gas-temperature vs independent-variable-form table [(*, K), (*, °F)]. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), gas temperature].
ALPTB	2 × NFTB|	Gas volume-fraction vs independent-variable-form table (*, –). Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), gas volume fraction].
PTB	2 × |NFTB|	Pressure vs independent-variable-form table [(*, Pa), (*, psia)]. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), pressure].
PATB	2 × |NFTB|	Noncondensable-gas partial pressure vs independent-variable-form table [(*, Pa), (*, psia)]. Input |NFTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), noncondensable-gas partial pressure].

Card Set 20. If ISOLUT = 0 (Word 3 on Main-Data Card 6) or IFTY ≠ 6 or 9 (Word 2 on Card Number 2), do not input Card Set 20 (array CONCTB).

Variable	Dimension	Description
CONCTB	$2 \times |NFTB|$	Solute mass to liquid-coolant mass ratio vs break independent-variable-form table [{*, kg(solute) kg^{-1} (liquid)}, {*, lb$_m$ (solute) lb$_m^{-1}$ (liquid)}]. Input $|NFTB|$ (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IFSV (Word 2 on Card Number 4), solute mass to liquid-coolant mass ratio]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 21. If NFRF = 0 (Word 5 on Card Number 3), do not input Card Set 21 (array RFTB).

Variable	Dimension	Description
RFTB	$2 \times |NFRF|$	Rate-factor table (*,–) for the FILL-table's independent variable defined by IFSV and NFTB (Words 2 and 3 on Card Number 4). Input $|NFRF|$ (Word 5 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NFSV (Word 4 on Card Number 4), rate factor to be applied to the FILL-table independent variable].

6.3.7.2. HTSTR component with ROD or SLAB elements.

Note: The input data for HTSTR components with ROD or SLAB elements *must* follow the input data of *all* hydraulic components in the TRACIN input-data file.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–4	TYPE	Component type (ROD or SLAB).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq NUM \leq 999$ and greater than the ID numbers of all hydraulic components).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 5I14) NCRX, NCRZ, ITTC, IEXT, M1D

Columns	Variable	Description
1-14	NCRX	Number of different average (power) ROD or SLAB elements (they may be coupled to NCRX different hydraulic cells in the level of a VESSEL component or coupled to NCRX different 1D hydraulic components).
15–28	NCRZ	Number of axial intervals between node rows in the ROD or SLAB element.*
29–42	ITTC	Specification of an external thermocouple (T/C) on the ROD- or SLAB-element surface. 0 = no; 1 = yes.
43-56	IEXT	Specifies if this component input was generated by the postprocessor EXTRACT 0 = no (default); 1 = yes.
57-70	M1D	Option for multiple 1D hydraulic-component coupling to this HTSTR component by inputting M1D > 0. First input M1D = 0 for all HTSTRs that do not have multiple 1D hydraulic-component coupling. Then input M1D = 1 for the first, M1D = 2 for the second, M1D = 3 for the third, etc. HTSTRs that have multiple 1D hydraulic-component coupling and input these HTSTRs in that order.

Card Number 3. (Format 5I14) NOPOWR, NRIDR, MODEZ, LIQLEV, IAXCND

Columns	Variable	Description
1–14	NOPOWR	Power-source presence option. 0 = yes; 1 = no.
15–28	NRIDR	Specification of the hydraulic-cell location that is coupled to the inner and/or outer surfaces of the ROD or SLAB element. 0 = define the IDROD array (Card Set 44) for the supplemental ROD or SLAB elements [last NRODS–NCRX ROD or SLAB elements where NRODS (Word 1 on Card Number 12) is the total number of different ROD or SLAB elements evaluated], the average (power) rods are automatically distributed among the NCRX coolant paths.; 1 = define the IDROD array (Card Set 44) for all NRODS ROD or SLAB elements; or

*Currently, NCRZ + 1 must be ≤ 250; see variable NZMAX (Word 4 on Card Number 12) for a discussion on this limit.

Columns	Variable	Description
		2 = define the IDROD array for all NRODS ROD or SLAB elements for both surfaces of the HTSTR component. Card Set 44 (array IDROD) defines the hydraulic-cell coupling to the inner surface and Card Set 45 (array IDRODO) defines the hydraulic-cell coupling to the outer surface.
29–42	MODEZ	Specification of the axial cell-edge locations of the node rows or the axial cell lengths between node rows. 0 = input NCRZ + 1 axial cell-edge locations; 1 = input NCRZ axial cell lengths.
43–56	LIQLEV	Specification of liquid-level tracking. 0 = no liquid level calculated on ROD- or SLAB-element surface; 1 = liquid level tracked on ROD- or SLAB-element surface (this produces a more accurate axial heat-transfer solution).
57–70	IAXCND	Specification of axial conduction. 0 = no axial heat-transfer conduction calculated; 1 = axial heat-transfer conduction calculated in the ROD or SLAB element (explicit numerics when NAMELIST variable NRSLV = 0; implicit numerics when NRSLV = 1).

Card Number 4. (Format 2I14,2E14.4) IDBCI, IDBCO, HDRI, HDRO

Note: If ITTC = 1 (Word 3 on Card Number 2), input IDBCI = 2 (to define the outer clad-surface hydraulic-cell coupling) and IDBCO = 2 (to define the thermocouple-surface hydraulic-cell coupling).Variables HDRI and HDRD are only used if NAMELIST variable ITHD = 1, when the user wishes to specify an appropriate heated perimeter for heat transfer coefficient calculation.

Columns	Variable	Description
1–14	IDBCI	Boundary-condition option for the inner surface of the ROD or SLAB element. 0 = adiabatic boundary condition; 1 = constant HTCs and external temperatures; 2 = coupled to specified cells in one or more hydraulic components.
15–28	IDBCO	Boundary-condition option for the outer surface of the HTSTR ROD or SLAB element. 0 = adiabatic boundary condition; 1 = constant HTCs and external temperatures; 2 = coupled to specified cells in one or more hydraulic components.

Columns	Variable	Description
29–42	HDRI	Heat-transfer diameter (m, ft) used to evaluate the heat-transfer coefficient (HTC) for the inside surface of the ROD or SLAB element. HDRI is used when NAMELIST variable ITHD = 1 and the hydraulic diameter HD is used when ITHD = 0.
43–56	HDRO	Heat-transfer diameter (m, ft) used to evaluate the heat-transfer coefficient (HTC) for the outside surface of the ROD or SLAB element. HDRO is used when NAMELIST variable ITHD = 1 and the hydraulic diameter HD is used when ITHD = 0.

Note: **Thermal Radiation Heat Transfer Model (Card Numbers 5 through 7).** Currently, the thermal radiation heat transfer model is only available in TRAC-M/F77. For TRAC-M/F90, Cards 5 to 7 must be omitted.

Card Number 5. (Format 2I14) IFRADI, IFRADO

Note: If NAMELIST variable NENCL = 0, do not input Card Number 5

Columns.	Variable.	Description.
1–14	IFRADI	Inner surface is part of a radiation enclosure option. 0 = no; 1 = yes.
15–28	IFRADO	Outer surface is part of a radiation enclosure option. 0 = no; 1 = yes.

Card Number 6. (Format 3E14.4) EMCIF1, EMCIF2, EMCIF3

Note: If NAMELIST variable NENCL = 0, do not input Card Number 6.

Note: Input Card Number 6 if IFRADI = 1 (Word 1 on Card Number 5). The following quadratic-polynomial coefficients define the inner-surface emissivity as a function of the inner-surface temperature.

Columns	Variable	Description
1–14	EMCIF1	Zero-order term in the quadratic fit of inner-surface emissivity as a function of the inner-surface temperature (–).
15–28	EMCIF2	First-order term in the quadratic fit of inner-surface emissivity as a function of the inner-surface temperature $(K^{-1}, °F^{-1})$.
29–42	EMCIF3	Second-order term in the quadratic fit of inner-surface emissivity as a function of the inner-surface temperature $(K^{-2}, °F^{-2})$.

Card Number 7. (Format 3E14.4) EMCOF1, EMCOF2, EMCOF3

Note: If NAMELIST variable NENCL = 0, do not input Card Number 7.

Note: Input Card Number 7 if IFRADO = 1 (Word 2 on Card Number 5). The following quadratic-polynomial coefficients define the outer-surface emissivity as a function of the outer-surface temperature.

Columns	Variable	Description
1–14	EMCOF1	Zero-order term in the quadratic fit of outer-surface emissivity as a function of the outer-surface temperature (–).
15–28	EMCOF2	First-order term in the quadratic fit of outer-surface emissivity as a function of the outer-surface temperature (K^{-1}, $°F^{-1}$).
29–42	EMCOF3	Second-order term in the quadratic fit of outer-surface emissivity as a function of the outer-surface temperature (K^{-2}, $°F^{-2}$).

Card Number 8. (Format E14.4,I14) WIDTH, IPATCH

Note: Input Card Number 8 for a SLAB (Word 1 on Card Number 1).

Columns	Variable	Description
1–14	WIDTH	Width (m, ft) of SLAB-element surface (used to compute surface area).
15–28	IPATCH	Hot-patch modeling. Used only if NAMELIST variable NEWRFD = 1. 0 = no; 1 = yes.

Card Number 9. (Format 4E14.4) ZUPTOP, ZUPBOT, ZLPTOP, ZLPBOT

Note: If IPATCH = 0 (Word 2 on Card Number 8), do not input Card Number 9.

Note: These axial locations are defined to be consistent with Card Set 35 (array Z) or SHELV (Word 5 on Card Number 13) and Card Set 36 (array DZ).

Columns	Variable	Description
1–14	ZUPTOP	Axial location (m, ft) of the top of the upper hot patch.
15–28	ZUPBOT	Axial location (m, ft) of the bottom of the upper hot patch.

Columns	Variable	Description
29–42	ZLPTOP	Axial location (m, ft) of the top of the lower hot patch.
43–70	ZLPBOT	Axial location (m, ft) of the bottom of the lower hot patch.

Card Number 10. (Format 4E14.4) TLI, TVI, HLI, HVI

Note: Input Card Number 10 if IDBCI = 1 (Word 1 on Card Number 4).

Columns	Variable	Description
1–14	TLI	Constant liquid temperature (K, °F) at the inner surface of the ROD or SLAB element.
15–28	TVI	Constant vapor temperature (K, °F) at the inner surface of the ROD or SLAB element.
29–42	HLI	Constant liquid heat-transfer coefficient (HTC) (W m^{-2} K^{-1} Btu ft^{-2} °F^{-1} h^{-1}) at the inner surface of the ROD or SLAB element.
43–56	HVI	Constant vapor HTC (W m^{-2} K^{-1} Btu ft^{-2} °F^{-1} h^{-1}) at the inner surface of the ROD or SLAB element.

Card Number 11. (Format 4E14.4) TLO, TVO, HLO, HVO

Note: Input Card Number 11 if IDBCO = 1 (Word 2 on Card Number 4).

Columns	Variable	Description
1–14	TLO	Constant liquid temperature (K, °F) at the outer surface of the ROD or SLAB element.
15–28	TVO	Constant vapor temperature (K, °F) at the outer surface of the ROD or SLAB element.
29–42	HLO	Constant liquid HTC (W m^{-2} K^{-1} Btu ft^{-2} °F^{-1} h^{-1}) at the outer surface of the ROD or SLAB element.
43–70	HVO	Constant vapor HTC (W m^{-2} K^{-1} Btu ft^{-2} °F^{-1} h^{-1}) at the outer surface of the ROD or SLAB element.

Card Number 12. (Format 5I14) NRODS, NODES, IRFTR, NZMAX, IRFTR2

Columns	Variable	Description
1–14	NRODS	Total number of calculational ROD or SLAB elements defined by this HTSTR component (NRODS ≥ NCRX). If NRODS > NCRX (Word 1 on Card Number 2), the last NRODS-NCRX supplemental ROD or SLAB elements do not affect the fluid-dynamic solution through heat-transfer coupling.
15–28	NODES	Number of ROD-radial or SLAB-thickness heat-transfer nodes in the ROD or SLAB elements. A value of 1 invokes the lumped-parameter solution (see TRAC-M/F90 Theory Manual). Its value should include the thermocouple if ITTC = 1 (Word 3 on Card Number 2).NODES must be ≤ NRFMX, where NRFMX is a parameter constant set in module VessCon (header file PARSET1 for TRAC-M/F77), currently to 20.
29–42	IRFTR	Trip ID number for implementing the axial fine-mesh calculation (no axial fine-mesh calculation is performed if IRFTR = 0 or if trip IRFTR is not set ON).
43–56	NZMAX	Maximum number of rows of nodes in the axial direction $\left\lfloor (NCRZ + 1) + \sum_I NFAX(I) \right\rfloor \leq NZMAX \leq$ NZFMX, where array NFAX is input on HTSTR Card Set 50, and NZFMX ia a parameter constant set in TRAC-M/F90 module VessCon (header file PARSET1 for TRAC-M/F77). If NZMAX is greater than NZFMX, the code internally sets NZMAX = NZFMX. Currently, NZFMX = 250. If NZMAX is less than NCRZ + 1, the code internally sets NZMAX = NCRZ + 1. Users should use small values of NZMAX if possible and especially if axial-conduction heat transfer will not be calculated. Large values of NZMAX lead to very large graphics files and a large HTSTR computer-memory requirement.
57–70	IRFTR2	Trip ID number for evaluating the core reflood model when the trip set status is ON and NEWRFD = 1 [the reflood model is not evaluated when IRFTR2 = 0 or when the IRFTR2 ¦ 0 trip set status is OFF].

Card Number 13. (Format 5E14.4) DTXHT(1), DTXHT(2), DZNHT, HGAPO, SHELV

Columns	Variable	Description
1–14	DTXHT(1)	Maximum ΔT (K, °F) surface-temperature change between node rows above which a row of nodes is inserted in the axial fine-mesh heat-transfer calculation for the nucleate and transition boiling regimes [suggested value: DTXHT(1) = 3.0 K (5.4°F)].
15–28	DTXHT(2)	Maximum ΔT (K, °F) surface-temperature change between node rows above which a row of nodes is inserted in the axial fine-mesh heat-transfer calculation for all heat-transfer regimes except the nucleate and transition-boiling regimes [suggested value: DTXHT(2) = 10.0 K (18.0°F)].
29–42	DZNHT	Minimum ŷZ (m, ft) axial interval between node rows below which no additional row of nodes is inserted in the axial fine-mesh heat-transfer calculation (this value should be based on the diffusion number when explicit axial heat-conduction numerics is being evaluated).
43–56	HGAPO	ROD or SLAB element gas-gap HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}). HGAPO must be set to a non-zero value. HGAPO is used as the gap conductance when NFCI = 0 (Word 2 on Card 19); it is used as an initial guess for the gap conductance when NFCI = 1.
57–70	SHELV	Axial location (m,ft) of the first (bottom) node row [use to define Z(1) when MODEZ =1 (Word 3 on Card Number 3) and DZ axial cell-interval lengths are input with Card Set 36].

Note: If NOPOWR = 1 (Word 1 on Card Number 3) for an unpowered HTSTR component, go to the array-data beginning with Card Set 27 (NHCOMI, etc.). If NOPOWR = 0, input the following scalar parameters that need to be defined for powered HTSTR component ROD or SLAB elements.

Card Number 14. (Format 5I14) IRPWTY, NDGX, NDHX, NRTS, NHIST

Columns	Variable	Description
1–14	IRPWTY	Neutronic point-reactor kinetics or reactor-core power option for defining programmed reactivity (–) or reactor-core power (W, Btu h^{-1}). Input parameters required for each option value are shown in parentheses. Add 10 to the value of IRPWTY if reactivity feedback is to be evaluated. For IRPWTY = 15, 16, or 17, reactivity feedback is evaluated and output but not used because the reactor-core power is being defined directly.

1 = point-reactor kinetics with constant REACT programmed reactivity (requires RPOWRI and REACT);

2 = point-reactor kinetics with table lookup of programmed reactivity (requires RPOWRI, IRPWSV, NRPWTB, and RPWTB);

3 = point-reactor kinetics with an initial zero programmed reactivity and trip-initiated constant REACT programmed reactivity (requires RPOWRI, IRPWTR, and REACT);

4 = point-reactor kinetics with an initial constant REACT programmed reactivity and trip-initiated table lookup of programmed reactivity (requires RPOWRI, REACT, IRPWTR, IRPWSV, NRPWTB, and RPWTB);

5 = constant reactor-core power (requires RPOWRI);

6 = table lookup of reactor-core power (requires IRPWSV, NRPWTB, and RPWTB);

7 = initial constant reactor-core power with trip-initiated table lookup of reactor-core power (requires RPOWRI, IRPWTR, IRPWSV, NRPWTB,

Columns	Variable	Description
15–28	NDGX	The number of delayed-neutron groups (if NDGX ≤ 0 is input when IRPWTY = 1, 2, 3, 4, 11, 12, 13, or 14, TRAC-P defaults to 6 delayed-neutron groups with the delayed-neutron constants defined internally; input NDGX = 0 when IRPWTY = 5, 6, 7, 15, 16, or 17).

Columns	Variable	Description
29–42	NDHX	The number of decay-heat groups [For IRPWTY = 1, 2, 3, 4, 11, 12, 13, or 14: input NDHX = 69 to define the ANS-79 decay-heat standard, input NDHX = 71 to define the ANS-79 decay-heat standard plus the heavy-element decay for ^{239}U and ^{239}Np, input any other positive value for NDHX when the TRAC-M user wishes to input-specify their own decay-heat parameters, or input NDHX ≠ 0 to have TRAC-M internally default to the ANS-79 decay-heat standard of NDHX = 69 (an exception to this default occurs when inputting NDHX = –11 to have TRAC-M internally define the 11 decay-heat group that was the default in the MOD1 and earlier versions of TRAC). For IRPWTY = 5, 6, 7, 15, 16, or 17: input NDHX = 0].
43–56	NRTS	The number of timesteps between file output edits of the reactor-core power and reactivity-feedback changes to the TRCOUT file (NRTS = 10, default).
57–70	NHIST	The number of value pairs in the power-history table. NHIST = 0 when IRPWTY = 5, 6, 7, 15, 16, or 17. 0 = the user will input the delayed-neutron precursor concentrations (CDGN) and the decay-heat precursor concentrations (CDHN); 1 = CDGN and CDHN will be calculated assuming an infinite history of operation at the user input power level of RPOWRI; ≥2 = a power history table will be input and used to calculate initial values for CDGN and CDHN.

Card Number 15. (Format 5E14.4) Q235, Q239, Q238, QAVG, R239PF

Note: If IRPWTY = 1, 2, 3, 4, 11, 12, 13, or 14 (Word 1 on Card Number 14) and NDHX = 69 or 71 or <0 (but not –11) (Word 3 on Card Number 14), input Card Number 15; otherwise, skip this card.

Column	Variable	Description
1–14	Q235	Energy per fission from ^{235}U (Mev per fission).
15–28	Q239	Energy per fission from ^{239}Pu (Mev per fission).
29–42	Q238	Energy per fission from ^{238}U (Mev per fission).
43–56	QAVG	Average energy per fission (Mev per fission).
57–70	R239PF	Atoms of ^{239}U produced per fission.

Card Number 16. (Format 4E14.4) FISPHI, RANS, FP235, FP238

Note: If IRPWTY = 1, 2, 3, 4, 11, 12, 13, or 14 (Word 1 on Card Number 14) and NDHX = 69 or 71 or <0 (but not −11) (Word 3 on Card Number 14), input Card Number 16; otherwise, skip this card.

Note: It is assumed that FP235 + FP238 + FP239 = 1.0, where FP239 is the corresponding ^{239}Pu fraction. FP235 and FP238 are used only if NHIST < 2 (Word 5 on Card Number 14).

Columns	Variable	Description
1–14	FISPHI	Fissions per initial fissile atom.
15–28	RANS	Multiplier (−) applied to the ANS 79 decay heat (RANS = 1.0, default).
29–42	FP235	Fraction of fission power (−) associated with ^{235}U fissions at time zero.
43–56	FP238	Fraction of fission power (−) associated with ^{238}U fissions at time zero.

Card Number 17. (Format 5I14) IRPWTR, IRPWSV, NRPWTB, NRPWSV, NRPWRF

Note: If IRPWTY = 1, 5, 11, or 15 (Word 1 on Card Number 11), do not input Card Number 17.

Columns	Variable	Description
1–14	IRPWTR	The trip ID number which controls initiation of the reactivity-power table ($0 < |IRPWTR| \leq 9999$ when IRPWTY = 3, 4, 7, 13, 14, or 17; IRPWTR = 0 otherwise).
15–28	IRPWSV	The reactivity-power table's abscissa-coordinate independent variable ID number. IRPWSV defines the independent-variable parameter for the reactivity-power table. IRPWSV > 0 defines the ID number for a signal-variable parameter; IRPWSV < 0 defines the ID number for a control-block output parameter ($0 < |IRPWSV| \leq 9999$ when IRPWTY = 2, 4, 6, 7, 12, 14, 16, or 17; IRPWSV = 0 otherwise).

Columns	Variable	Description
29–42	NRPWTB	The number of reactivity-power table value pairs (defined by the absolute value of NRPWTB). NRPWTB > 0 defines the table's independent-variable form to be the IRPWSV parameter; NRPWTB < 0 defines the reactivity-power table independent-variable form to be the sum of the change in the IRPWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the reactivity-power table is trip controlled); NRPWTB = 0 defines the reactivity-power table's reactivity or power to be the IRPWSV parameter.
43–56	NRPWSV	The rate-factor table's abscissa-coordinate variable ID number. NRPWSV defines the independent-variable parameter to determine the rate factor that is applied to the reactivity-power table's independent variable. NRPWSV > 0 defines the ID number for a signal-variable parameter; NRPWSV < 0 defines the ID number for a control-block output parameter; NRPWSV = 0 (when NRPWRF ≠ 0) defines the difference between the trip signal and the setpoint value that turns the trip OFF when the reactivity-power table is trip controlled.
57–70	NRPWRF	The number of rate-factor table value pairs (defined by the absolute value of NRPWRF). The rate factor is applied to the reactivity-power table's independent variable when the rate factor is defined. No rate factor is defined when NRPWSV and NRPWRF (Words 4 and 5 on Card Number 14) are both zero. NRPWRF > 0 defines the rate-factor table's abscissa coordinate to be the NRPWSV parameter; NRPWRF < 0 defines it to be the sum of the change in the NRPWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the reactivity-power table is trip controlled); NRPWRF = 0 defines the rate factor to be the NRPWSV parameter.

Card Number 18. (Format 5I14) IZPWTR, IZPWSV, NZPWTB, NZPWSV, NZPWRF

Columns	Variable	Description
1–14	IZPWTR	The trip ID number that controls the evaluation of the axial-power-shape table (0 < | IZPWTR | ≤ 9999) (input IZPWTR = 0 when the evaluation of the axial power-shape table is not trip controlled).

Columns	Variable	Description
15–28	IZPWSV	The axial-power-shape table's abscissa-coordinate variable ID number. IZPWSV defines the independent variable-parameter for the axial-power-shape table. IZPWSV > 0 defines the ID number for a signal-variable parameter; IZPWSV < 0 defines the ID number for a control-block output parameter.
29–42	NZPWTB	The number of axial-power-shape table [x, f(z) shape] value pairs (defined by the absolute value of NZPWTB). Each pair consists of an abscissa-coordinate value x and NZPWZ (Word 1 on Card Number 17) ordinate-coordinate values of f(z) defining the axial-power shape. NZPWTB > 0 defines the table's independent-variable form to be the IZPWSV parameter; NZPWPB < 0 defines the axial-power-shape table independent-variable form to be the sum of the change in the IZPWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the axial-power-shape table is trip controlled).
43–56	NZPWSV	The rate-factor table's abscissa-coordinate variable ID number. NZPWSV defines the independent-variable parameter to determine the rate factor that is applied to the axial-power-shape table's independent variable. NZPWSV > 0 defines the ID number for a signal-variable parameter; NZPWSV < 0 defines the ID number for a control-block output parameter; NZPWSV = 0 (when NZPWRF ≠ 0) defines the difference between the trip signal and the setpoint value that turns the trip OFF when the axial-power-shape table is trip controlled.
57–70	NZPWRF	The number of rate-factor table value pairs (defined by the absolute value of NZPWRF). The rate factor is applied to the axial-power-shape table's independent variable when the rate factor is defined. No rate factor is defined when NZPWSV and NZPWRF (Words 4 and 5 on Card Number 15) are both zero. NZPWRF > 0 defines the rate-factor table's abscissa coordinate to be the NZPWSV parameter; NZPWRF < 0 defines it to be the sum of the change in the NZPWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the axial-power-shape table is trip controlled); NZPWRF = 0 defines the rate factor to be the NZPWSV parameter.

Card Number 19. (Format 5I14) NMWRX, NFCI, NFCIL, IPWRAD, IPWDEP

Columns	Variable	Description
1–14	NMWRX	Metal-water reaction option. 0 = off; 1 = on.
15–28	NFCI	Fuel-cladding gap conductance calculation option. NFCI = 1 performs the dynamic gas-gap conductance calculation. When NFCI = 0, HGAPO (Word 4 on Card Number 13) is used as the gap conductance. 0 = off; 1 = on.
29–42	NFCIL	Maximum number of fuel-cladding gas-gap conductance calculations per timestep. Input NFCIL = 1 when NFCI = 1.
43–56	IPWRAD	Spatial power-shape option. 0 = 1D axial power-shape table (default); 1 = 2D axial-r or axial-x power-shape table.
57–70	IPWDEP	Power-shape table-dependence option. −1 = the power-shape table dependence is defined for each node by a signal-variable or control-block ID number that defines the node power density, and the resulting power shape is not normalized by TRAC-P to a spatially averaged value of unity; 0 = the power-shape table dependence is defined by signal-variable or control-block ID number IZPWSV (Word 2 on Card Number 18) (default); 1 = the power-shape table dependence is defined for each node by a signal-variable or control-block ID number that defines the node power density, and the resulting power shape is normalized by TRAC-P to a spatially averaged value of unity.

Card Number 20. (Format 5I14) NZPWZ, NZPWI, NFBPWT, NRPWR, NRPWI

Columns	Variable	Description
1–14	NZPWZ	Number of axial locations defining the axial-power shape; if NZPWZ < 2 is input, NZPWZ is redefined to be NCRZ+1 (NCRZ is Word 2 on Card Number 2) and Card Set 57 (array ZPWZT) is not input.

Columns	Variable	Description
15–28	NZPWI	Axial-power shape integration option for the heat-transfer calculation. −1 = histogram with step changes at the axial locations defined by Card Set 57 (array ZPWZT); 0 = histogram with step changes midway between the axial locations defined by ZPWZT; 1 = trapezoidal integration [with linear variation between the axial-power shape densities defined by Card Set 59 (array ZPWTB) at the axial locations defined by ZPWZT].
29–42	NFBPWT	Option for replacing the radial, axial, and/or horizontal-plane power shapes with another user-defined shape for volume averaging the reactivity-feedback parameters over the core region. (Add 1 for defining ROD-radial or SLAB-thickness shape, 2 for defining an axial shape, and 4 for defining a (r,θ) or (x,y) plane shape).
43–56	NRPWR	Number of ROD-radial or SLAB-thickness locations defining the 2D axial-r or axial-x power shape if IPWRAD = 1 (Word 4 on Card Number 19) and NRPWR ≥ 2; if IPWRAD = 1 and NRPWR < 2, the same definition applies and NRPWR is redefined to be NODES (Word 2 on Card Number 12), array RPWRT (Card Set 58) is not input, and array RADRD (Card Set 47) defines array RPWRT. If IPWRAD = 0, a 1D axial power shape and a 1D radial or Cartesian power shape are input, NRPWR is redefined by TRAC-M to be 1, and array RPWRT is not input.
57–70	NRPWI	ROD-radial or SLAB-thickness power-shape integration option for the heat-transfer calculation when IPWRAD = 1 (Word 4 on Card Number 19). −1 = histogram with step changes at the radial or thickness locations defined by array RPWRT (Card Set 58); 0 = histogram with step changes midway between the radial or thickness locations defined by array RPWRT; 1 = trapezoidal integration with linear variation between the radial or Cartesian geometry power-shape densities defined by array ZPWTB (Card Set 59) at the radial or thickness locations defined by array RPWRT.

Card Number 21. (Format 5E14.4) REACT, TNEUT, RPWOFF, RRPWMX, RPWSCL

Columns	Variable	Description
1–14	REACT	Initial programmed reactivity (–) (IRPWTY = 1, 2, 4, 11, 12, 14) or trip-initiated programmed reactivity (–) (IRPWTY = 3 or 13) [REACT = ρ_{PROG} = $(K_{eff} - 1)\, K_{eff}^{-1}$, where K_{eff} is the reactor-multiplication constant; both and K_{eff} have no units].
15–28	TNEUT	The prompt-neutron lifetime (s) (TNEUT 0.0 s defaults internally to TNEUT = 1.625×10^{-5} s).
29–42	RPWOFF	Programmed reactivity (–) (IRPWTY = 3, 4, 13, 14) or reactor-core power (W, Btu h^{-1}) (IRPWTY = 7 or 17) when the reactivity/power controlling trip is OFF after being ON; the last value when the trip was ON is held constant when RPWOFF $\leq -1.0 \times 10^{19}$ W(-3.4121×10^{19} Btu h^{-1}).
43–56	RRPWMX	The maximum rate of change of programmed reactivity (s-1) or reactor power (W s^{-1}, Btu h^{-1} s^{-1}) [RRPWMX ≥ 0.0 s^{-1} or 0.0 W s^{-1} (0.0 s^{-1} or 0.0 Btu h^{-1} s^{-1})].
57–70	RPWSCL	Reactivity-power table's scale factor for programmed reactivity (–) or reactor-core power (–). The dependent variable in the table Card Set 62 (array RPWTBR or RPWTBP) is multiplied by RPWSCL to obtain its absolute value of programmed reactivity (–) or reactor-core power (W, Btu h^{-1}).

Card Number 22. (Format 4E14.4) RPOWRI, ZPWIN, ZPWOFF, RZPWMX

Columns	Variable	Description
1–14	RPOWRI	Initial total reactor-core power (W, Btu h^{-1}) of all the average (power) ROD or SLAB elements of this HTSTR component.
15–28	ZPWIN	The axial-power-shape table's abscissa-coordinate variable value (*) corresponding to the initial axial-power shape.

Columns	Variable	Description
29–42	ZPWOFF	The axial-power-shape table's abscissa-coordinate variable value (*) corresponding to the axial-power shape to be used when the axial-power-shape table's controlling trip is OFF after being ON; use the last evaluated axial-power shape when the trip was ON when ZPWOFF $\leq -1.0 \times 10^{19}$ (*).
43–56	RZPWMX	The maximum rate of change of any z-location value in the axial-power shape (s^{-1}) (RZPWMX ≥ 0.0 s^{-1}).

Card Number 23. (Format 4E14.4) EXTSOU, PLDR, PDRAT, FUCRAC

Columns	Variable	Description
1–14	EXTSOU	The fission power (W, Btu h^{-1}) produced by external source neutrons in the reactor core (used only when the point-reactor kinetics equations are evaluated: IRPWTY = 1, 2, 3, 4, 11, 12, 13, or 14).
15–28	PLDR	Pellet-dish radius (m, ft) [no calculation of pellet dishing is performed if PLDR = 0.0 m (0.0 ft)] (currently not used in subroutine FROD).
29–42	PDRAT	ROD element pitch-to-diameter or SLAB element pitch-to-thickness ratio (–) (currently not used in subroutines CHEN and CHF).
43–56	FUCRAC	Fraction of the fue pellet radius l (–) which is not cracked [used only when NFCI = 1 (Word 2 on Card Number 19)].

Card Number 24. (Format 5I14) IRCJTB(I,J), I = (1, 4), IBU(J) where J = (1, 4)

Note: If reactivity feedback is not evaluated when IRPWTY < 11 (Word 1 on Card Number 14), do not input Card Number 24.

Card Number 24 has a total of four cards that are input:

    the J = 1 card defines the fuel-temperature reactivity-coefficient table,
    the J = 2 card defines the coolant-temperature reactivity-coefficient table,
    the J = 3 card defines the gas volume-fraction reactivity-coefficient table, and
    the J = 4 card defines the solute-mass concentration reactivity-coefficient table.

Columns	Variable	Description
1–14	IRCJTB(1,J)	The number of fuel-temperature T_f-dependent entries in the Jth reactivity-coefficient table [1 $\leq$ IRCJTB(1,J)].

Columns	Variable	Description
15–28	IRCJTB(2,J)	The number coolant-temperature T_c-dependent entries in the Jth reactivity-coefficient table $[1 \leq \text{IRCJTB}(2,J)]$.
29–42	IRCJTB(3,J)	The number of gas volume-fraction -dependent entries in the Jth reactivity-coefficient table $[1 \leq \text{IRCJTB}(3,J)]$.
43–56	IRCJTB(4,J)	The number of solute-mass B_r or B_m-dependent entries in the Jth reactivity-coefficient table $[1 \leq \text{IRCJTB}(4,J)]$.
57–70	IBU(J)	The solute-units definition index for the Jth reactivity coefficient:

$$\text{IBU(J)} = -2 \text{ if } x = B_r \text{ and } B = B_r,$$
$$\text{IBU(J)} = -1 \text{ if } x = B_r \text{ and } B = B_m,$$
$$\text{IBU(J)} = 0 \text{ if } x = B_m \text{ and } B = B_r,$$
$$\text{IBU(J)} = 1 \text{ if } x = B_m \text{ and } B = B_m,$$

where $\partial K_{eff}/\partial x = \text{fcn}(T_f, T_c, \alpha, B)$. The two solute-mass concentrations are: B_m density, which is the mass of solute in the coolant-channel volume (kg m^{-3}, lb$_m$ ft^{-3}) and B_r ratio which is the parts solute mass per million parts liquid-coolant mass (ppm).

Card Number 25. (Format 5I14) IRCJFM(J), J = (1, 4), ISNOTB

Note: If reactivity feedback is not evaluated when IRPWTY < 11 (Word 1 on Card Number 14), do not input Card Number 25.

The reactivity-coefficient type form numbers are defined as follows:

IRCJFM(J) = 0 for $\partial K_{eff}/\partial x$,
IRCJFM(J) = 1 for $(1/K_{eff}) \neq \partial K_{eff}/\partial x$,
IRCJFM(J) = 2 for $x\,\partial K_{eff}/\partial x$, and
IRCJFM(J) = 3 for $(x/K_{eff}) \neq \partial K_{eff}/\partial x$,

where $x = T_f$ for J = 1, $x = T_c$ for J = 2, $x = \alpha$ for J = 3, and $x = B_m$ [when IBU(4) = (0, 1)] or $x = B_r$ [when IBU(4) = (–2, –1)] for J = 4.

Columns	Variable	Description
1–14	IRCJFM(1)	Form number for the fuel-temperature reactivity-coefficient type.
15–28	IRCJFM(2)	Form number for the coolant-temperature reactivity-coefficient type.

Columns	Variable	Description
29–42	IRCJFM(3)	Form number for the gas volume-fraction reactivity-coefficient type.
43–56	IRCJFM(4)	Form number for the solute-mass concentration reactivity-coefficient type.
57–70	ISNOTB	Option to exclude burnable-poison pin and control-rod boron from the solute reactivity-feedback calculation. 0 = no (the solute is assumed to be orthoboric acid); 1 = yes.

Card Number 26. (Format 5E14.4) POWEXP, BPP0, BPP1, BCR0, BCR1

Note: If reactivity feedback is not evaluated when IRPWTY < 11 (Word 1 on Card Number 14), do not input Card Number 26.

Columns	Variable	Description
1–14	POWEXP	Exponent value (–) to which the cell values of the power distribution are raised in defining the weighting factor for volume averaging the reactivity-feedback parameters over the powered reactor-core region (suggested value: 2.0).
15–28	BPP0	Zero-order coefficient ($kg\ m^{-3}$, $lb_m\ ft^{-3}$) of the first-order polynomial $B_{m_{BPP}} = BPP0 + BPP1 \times T_c$ that defines the effective (smeared and shielded) core-averaged concentration of burnable-poison pin boron in the coolant-channel volume.
29–42	BPP1	First-order coefficient ($kg\ m^{-3}\ K^{-1}$, $lb_m\ ft^{-3}\ °F^{-1}$) of the first-order polynomial $B_{m_{BPP}} = BPP0 + BPP1 \times T_c$ that defines the effective (smeared and shielded) core-averaged concentration of burnable-poison pin boron in the coolant-channel volume. Tc is the core-averaged coolant temperature (K, °F).
43–56	BCR0	Zero-order coefficient ($kg\ m^{-3}$, $lb_m\ ft^{-3}$) of the first-order polynomial $B_{m_{BCR}} = BCR0 + BCR1 \times \rho_{PROG}$ that defines the effective (smeared and shielded) core-averaged concentration of control-rod pin boron in the coolant-channel volume.

Columns	Variable	Description
57–70	BCR1	First-order coefficient (kg m^{-3}, lb$_m$ ft^{-3}) of the first-order polynomial $B_{m_{BCR}} = BCR0 + BCR1 \times \rho_{PROG}$ that defines the effective (smeared and shielded) core-averaged concentration of control-rod pin boron in the coolant-channel volume. ρ_{PROG} is programmed reactivity and has no units.

HTSTR Array Cards. (Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.)

Note: Card Sets 27 to 30. When M1D ≠ 0 (Word 5 on Card Number 2), input NCRX (Word 1 on Card Number 2) groups of Card Sets 27 to 30. The required order when NCRX > 1 for multiple 1D hydraulic component coupling is Card Sets 27 to 30 for the first average (power) ROD or SLAB element, Card Sets 27 to 30 for the second average (power) ROD or SLAB element, etc.

Note: Card Sets 27 to 30. If ITTC = 1 (Word 3 on Card Number 2), then IDBCI = 2 and IDBCO = 2 (Words 1 and 2 on Card Number 4) and NHCOMI and NHCELI refer to the ROD or SLAB element outer-surface hydraulic coupling and NHCOMO and NHCELO refer to the thermocouple-surface hydraulic coupling.

Card Sets 27 & 28. If IDBCI ≠ 2 (Word 1 on Card Number 4), do not input Card Sets 27 and 28 (arrays NHCOMI and NHCELI).

Variable	Dimension	Description
NHCOMI	NCRZ+2	Component numbers of the hydraulic cells to which the HTSTR ROD- or SLAB-element inner surface is coupled starting with the cell below the first node row and going to the cell above the last node row. NHCOMI(J) defines the component number of the hydraulic cell between node rows J–1 and J. The input values for NHCOMI(1) and NHCOMI(NCRZ+2) are redefined internally.
NHCELI	NCRZ+2	Cell numbers of the hydraulic cells to which the heat-structure ROD- or SLAB-element inner surface is coupled starting with the cell below the first node row and going to the cell above the last node row. NHCELI(J) defines the cell number of the hydraulic cell between node rows J–1 and J. The input values for NHCELI(1) and NHCELI(NCRZ+2) are redefined internally. Define NHCELI(J) > 0 when the cell's higher-numbered interface is aligned with node row J; define NHCELI(J) < 0 when the cell's lower-numbered interface is aligned with node row J.

Card Sets 29 & 30. If IDBCO ≠ 2 (Word 2 on Card Number 4), do not input Card Sets 29 and 30 (arrays NHCOMO and NHCELO)

Variable	Dimension	Description
NHCOMO	NCRZ+2	Component numbers of the hydraulic cells to which the HTSTR ROD- or SLAB-element outer surface is coupled starting with the cell below the first node row and going to the cell above the last node row. NHCOMO(J) defines the component number of the hydraulic cell between node rows J–1 and J. The input values for NHCOMO(1) and NHCOMO(NCRZ+2) are redefined internally.
NHCELO	NCRZ+2	Cell numbers of the hydraulic cells to which the heat-structure ROD- or SLAB-element outer surface is coupled starting with the cell below the first node row and going to the cell above the last node row. NHCELO(J) defines the cell number of the hydraulic cell between node rows J–1 and J. The input values for NHCELO(1) and NHCELO(NCRZ+2) are redefined internally. Define NHCELO(J) > 0 when the cell's higher-numbered interface is aligned with node row J; define NHCELO(J) < 0 when the cell's lower-numbered interface is aligned with node row J.

Card Set 31. If NAMELIST variable MHTLI = 0 or IRFTR ≠ 0, do not input Card Set 31 (array HTMLI).

Variable	Dimension	Description
HTMLI	NCRZ	Liquid-phase wall heat-transfer multiplier factor for the inner surface (–) [$0.9 \leq HTMLI \leq 1.1$].

Card Set 32. If NAMELIST variable MHTLO = 0 or IRFTR ≠ 0, do not input Card Set 32 (array HTMLO).

Variable	Dimension	Description
HTMLO	NCRZ	Liquid-phase wall heat-transfer multiplier factor for the outer surface (–) [$0.9 \leq HTMLO \leq 1.1$].

Card Set 33. If NAMELIST variable MHTVI = 0 or IRFTR ≠ 0, do not input Card Set 33 (array HTMVI).

Variable	Dimension	Description
HTMVI	NCRZ	Gas-phase wall heat-transfer multiplier factor for the inner surface (–) [$0.9 \leq HTMVI \leq 1.1$].

Card Set 34. If NAMELIST variable MHTVO = 0 or IRFTR ≠ 0, do not input Card Set 34 (array HTMVO).

Variable	Dimension	Description
HTMVO	NCRZ	Gas-phase wall heat-transfer multiplier factor for the outer surface (–) [0.9 ≤ HTMVO ≤ 1.1].

Card Set 35. If MODEZ = 0 (Word 3 on Card Number 3), input Card Set 35 (array Z).

Variable	Dimension	Description
Z	NCRZ+1	Axial location (m, ft) of the hydraulic-cell edges where node rows are located in the ROD or SLAB element.

Card Set 36. If MODEZ = 1 (Word 3 on Card Number 3), input Card Set 36 (array DZ).

Variable	Dimension	Description
DZ	NCRZ	Axial cell lengths (m, ft) of the hydraulic-cells. TRAC-M internally defines Z(1) = SHELV and Z(k+1) = SHELV + DZ(1) + DZ(2) + DZ(k) for k=(1,NCRZ), where SHELV is Word 5 on Card Number 13.

Note: Thermal Radiation Heat Transfer Model (Card 37, Card Sets 38 and 39, Card 40, Card Sets 41 and 42). Currently, the thermal radiation heat transfer model is only available in TRAC-M/F77. For TRAC-M/F90, Cards 37 to 42 must be omitted.

Card Number 37. (Format 3I14) IENCLU, IFACEI, IZSI

Note: Card 37, Card Sets 38 and 39. If IFRADI = 1 (Word 1 on Card Number 5), input NCRZ (Word 2 on Card Number 2) groups of Card Number 37 and Card Sets 38 and 39. This group of cards is repeated on a hydraulic-cell basis to supply radiation parameters for the inner surface. The total number of ITFACI faces is defined by the Radiation-Enclosure Data Cards that were input after the Control-Parameter Data section

Columns	Variable	Description
1–14	IENCLU	Radiation-enclosure number to which this node-row interval belongs. If the value is 0, the node-row interval does not belong to any radiation enclosure, IFACEI and IZSI are not used, and Card Sets 38 and 39 are not read.
15–28	IFACEI	Radiation face number that this node-row interval represents.
29–42	IZSI	Hydraulic-cell level that this node-row interval represents.

Card Sets 38 & 39.

Note: Card 37, Card Sets 38 and 39. If IFRADI = 1 (Word 1 on Card Number 5), input NCRZ (Word 2 on Card Number 2) groups of Card Number 37 and Card Sets 38 and 39. This group of cards is repeated on a hydraulic-cell basis to supply radiation parameters for the inner surface. The total number of ITFACI faces is defined by the Radiation-Enclosure Data Cards that were input after the Control-Parameter Data section

Variable	Dimension	Description
GVF	ITFACI	Geometric view factor (–) from the IFACEI face to each of the ITFACI faces of the radiation enclosure.
PLEN	ITFACI	Radiation path length (m, ft) from the IFACEI face to each of the ITFACI faces of the radiation enclosure.

Card Number 40. (Format 3I14) IENCLU, IFACEO, IZSO

Note: Card 40, Card Sets 41 and 42. If IFRADO = 1 (Word 2 on Card Number 5), input NCRZ (Word 2 on Card Number 2) groups of Card Number 40 and Card Sets 41 and 42. This group of cards is repeated on a hydraulic-cell basis to supply radiation parameters for the outer surface. The total number of ITFACI faces is defined by the Radiation-Enclosure Data Cards that were input at the end of the Control-Parameter Data section.

Columns	Variable	Description
1–14	IENCLU	Radiation-enclosure number to which this node-row interval belongs. If the value is 0, the node-row interval does not belong to any radiation enclosure, IFACEO and IZSO are not used, and Card Sets 41 and 42 are not read.
15–28	IFACEO	Radiation face number that this node-row interval represents.
29–42	IZSO	Hydraulic-cell level that this node-row interval represents.

Card Sets 41 & 42.

Note: Card 40, Card Sets 41 and 42. If IFRADO = 1 (Word 2 on Card Number 5), input NCRZ (Word 2 on Card Number 2) groups of Card Number 40 and Card Sets 41 and 42. This group of cards is repeated on a hydraulic-cell basis to supply radiation parameters for the outer surface. The total number of ITFACI faces is defined by the Radiation-Enclosure Data Cards that were input at the end of the Control-Parameter Data section.

Variable	Dimension	Description
GVF	ITFACI	Geometric view factor (--) from the IFACEO face to each of the ITFACI faces of the radiation enclosure.
PLEN	ITFACI	Radiation path length (m, ft) from the IFACEO face to each of the ITFACI faces of the radiation enclosure.

Card Set 43.

Variable	Dimension	Description
GRAV or ELEV	NCRZ	Gravity-defining array (-- or m, ft). If NAMELIST variable IELV = 0, each ROD- or SLAB-element axial cell is oriented to vertical by this GRAV array definition (similar to GRAV in the hydrodynamic components).
		GRAV is the cosine of the angle between a vector pointing upward and a vector from the low-numbered to the high-numbered axial cells. If NAMELIST variable IELV = 1, the elevation (m, ft) of each axial-cell center location defines GRAV internally in TRAC-M.

Card Set 44. If NRIDR = 0 (Word 2 on Card Number 3) and NRODS–NCRX = 0 (Word 1 on Card Number 12 and Word 1 on Card Number 2), do not input Card Set 44 (array IDROD).

Variable	Dimension	Description
IDROD	NRODS–NCRX when NRIDR = 0; NRODS when NRIDR = 1 or 2.	When coupled to a VESSEL component, IDROD defines the (r, θ)- or (x,y)-plane cell numbers of a VESSEL-component level where the supplemental (if NRIDR = 0) or all (if NRIDR = 1 or 2) ROD or SLAB elements are located. When coupled to 1D hydraulic components, IDROD defines the single average (power) and zero or more supplemental ROD- or SLAB-element numbers that couple to the same 1D hydraulic component. For 1D, this defines where the supplemental (if NRIDR = 0) or average + supplemental (if NRIDR = 1 or 2) ROD or SLAB elements are located. NRIDR is Word 2 on Card Number 3. For coupling to a VESSEL component, this array is used to define coupling to a specific hydraulic cell within a VESSEL-component level. In a VESSEL level, cell numbers first vary by θ or y and then by r or x. For 1D, numbers 1 through NCRX are first specified for the average rods, then appropriate numbers between 1 and NCRX for the supplemental rods.

Variable	Dimension	Description
		This definition is for the inner or outer surface of the ROD or SLAB element when NRIDR = 0 or 1 and is specifically for the inner surface of the ROD or SLAB element when NRIDR = 2.

Card Set 45. If NRIDR ≠ 2 (Word 2 on Card Number 3), do not input Card Set 45 (array IDRODO).

Variable	Dimension	Description
IDRODO	NRODS	IDRODO has the same definition as IDROD (Card Set 31) but is for the outer surface of the ROD or SLAB element when NRIDR = 2.

Card Sets 46 & 47.

Variable	Dimension	Description
RDX	NCRX	Number of actual physical fuel rod elements in each of the NCRX (r,θ) or (x,y) mesh-cell locations of a VESSEL component or in each of the NCRX 1D hydraulic components. This is a real-valued number, not an integer. A value with a fractional part models with the fractional part a ROD or SLAB element that is partly within the mesh cell.
RADRD	NODES	Distances to the heat conduction noes. ROD radii or SLAB thickness (m, ft) from the inside surface at no power cold conditions. **Note:** If ITTC = 1 (Word 3 on Card Number 2), then RADRD(NODES) corresponds to the external thermocouple.

Card Set 48. If ITTC=0 (Word 3 on Card Number 2), do not input the Card Set 48 (array TC).

Variable	Dimension	Description
TC	6	The following six thermocouple parameters are input as array elements.
		ANTC = Number of thermocouples per ROD or SLAB element;
		DIA = Diameter of the thermocouple (m, ft);
		AW = Perimeter of the ROD- or SLAB-element surface to thermocouple weld (m, ft);

Variable	Dimension	Description
		ATW = Thickness of the ROD or SLAB element at thermocouple weld (m, ft);
		CKW = The ROD or SLAB element to thermocouple effective thermal conductivity (W m^{-1} K^{-1}, Btu ft^{-1} °F^{-1} h^{-1});
		RADT = Distance from the ROD- or SLAB-element center to the center of the thermocouple (m, ft).

Card Set 49. Adjacent MATRD elements cannot both have the value 3 and MATRD(1) and MATRD(NODES – 1) cannot be 3. Additional material properties can be input (see Section 6.3.3.). Choose material properties for regionsbounded by array RADRD (Card Set 47). .

Variable	Dimension	Description
MATRD	NODES –1	ROD- or SLAB-element material ID numbers [dimension is 1 if NODES = 1 (Word 2 on Card Number 12)].

ID   Material Type
1 = mixed oxide;
2 = zircaloy;
3 = fuel-clad gap gases;
4 = boron-nitride insulation;
5 = constantan/Nichrome heater wire;
6 = stainless steel, type 304;
7 = stainless steel, type 316;
8 = stainless steel, type 347;
9 = carbon steel, type A508;
10 = inconel, type 718;
11 = zircaloy dioxide;
12 = inconel, type 600.

Card Set 50.

Variable	Dimension	Description
NFAX	NCRZ	Number of permanent axial fine-mesh node rows added per axial hydraulic-cell interval at the start of the fine-mesh calculation when trip IRFTR (Word 3 on Card Number 12) is set ON. These permanent (and all temporary rezoning) axial fine-mesh node rows are removed when trip IRFTR is set OFF. [The total number of heat-transfer node rows per ROD or SLAB element: $NCRZ + 1 + \sum_I NFAX(I)$, must not be greater than NZMAX (Word 4 on Card Number 12)].

Card Set 51.

Note: **Temperature Array.** Input an RFTN Card Set for each of the NRODS (Word 1 on Card Number 12) ROD or SLAB elements. This includes each average and supplemental ROD or SLAB element.

Variable	Dimension	Description
RFTN	NODES × (NCRZ+1)	ROD (radial by axial) or SLAB (thickness by axial) element temperatures (K, °F).

Note: **Unpowered HTSTR.** If NOPOWR = 1 (Word 1 on Card Number 3) for an unpowered HTSTR component, do not input the remaining arrays, which are defined for powered HTSTR-component ROD or SLAB elements.

Card Set 52. IF IPWRAD = 1 (Word 4 on Card Number 19), do not input Card Set 52 (array RDPWR).

Variable	Dimension	Description
RDPWR	NODES	Relative ROD-radial or SLAB-thickness power-density distribution (–) at the node locations defined by Card Set 47 (array RADRD).

Card Set 53. If NFBPWT (Word 3 on Card Number 20) is 0 or even valued, do not input Card Set 53 (array RS)

Variable	Dimension	Description
RS	NODES	Relative ROD-radial or SLAB-thickness power-density distribution (–) at the node locations defined by Card Set 47 (array RADRD) that will be used to volume average the reactivity-feedback parameters over the powered-core region. If IPWRAD = 1 (Word 4 on Card Number 19) and array RS is input, array ZS (Card Set 61) must be input as well.

Card Set 54.

Variable	Dimension	Description
CPOWR	NCRX	Relative power-density distribution (–) in the average (power) ROD or SLAB elements heat-transfer coupled to the (r,) or (x,y) mesh cells of a VESSEL-component level or to one or more 1D hydraulic components.

Card Set 55. If NFBPWT (Word 3 on Card Number 20) is less than 4, do not input Card Set 55 (array HS)

Variable	Dimension	Description
HS	NCRX	Relative power-density distribution (–) in the average (power) ROD or SLAB elements heat-transfer coupled to the (r,) or (x,y) mesh cell of a VESSEL-component level or to one or more 1D hydraulic components that will be used to volume average the reactivity-feedback parameters over the powered-core region.

Card Set 56.

Variable	Dimension	Description
RPKF	NRODS–NCRX	Supplemental ROD or SLAB element power-peaking factors [relative to the average (power) ROD or SLAB elements. which together are coupled to the (r,θ) or (x,y) mesh cells of a VESSEL-component level or to one or more 1D hydraulic components].

Card Set 57. If NZPWZ < 2 (Word 1 on Card Number 20) from input or NZPWTB = 0 (Word 3 on Card Number 18), do not input Card Set 57 (array ZPWZT)

Variable	Dimension	Description
ZPWZT	NZPWZ	The axial locations (m, ft) where the axial-power shape's relative power densities are defined [define ZPWZT(1) = Z(1) and ZPWZT(NZPWZ) = Z(NCRZ+1) to have the power distribution span the axial range over which the ROD- or SLAB-element node rows are defined (Card Set 35 defines array Z)].

Card Set 58. If IPWRAD = 0 (Word 4 on Card Number 19) or NRPWR < 2 (Word 4 on Card Number 20) or NZPWTB = 0 (Word 3 on Card Number 18), do not input Card Set 58 (array RPWRT).

Variable	Dimension	Description
RPWRT	NRPWR	The ROD-radial or SLAB-thickness locations (m, ft) where the power shape's relative power densities are defined [define RPWRT(1) = RADRD(1) and RPWRT(NRPWR) = RADRD(NODES) to have the power distribution span the radial or Cartesian range over which the ROD- or SLAB-element node rows are define (Card Set 47 defines array RADRD)].

Card Set 59. If NZPWTB = 0 (Word 3 on Card Number 18), do not input Card Set 59 (array ZPWTB).

Variable	Dimension	Description
ZPWTB	(1+NZPWZ × NRPWR) × |NZPWTB| where NZPWZ is NCRZ+1 if NZPWZ < 2 is input.	1D axial (if IPWRAD = 0, Word 4 on Card Number 19) or 2D axial-r or axial-x (if IPWRAD = 1) power-shape vs independent-variable form table (*, –). Input |NZPWTB| table-defining data pairs having the following form [independent-variable form defined by IZPWSV (Word 2 on Card Number 18), NZPWZ × NRPWR (Words 1 and 4 on Card Number 20) power-density values). NRPWR = 1 when IPWRAD = 0. NZPWTB = 1 and the power-density values are real values of the signal-variable or control-block ID numbers that TRAC-P uses to define the actual power-density values when IPWDEP = ±1 (Word 5 on Card Number 19). The relative power densities defining the power shape are specified at the NZPWZ axial locations of the ZPWZT array defined by Card Set 57 and at the NRPWR ROD-radial or SLAB-thickness locations of the RPWRT array defined by Card Set 58. There are |NZPWTB| power shapes being input with an independent-variable value and NZPWZ x NRPWR power-density values for each shape.

Card Set 60. If NZPWTB = 0 (Word 3 on Card Number 18) or NZPWRF = 0 (Word 5 on Card Number 18), do not input Card Set 60 (array ZPWRF).

Variable	Dimension	Description
ZPWRF	2 × |NZPWRF|	Rate-factor table (*,–) for the axial-power-shape table's independent variable. Input |NZPWRF| (Word 5 on Card Number 18) table-defining data pairs having the following form [independent-variable form defined by NZPWSV (Word 4 on Card Number 15), rate factor].

Card Set 61. If IRPWTY = 1, 5, 11, or 15 (Word 1 on Card Number 14) or NFBPWT = 0, 1, 4, or 5 (Word 3 on Card Number 20), do not input Card Set 61 (array ZS).

Variable	Dimension	Description
ZS	NZPWZ where NZPWZ is NCRZ+1 if NZPWZ < 2 is input	Relative axial-power-shape density (–) used to volume average the reactivity-feedback parameters over the powered-core region. If IPWRAD = 1 (Word 4 on Card Number 19) and array ZS is input, array RS (Card Set 53) must be input as well.

Card Set 62. If IRPWTY = 1, 5, 11, or 15 (Word 1 on Card Number 14) or NRPWTB = 0 (Word 3 on Card Number 17), do not input Card Set 62 (array RPWTBR or RPWTBP).

Variable	Dimension	Description
RPWTBR or RPWTBP	2×|NRPWTB|	Programmed-reactivity (–) or reactor-core power (W or Btu h^{-1}) vs independent-variable form (*) table [(*,– or W), (*,– or Btu h^{-1})]. Input |NRPWTB| (Word 3 on Card Number 17) table-defining data pairs having the following form [independent-variable form defined by IRPWSV (Word 2 on Card Number 17), programmed reactivity or reactor power as defined by IRPWTY].

Card Set 63. If NRPWTB = 0 (Word 3 on Card Number 17) or NRPWRF = 0 (Word 5 on Card Number 17), do not input Card Set 63 (array RPWRF).

Variable	Dimension	Description
RPWRF	2×|NRPWRF|	Rate-factor table (*,–) for the programmed-reactivity or reactor-power table's independent variable. Input |NRPWRF| (Word 5 on Card Number 17) table-defining data pairs having the following form [independent-variable form defined by NRPWSV (Words 4 on Card Number 17), rate factor to be applied to the programmed-reactivity or reactor-power table's independent variable].

Card Sets 64 to 67. If IRPWTY < 11 (Word 1 on Card Number 14), do not input Card Sets 64 to 67 (array RCTF, RCTC, RCAL, and RCBM, respectively).

Note: See Appendix I for detailed explanations and examples of the reactivity-coefficient tables RCTF, RCTC, RCAL, and RCBM.

Variable	Dimension	Description
RCTF	IRCJTB(1,1) + IRCJTB(2,1) + IRCJTB(3,1) + IRCJTB(4,1) + (IRCJTB(1,1) × IRCJTB(2,1) × IRCJTB(3,1) × IRCJTB(4,1))	The fuel-temperature reactivity-coefficient table. Input IRCJTB(1,1) T_f values, IRCJTB(2,1) T_c values, IRCJTB(3,1) values, IRCJTB(4,1) B_r or B_m values, and IRCJTB(1,1) × IRCJTB(2,1) × IRCJTB(3,1) × IRCJTB(4,1) fuel-temperature reactivity-coefficient values that define the four dimensionally dependent table. (**Note:** This table and the following three tables are **not** entered with two-value pairs as is done for the one dimensionally dependent tables.)

Variable	Dimension	Description
RCTC	IRCJTB(1,2) + IRCJTB(2,2) + IRCJTB(3,2) + IRCJTB(4,2) + (IRCJTB(1,2) x IRCJTB(2,2) x IRCJTB(3,2) x IRCJTB(4,2))	The coolant-temperature reactivity-coefficient table.
RCAL	IRCJTB(1,3) + IRCJTB(2,3) + IRCJTB(3,3) + IRCJTB(4,3) + (IRCJTB(1,3) x IRCJTB(2,3) x IRCJTB(3,3) x IRCJTB(4,3))	The gas volume-fraction reactivity-coefficient table.
RCBM	IRCJTB(1,4) + IRCJTB(2,4) + IRCJTB(3,4) + IRCJTB(4,4) + (IRCJTB(1,4) x IRCJTB(2,4) x IRCJTB(3,4) x IRCJTB(4,4))	The solute-mass concentration reactivity-coefficient table.

Note: Direct Definition of Reactor-Core Power. If IRPWTY = 5, 6, 7, 15, 16, or 17 (Word 1 on Card Number 14), do not input Card Sets 68 to 74 (arrays BETA, LAMDA, CDGN, LAMDH, EDH, CDHN, and PHIST).

Card Sets 68 & 69. If NDGX ≤ 0 (Word 2 on Card Number 14), do not input Card Sets 68 and 69 (arrays BETA and LAMDA). The default 6-group delayed-neutron constants will be defined internally by TRAC-M.

Variable	Dimension	Description
BETA	NDGX	The effective delayed-neutron neutron fraction (–).
LAMDA	NDGX	The delayed-neutron decay constant (s^{-1}).

Card Set 70. If NDGX > 0 and NHIST = 0 (Words 2 and 5 on Card Number 14) input Card Set 70 (array CDGN).

Variable	Dimension	Description
CDGN	NDGX	The delayed-neutron precursor power (W, Btu h^{-1}).

Card Sets 71 & 72. If NDHX ≤ 0 or NDHX = 69 or 71 (Word 3 on Card Number 14), do not input Card Sets 71 and 72 (arrays LAMDH and EDH). The default 69-group decay-heat constants will be defined internally by TRAC-M if NDHX ≤ 0 or the ANS 79 decay-heat constants will be defined internally by TRAC-M if NDHX = 69 or 71.

Variable	Dimension	Description
LAMDH	NDHX	The decay-heat decay constant (s^{-1}).
EDH	NDHX	The effective decay-heat energy fraction (–).

Card Set 73. If NDHX > 0 and NHIST = 0 (Words 3 and 5 on Card Number 14), input Card Set 73 (array CDHN).

Variable	Dimension	Description
CDHN	NDHX	The decay-heat precursor power (W, Btu h^{-1}).

Card Set 74. If NHIST = 0 or 1 (Word 5 on Card Number 14), do not input Card Set 74 (array PHIST).

Variable	Dimension	Description
PHIST	2 × NHIST	Power-history table [(s, W), (s, Btu h^{-1})]. Input NHIST (Word 5 on Card Number 14) table-defining data pairs having the following form [time at the start of the transient minus the past time, reactor-core prompt-fission power at that past time]. The first data pair should be for the power level at the start of the transient; that is, the time at the start of the transient minus the past time, which in this case is 0.0 s, with the time difference for subsequent data pairs being positive valued and increasing monotonically for each data pair.

Card Sets 75 & 76. If NDHX ≠ 69 and NDHX ≠ 71 or NHIST = 0 (Words 3 and 5 on Card Number 14), do not input Card Sets 75 and 76 (arrays FP235 and FP239).

Note: It is assumed that FP235 + FP239 + FP238 = 1.0.

Variable	Dimension	Description
FP235	max(1,NHIST-1)	Fraction (–) of fission power associated with ^{235}U fission during the power-history table interval from i to i+1.
FP239	max(1,NHIST-1)	Fraction (–) of fission power associated with ^{239}Pu fission during the power-history table interval from i to i+1.

Card Sets 77 to 84.

Variable	Dimension	Description
FPUO2	NCRX	Fraction (–) of plutonium dioxide (PuO_2) in mixed-oxide fuel.
FTD	NCRX	Fraction (–) of theoretical fuel density.
GMIX	NCRX*7	Mole fraction (–) of gap-gas constituents. GMIX is not used if NFCI = 0 (Word 2 on Card Number 19) but must be input. Enter data for NCRX (Word 1 on Card Number 2) cells for each gas in the order indicated. Index Gas 1 = helium; 2 = argon; 3 = xenon; 4 = krypton; 5 = hydrogen; 6 = air/nitrogen; 7 = water vapor.
GMLES	NCRX	Gram moles of gap gas (g-moles) per ROD or SLAB element. XGMILES is not used, but must be input.
PGAPT	NCRX	Average gap-gas pressure (Pa, psia). PGAPT is not used if NFCI = 0 (Word 2 on Card Number 16), but must be input.
PLVOL	NCRX	Plenum volume (m^3, ft^3) in each ROD or SLAB element above the pellet stack. PLVOL is not used, but must be input.
PSLEN	NCRX	Pellet-stack length (m, ft). PSLEN is not used, but must be input.
CLENN	NCRX	Clad total length (m, ft). CLENN is not used, but must be input.

Card Set 85.

Note: **Burnup Arrays.** Input a BURN Card Set for each of the NRODS (Word 1 on Card Number 12) ROD or SLAB elements. This includes each average and supplemental ROD or SLAB element of the HTSTR component.

Variable	Dimension	Description
BURN	NCRZ+1	ROD or SLAB element axial-location fuel burnup (MWD/MTU).

6.3.7.3. PIPE component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–4	TYPE	Component type (PIPE left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \le NUM \le 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14,E14.4) NCELLS, NODES, JUN1, JUN2, EPSW

Columns	Variable	Description
1–14	NCELLS	Number of fluid cells in the PIPE component.
15–28	NODES	Number of radial heat-transfer nodes in the PIPE wall. A value of zero specifies no wall heat transfer.
29–42	JUN1	Junction number for the junction adjacent to cell 1.
43–56	JUN2	Junction number for the junction adjacent to cell NCELLS (Word 1 on Card Number 2).
57–70	EPSW	Wall-surface roughness (m, ft).

Card Number 3. (Format 4I14) ICHF, ICONC, IACC, IPOW

Columns	Variable	Description
1–14	ICHF	CHF-calculation option. 0 = no; 1 = yes.
15–28	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.

Columns	Variable	Description
29–42	IACC	Accumulator model option. 0 = no accumulator logic; 1 = calculation of water level, volumetric flow, and liquid volume discharge, and the implementation of an interface sharpener; 2 = same as (1) plus the application of a liquid-separator model at JUN2 (the gas phase is never allowed to flow across the JUN2 interface).
43–56	IPOW	Power deposited in (to) the coolant option. 0 = no; 1 = yes.

Card Number 4. (Format 5I14) IPOWTR, IPOWSV, NPOWTB, NPOWSV, NPOWRF

Note: If IPOW = 0 (Word 4 on Card Number 3), do not input Card Number 4.

Columns	Variable	Description
1–14	IPOWTR	The trip ID number that controls the evaluation of the power-to-fluid table defined by Card Set 32 (array POWTB) ($|$IPOWTR$| \leq 9999$) (input IPOWTR = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IPOWSV	The independent-variable ID number for the power-to-the-fluid table. IPOWSV > 0 defines the ID number for a signal-variable parameter; IPOWSV < 0 defines the ID number for a control-block output parameter.
29–42	NPOWTB	The number of power-to-the-fluid table data (defined by the absolute value of NPOWTB). NPOWTB > 0 defines the table independent-variable form to be the IPOWSV parameter; NPOWTB < 0 defines the table independent-variable form to be the sum of the change in the IPOWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-fluid table is trip controlled); NPOWTB = 0 defines the power to the fluid to be the IPOWSV parameter.

Columns	Variable	Description
43–56	NPOWSV	The independent-variable ID number for the rate factor that is applied to the power-to-the-fluid table independent variable. NPOWSV > 0 defines the ID number for a signal-variable parameter; NPOWSV < 0 defines the ID number for a control-block output parameter; NPOWSV = 0 (when NPOWRF ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-fluid table is trip controlled.
57–70	NPOWRF	The number of rate-factor table data pairs (defined by the absolute value of NPOWRF). The rate factor is applied to the power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPOWSV and NPOWRF are both zero. NPOWRF > 0 defines the rate-factor table independent variable to be the NPOWSV parameter; NPOWRF < 0 defines it to be the sum of the change in the NPOWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-fluid table is trip controlled); NPOWRF = 0 defines the rate factor to be the NPOWSV parameter.

Card Number 5. (Format 5I14) IQP3TR, IQP3SV, NQP3TB, NQP3SV, NQP3RF

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 5.

Columns	Variable	Description
1–14	IQP3TR	The trip ID number that controls the evaluation of the power-to-the-wall table defined by Card Set 34 (array QP3TB) (|IQP3TR| ≤ 9999) [input IQP3TR = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation].
15–28	IQP3SV	The independent-variable ID number of the power-to-the-wall table. IQP3SV > 0 defines the ID number for a signal-variable parameter; IQP3SV < 0 defines the ID number for a control-block output parameter.
29–42	NQP3TB	The number of power-to-the-wall table data pairs (defined by the absolute value of NQP3TB). NQP3TB > 0 defines the table independent-variable form to be the IQP3SV parameter; NQP3TB < 0 defines the table independent-variable form to be the sum of the change in the IQP3SV parameter over each timestep times the trip set-status value ISET during that timestep (when

Columns	Variable	Description
		the power-to-the-wall table is trip controlled); NQP3TB = 0 defines the power to the wall to be the IQP3SV parameter.
43–56	NQP3SV	The independent-variable ID number for the rate factor that is applied to the power-to-the-wall table independent variable. NQP3SV > 0 defines the ID number for a signal-variable parameter; NQP3SV < 0 defines the ID number for a control-block output parameter; NQP3SV = 0 (when NQP3RF ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQP3RF	The number of (x,y) rate-factor table data pairs (defined by the absolute value of NQP3RF). The rate factor is applied to the power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQP3SV and NQP3RF are both zero. NQP3RF > 0 defines the rate-factor table independent variable to be the NQP3SV parameter; NQP3RF < 0 defines it to be the sum of the change in the NQP3SV parameter over each timestep times the trip set-status value ISET during that time (when the power-to-the-wall table is trip controlled); NQP3RF = 0 defines the rate factor to be the NQP3SV parameter.

Card Number 6. (Format 5E14.4) RADIN, TH, HOUTL, HOUTV, TOUTL

Columns	Variable	Description
1–14	RADIN	Inner radius (m, ft) of the PIPE wall.
15–28	TH	Wall thickness (m, ft).
29–42	HOUTL	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2}°F^{-1} h^{-1}) between the outer boundary of the PIPE wall and the liquid outside the PIPE wall.
43–56	HOUTV	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the PIPE wall and the gas outside the PIPE wall.
57–70	TOUTL	Liquid temperature (K, °F) outside the PIPE wall.

Note: External Heat Loss. The four parameters, HOUTL, HOUTV, TOUTL, and TOUTV, (Card Number 7), allow flexibility in calculating possible heat losses from the outside of the PIPE wall. Typically, such heat losses are not important for fast transients or large-break loss-of-coolant accidents (LOCAs), and HOUTL and HOUTV can be set equal to zero. When heat losses are significant, they often can be approximated by a constant HTC temperature for the liquid and gas fluid phases outside the pipe wall.

Card Number 7. (Format 5E14.4) TOUTV, POWIN, POWOFF, RPOWMX, POWSCL

Columns	Variable	Description
1–14	TOUTV	Gas temperature (K, °F) outside the PIPE wall.
15–28	POWIN	Initial total power (W, Btu h^{-1}) deposited in (to) the fluid [not used if IPOW = 0 (Word 4 on Card Number 3)]. The power is distributed uniformly along the PIPE length.
29–42	POWOFF	Total power (W, Btu h^{-1}) to the fluid when the controlling trip is OFF after being ON (not used when IPOW = 0 or IPOWTR = 0). If POWOFF ≤ –10^{19} W (–3.41 × 10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
43–56	RPOWMX	The maximum rate of change of power to the fluid (W s-1, Btu h-1 s-1) [RPOWMX ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used if IPOW = 0(Word 4 on Card Number 3)].
57–70	POWSCL	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table defined by Card Set 32 (array POWTB) is multiplied by POWSCL to obtain the absolute power (W, Btu h^{-1}) deposited in the fluid [not used if IPOW = 0 (Word 4 on Card Number 3) or NPOWTB = 0 (Word 3 on Card Number 4)].

Card Number 8. (Format 4E14.4) QP3IN, QP3OFF, RQP3MX, QP3SCL

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 8.

Columns	Variable	Description
1–14	QP3IN	Initial power (W, Btu h^{-1}) deposited in (to) the wall and distributed according to the QPPP array. If QP3IN > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QP3IN < 0.0 W (0.0 Btu h^{-1}), the power to the wall in each cell is |QP3IN|, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELLS (Word 1 on Card Number 2) power values.

Columns	Variable	Description
		Each data pair of the power-to-the-wall table [for QP3IN < 0.0 W (0.0 Btu h^{-1})] has 1 + NCELLS values [an independent-variable value and NCELLS power values for cells 1 through NCELLS]. When the power-to-the-wall table is not being evaluated, the same power value of |QP3IN| or QP3OFF [if QP3OFF > −10^{19} W (−3.41 × 10^{19} Btu h^{-1})] is applied at each of the NCELLS cells.
15–28	QP3OFF	Power (W, Btu h^{-1}) to the wall when the controlling trip is OFF after being ON [not used when IQP3TR = 0; use the last table-evaluated power when the trip was ON if QP3OFF ≤ −10^{19} W (−3.41 × 10^{19} Btu h^{-1})].
29–42	RQP3MX	Maximum rate of change of the power to the wall (W s^{-1}, Btu h^{-1} s^{-1}) [RQP3MX ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QP3SCL	Scale factor (–) for the power-to-the-wall table. The dependent variable in the table, defined by Card Set 34 (array QP3TB), is multiplied by QP3SCL to obtain the absolute power (W, Btu h^{-1}) to the wall.

PIPE Array Cards. Twenty-five Card Sets, one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 9 to 11.

Variable	Dimension	Description
DX	NCELLS	Cell lengths (m, ft).
VOL	NCELLS	Cell volumes (m^3, ft^3).
FA	NCELLS+1	Cell-edge flow areas (m^2, ft^2).

Card Set 12.

Note: **Separator Models.** Setting FRIC > 10^{20} at a cell edge invokes the steam-separator model (only the gas phase is allowed to flow through the cell interface); setting FRIC < −10^{20} invokes the liquid-separator model (only the liquid is allowed to flow through the cell interface). If the reverse additive loss-coefficient option (NFRC1 = 2 in the NAMELIST data) is chosen, steam-separator and liquid-separator models may be used separately in each forward and reverse direction.

Variable	Dimension	Description
FRIC	NCELLS+1	Additive loss coefficients (–). See NAMELIST variables IKFAC and NFRC1 for optional K factors and reverse-direction additive loss coefficient input.

Card Sets 13 & 14.

Variable	Dimension	Description
GRAV or ELEV	NCELLS+1	Gravity or elevation terms (– or m, ft). GRAV is the ratio of the elevation difference to the DX flow length between the centers of cell i and cell i-1 for interface i. A positive GRAV value indicates increasing elevation with increasing cell number. See NAMELIST variable IELV for optional cell-centered elevation ELEV input.
HD	NCELLS+1	Hydraulic diameters (m, ft). See NAMELIST variable NDIA1 for additional input of heat-transfer diameters.

Card Set 15. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 15 (array ICFLG).

WARNING: Setting ICFLG > 0 at adjacent, closely spaced cell-edges can lead to numerical difficulties.

Variable	Dimension	Description
ICFLG	NCELLS+1	Cell-edge choked-flow model option. 0 = no choked-flow model calculation; 1 = choked-flow model calculation using default multipliers; 2 to 5 = choked-flow model calculation using NAMELIST variable defined multipliers. **Note:** All nonzero values of ICFLG must be the same for the interfaces of a hydraulic component.

Card Set 16.

Variable	Dimension	Description
NFF	NCELLS+1	Friction-factor correlation option. 0 = constant friction factor based on FRIC input; 1 = homogeneous-flow friction factor plus FRIC; –1 = homogeneous-flow friction factor plus FRIC plus an abrupt flow-area change form loss evaluated internally by TRAC-M (see the TRAC-M/F90 Theory Manual Section 7.1.); –100 = FRIC plus an abrupt flow-area change form loss evaluated internally by TRAC-M.

Card Set 17. If NCCFL = 0 (Word 5 on Main-Data Card 6), do not input Card Set 17 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELLS+1	Countercurrent flow limitation option. 0 = no countercurrent flow limitation calculation at the cell interface; N = the countercurrent flow limitation parameter set number used to evaluate countercurrent flow limitation at the cell interface [1≤ N ≤ NCCFL (Word 5 on Main-Data Card 6)].

Card Sets 18 to 24.

Variable	Dimension	Description
ALP	NCELLS	Initial gas volume fractions (–).
VL	NCELLS+1	Initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELLS+1	Initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELLS	Initial liquid temperatures (K, °F).
TV	NCELLS	Initial gas temperatures (K, °F).
P	NCELLS	Initial pressures (Pa, psia).
PA	NCELLS	Initial noncondensable-gas partial pressures (Pa, psia).

Card Set 25. If NAMELIST variable MWFL = 0, do not input Card Set 25 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELLS+1	Wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 26. If NAMELIST variable MWFV = 0, do not input Card Set 26 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELLS+1	Wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 27 to 29. PIPE-Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 27 to 29 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELLS	A relative power profile (–) in the PIPE wall. Input values for cell 1, node 1 through NODES; then for cell 2, node 1 through NODES, etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power profile to have a volume-averaged value of unity (each QPPPP(I) is normalized to have the value QPPP(I) × [VOL(K)] / [QPPP(K) × VOL(K)]. Filling the array with zeros results in no power being deposited in the PIPE wall regardless of the values of QP3IN, QP3TB, etc.
MATID	NODES–1	Wall-material ID array which specifies material ID between radial nodes. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (See available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input.). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the PIPE component.
TW	NODES × NCELLS	Initial wall temperatures (K, °F) (input in the same order as QPPP).

Card Set 30. If ICONC = 0 (Word 2 on Card Number 3), do not input Card Set 30 (array CONC).

Variable	Dimension	Description
CONC	NCELLS	Initial ratio of solute mass to liquid-coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m$$^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 31. If ICONC = 0 or 1 (Word 2 on Card Number 3), do not input Card Set 31 (array S).

Variable	Dimension	Description
S	NCELLS	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 32. If NPOWTB = 0 (Word 3 on Card Number 4), do not input Card Set 32 (array POWTB).

Variable	Dimension	Description
POWTB	2×|NPOWTB|	Power-to-the-fluid vs independent-variable-form table [(*,W) (*, Btu h⁻¹). Input |NPOWTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IPOWSV (Word 2 on Card Number 4), power to the fluid]. The power is deposited directly in to the fluid in the PIPE with a uniform power density along the PIPE length.

Card Set 33. If NPOWTB = 0 or NPOWRF = 0 (Words 3 and 5 on Card Number 4), do not input Card Set 33 (array POWRF).

Variable	Dimension	Description
POWRF	2×|NPOWRF|	Rate-factor table (*,–) for the power-to-the-fluid table independent variable. Input |NPOWRF| (Word 5 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NPOWSV (Word 4 on Card Number 4), rate factor to be applied to the power-to-the-fluid table independent variable].

Card Set 34. If NQP3TB = 0 (Word 3 on Card Number 5), do not input Card Set 34 (array QP3TB).

Variable	Dimension	Description
QP3TB	2 × |NQP3TB| when QP3IN > 0.0; (1+NCELLS) × |NQP3TB| when QP3IN < 0.0.	Power-to-the-wall vs independent-variable-form table [(*,W), (*,Btu h⁻¹)]. Input |NQP3TB| (Word 3 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by IQP3SV (Word 2 on Card Number 5), power to the wall]. If QP3IN > 0.0 W (0.0 Btu h⁻¹), the dependent variable specifies the total power to the entire wall; if QP3IN < 0.0 W (0.0 Btu h⁻¹), the dependent variable is a power distribution that specifies the power to the wall at each cell from cell 1 to cell NCELLS.

Card Set 35. If NQP3TB or NQP3RF = 0 (Words 3 and 5 on Card Number 5), do not input Card Set 35 (array QP3RF).

Variable	Dimension	Description
QP3RF	$2 \times |NQP3RF|$	Rate-factor table (*,–) for the power-to-the-wall table independent variable. Input $|NQP3RF|$ (Word 5 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by NQP3SV (Word 4 on Card Number 5), rate factor to be applied to the power-to-the-wall table independent variable].

6.3.7.4. PLENUM component.

Note: No heat-transfer coupling of a HTSTR ROD and SLAB component to the hydraulic cell of a PLENUM component is allowed. FILL, BREAK, and VESSEL components cannot be connected to a PLENUM component junction.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–6	TYPE	Component type (PLENUM left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq NUM \leq 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14) NPLJN, ICONC, JUNS1, JUNS2

Columns	Variable	Description
1–14	NPLJN	Number of junction interfaces on the boundary of the single-cell PLENUM component (NPLJN $\geq$ 1).
15–28	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
29–42	JUNS1	The number of junctions on side 1 of the PLENUM cell that convect momentum across the cell [side 1 junctions are the first to the JUNS1th junction numbers; input 0 if no momentum is to be convected across the PLENUM cell].

Columns	Variable	Description
43–56	JUNS2	The number of junctions on side 2 of the PLENUM cell that convect momentum across the cell [side 2 junctions are on the opposite side of the PLENUM cell from side 1 and the side 2 junctions are the (JUNS1 + 1)th to the (JUNS1 + JUNS2)th junction numbers; input 0 if no momentum is to be convected across the PLENUM cell and JUNS1 = 0].

PLENUM Array Cards. Eleven Card Sets; one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 3 to 11.

Variable	Dimension	Description
JUNJ	NPLJN	PLENUM junction numbers (–).
DX	NPLJN	Effective PLENUM cell length for each junction connected to the PLENUM cell (m, ft).
VOL	1	Cell volume (m^3, ft^3).
ELEV	1	Cell-centered elevation (m, ft). Used only when NAME-LIST variable IELV = 1. However, this Card Set must always be input.
ALP	1	Initial gas volume fraction (–).
TL	1	Initial liquid temperature (K, °F).
TV	1	Initial gas temperature (K, °F).
P	1	Initial pressure (Pa, psia).
PA	1	Initial noncondensable-gas partial pressure (Pa, psia).

Card Set 12. If ICONC = 0 (Word 2 on Card Number 2), do not input Card Set 12 (array BOR).

Variable	Dimension	Description
BOR	1	Initial ratio of solute mass to liquid-coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 13. If ICONC = 0 or 1 (Word 2 on Card Number 2), do not input Card Set 13 (array SOLID).

Variable	Dimension	Description
SOLID	1	Initial macroscopic density of plated-out solute $(kg \cdot m^{-3}, lb_m \, ft^{-3})$. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

6.3.7.5. PRIZER component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–6	TYPE	Component type (PRIZER left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq NUM \leq 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14) NCELLS, NODES, JUN1, JUN2

Columns	Variable	Description
1–14	NCELLS	Number of fluid cells in the PRIZER component.
15–28	NODES	Number of radial heat-transfer nodes in the PRIZER wall. A value of zero specifies no wall heat transfer.
29–42	JUN1	Junction number for the junction adjacent to cell 1.
43–56	JUN2	Junction number for the junction adjacent to cell NCELLS (Word 1 on Card Number 2).

Card Number 3. (Format 2I14,E14.4) ICHF, ICONC, QP3IN

Columns	Variable	Description
1–14	ICHF	CHF-calculation option. 0 = no; 1 = yes.
15–28	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.

Columns	Variable	Description
29–42	QP3IN	Initial power (W, Btu h⁻¹) deposited in (to) the wall and distributed according to the QPPP array. If QP3IN > 0.0 W (0.0 Btu h⁻¹), it is the total power to the entire wall. When QP3IN < 0.0 W (0.0 Btu h⁻¹) the initial power to the wall in each cell is |QP3IN|, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELLS (Word 1 on Card Number 2) power values. Each data pair of the power-to-the-wall table [for QP3IN < 0.0 W (0.0 Btu h⁻¹)] has 1 + NCELLS values (an independent-variable value and NCELLS power values for cells 1 through NCELLS). When the power-to-the-wall table is not being evaluated, the same power value of |QP3IN| or QP3OFF [if QP3OFF > –10¹⁹ W (–3.41 × 10¹⁹ Btu h⁻¹)] is applied at each of the NCELLS cells.

Card Number 4. (Format 5E14.4) RADIN, TH, HOUTL, HOUTV, TOUTL

Columns	Variable	Description
1–14	RADIN	Inner radius (m, ft) of the PRIZER wall.
15–28	TH	Wall thickness (m, ft).
29–42	HOUTL	HTC (W m⁻² K⁻¹, Btu ft⁻² °F⁻¹ h⁻¹) between the outer boundary of the PRIZER wall and the liquid outside the PRIZER wall.
43–56	HOUTV	HTC (W m⁻² K⁻¹, Btu ft⁻² °F⁻¹ h⁻¹) between the outer boundary of the PRIZER wall and gas outside the PRIZER wall.
57–70	TOUTL	Liquid temperature (K, °F) outside the PRIZER wall.

Note: See PIPE input description, Section 6.3.7.3., for further comments on the HOUTL, HOUTV, TOUTL, and TOUTV (Card Number 5) heat-transfer parameters.

Card Number 5. (Format 5E14.4) TOUTV, QHEAT, PSET, DPMAX, ZHTR

Columns	Variable	Description
1–14	TOUTV	Gas temperature (K, °F) outside the PRIZER wall.
15–28	QHEAT	Total heater power (W, Btu h⁻¹).
29–42	PSET	Pressure setpoint (Pa, psia) for heater/sprayer control.
43–56	DPMAX	Pressure differential (Pa, psid) at which heater/sprayer has maximum power.
57–70	ZHTR	Water level (m, ft) for heater cutoff.

PRIZER Array Cards. Twenty-one Card Sets, one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 6 to 11.

Variable	Dimension	Description
DX	NCELLS	Cell lengths (m, ft).
VOL	NCELLS	Cell volumes (m^3, ft^3).
FA	NCELLS+1	Cell-edge flow areas (m^2, ft^2).
FRIC	NCELLS+1	Additive loss coefficients (–) (see PIPE input description, Section 6.3.7.3.).
GRAV or ELEV	NCELLS+1	Gravity or elevation terms (– or m, ft) (see PIPE input description, Section 6.3.7.3.).
HD	NCELLS+1	Hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 12. If NAMELIST variable ICFLOW = 0 or ICFLOW = 1, do not input Card Set 12 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 13.

Variable	Dimension	Description
NFF	NCELLS+1	Friction-factor correlation option (see PIPE input description, Section 6.3.7.3.).

Card Set 14. If NCCFL = 0 (Word 5 Main-Data Card 6), do not input Card Set 14 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELLS+1	Countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 15 to 21.

Variable	Dimension	Description
ALP	NCELLS	Initial gas volume fractions (–).
VL	NCELLS+1	Initial liquid velocities (m s⁻¹, ft s⁻¹).
VV	NCELLS+1	Initial gas velocities (m s⁻¹, ft s⁻¹).
TL	NCELLS	Initial liquid temperatures (K, °F).
TV	NCELLS	Initial gas temperatures (K, °F).
P	NCELLS	Initial pressures (Pa, psia).
PA	NCELLS	Initial noncondensable-gas partial pressures (Pa, psia).

Card Set 22. If NAMELIST variable MWFL = 0, do not input Card Set 22 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELLS+1	Wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 23. If NAMELIST variable MWFV = 0, do not input Card Set 23 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELLS+1	Wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 24 to 26. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 24 to 26 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELLS	A relative power profile (–) in the PRIZER wall. Input values for cell 1, node 1 through NODES; then for cell 2, node 1 through NODES, etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power profile to have a volume-average value of unity (each QPPP(I) is normalized to have the value QPPP(I) x [VOL(K)] / [QPPP(K) x VOL(K)]). Filling the array with zeros results in no power being deposited in the PRIZER wall regardless of the values of QP3IN, QP3TB, etc.

Variable	Dimension	Description
MATID	NODES–1	Wall-material ID array that specifies material ID between radial nodes. Dimension is 1 if NODES = 1 and 0 if NODES = 0. (See available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user specified material properties that are input.). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the PRIZER component.
TW	NODES × NCELLS	Initial wall temperatures (K, °F) (input in the same order as QPPP).

Card Set 27. If ICONC = 0 (Word 2 on Card Number 3), do not input Card Set 27 (array CONC).

Variable	Dimension	Description
CONC	NCELLS	Initial ratio of solute mass to liquid-coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m$$^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 28. If ICONC = 0 or 1 (Word 2 on Card Number 3), do not input Card Set 28 (array S).

Variable	Dimension	Description
S	NCELLS	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

6.3.7.6. PUMP component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–4	TYPE	Component type (PUMP left justified).
15–28	NUM	Component ID number (must be unique for each component, 1 ≤ NUM ≤ 999).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14, E14.4) NCELLS, NODES, JUN1, JUN2, EPSW

Columns	Variable	Description
1–14	NCELLS	Number of fluid cells in the PUMP component (NCELLS $\geq$ 2).
15–28	NODES	Number of radial heat-transfer nodes in the PUMP wall. A value of zero specifies no wall heat transfer.
29–42	JUN1	Junction number for the junction adjacent to cell 1.
43–56	JUN2	Junction number for the junction adjacent to cell NCELLS (Word 1 on Card Number 2).
57–70	EPSW	Wall surface roughness (m, ft).

Card Number 3. (Format 5I14) ICHF, ICONC, IPMPTY, IRP, IPM

Columns	Variable	Description
1–14	ICHF	CHF-calculation option. 0 = no; 1 = yes.
15–28	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
29–42	IPMPTY	Pump-type option. 0 = pump-impeller interface fluid velocity is specified by Card Set 61 (array PMPTB) when trip IPMPTR is ON and by signal variable or control block NPMPSD (word 5 on Card Number 13) when trip IPMPTR is OFF. 1 = pump-impeller rotational speed is specified by Card Set 61 (array PMPTB) when trip IPMPTR is ON and by OMEGAN (word 1 on Card Number 13) or signal variable or control block NPMPSD (word 5 on Card Number 13)] when trip IPMPTR is OFF. 2 = pump-impeller rotational speed is calculated from Equation (IV-222) when trip IPMPTR (Word 1 on Card Number 4) is set ON and defined by OMEGAN or NPMPSD when trip IPMPTR is OFF.

Columns	Variable	Description
43–56	IRP	Reverse-rotation option (only used for IPMPTY = 2). 0 = no; 1 = yes.
57–70	IPM	Degradation option. 0 = use single-phase homologous curves; 1 = use combined single-phase and fully degraded two-phase homologous curves.

Card Number 4. (Format 5I14) IPMPTR, IPMPSV, NPMPTB, NPMPSV, NPMPRF

Columns	Variable	Description
1–14	IPMPTR	The trip ID number that controls the evaluation of the pump-impeller rotational speed (IPMPTR=0 implies a constant pump speed) ($|$IPMPTR$| \leq 9999$). If the trip set status is OFF initially, the pump-impeller rotational speed is defined by a signal variable or control block with ID number NPMPSD (Word 5 on Card Number 13) or by a constant pump-impeller rotational speed OMEGAN (Word 1 on Card Number 13) when NPMPSD = 0.
15–28	IPMPSV	The pump-speed table abscissa-coordinate variable ID number. IPMPSV defines the independent-variable parameter in the IPMPTY = 1 pump-speed table. IPMPSV > 0 defines the ID number for a signal-variable parameter; IPMPSV < 0 defines the ID number for a control-block output parameter [if IPMPTY = 2 (Word 2 on Card Number 3), input IPMPSV = 0].
29–42	NPMPTB	The number of pump-speed table data pairs (defined by the absolute value of NPMPTB). NPMPTB > 0 defines the table independent-variable form to be the IPMPSV parameter; NPMPTB < 0 defines the table independent-variable form to be the sum of the change in the IPMPSV parameter over each timestep times the trip set-status value ISET during that timestep (when the pump-speed table is trip controlled); NPMPTB=0 defines the pump-impeller rotational speed to be the IPMPSV parameter [if IPMPTY = 2 (Word 3 on Card Number 3), input NPMPTB = 0].

Columns	Variable	Description
43–56	NPMPSV	The rate-factor table abscissa-coordinate variable ID number. NPMPSV defines the independent-variable parameter for the rate factor that is applied to the pump-speed table independ-ent variable. NPMPSV > 0 defines the ID number for a signal-variable parameter; NPMPSV < 0 defines the ID number for a control-block output parameter; NPMPSV = 0 (when NPMPRF ≠ 0) defines the difference between the trip signal and the setpoint value that turns the trip OFF [if IPMPTY = 2 (Word 3 on Card Number 3), input NPMPSV = 0].
57–70	NPMPRF	The number of rate-factor table data pairs (defined by the absolute value of NPMPRF). The rate factor is applied to the pump-speed table independent variable when the rate factor is defined. No rate factor is defined when NPMPSV and NPMPRF are both zero. NPMPRF > 0 defines the rate-factor table's abscissa coordinate to be the NPMPSV parameter; NPMPRF < 0 defines it to be the sum of the change in the NPMPSV parameter over each timestep times the trip set-status value ISET during that timestep (when the pump-speed table is trip controlled); NPMPRF = 0 defines the rate factor to be the NPMPSV parameter [if IPMPTY = 2 (Word 3 on Card Number 3), input NPMPRF = 0].

Card Number 5. (Format 5I14) IQP3TR, IQP3SV, NQP3TB, NQP3SV, NQP3RF

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 5.

Columns	Variable	Description
1–14	IQP3TR	The trip ID number that controls the evaluation of the power-to-the-wall table defined by Card Set 63 (array QP3TB) (|IQP3TR| ≤ 9999) (input IQP3TR = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IQP3SV	The independent-variable ID number for the power-to-the-wall table. IQP3SV > 0 defines the ID number for a signal-variable parameter; IQP3SV < 0 defines the ID number for a control-block output parameter.

Columns	Variable	Description
29–42	NQP3TB	The number of power-to-the-wall table data pairs (defined by the absolute value of NQP3TB). NQP3TB > 0 defines the table independent-variable form to be the IQP3SV parameter; NQP3TB < 0 defines the table independent-variable form to be the sum of the change in the IQP3SV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-wall table is trip controlled); NQP3TB = 0 defines the power to the wall to be the IQP3SV parameter.
43–56	NQP3SV	The independent-variable ID number for the rate factor that is applied to the power-to-the-wall table independent variable. NQP3SV > 0 defines the ID number for a signal-variable parameter; NQP3SV < 0 defines the ID number for a control-block output parameter; NQP3SV = 0 (when NQP3RF ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQP3RF	The number of rate-factor table data pairs (defined by the absolute value of NQP3RF). The rate factor is applied to the power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQP3SV and NQP3RF are both zero. NQP3RF > 0 defines the rate-factor table independent variable to be the NQP3SV parameter; NQP3RF < 0 defines it to be the sum of the change in the NQP3SV parameter over the last timestep times the trip set-status value ISET during that timestep (when the power-to-the-wall table is trip controlled); NQP3RF = 0 defines the rate factor to be the NQP3SV parameter.

Card Number 6. (Format 5E14.4) RADIN, TH, HOUTL, HOUTV, TOUTL

Columns	Variable	Description
1–14	RADIN	Inner radius (m, ft) of the PUMP wall.
15–28	TH	Wall thickness (m, ft).
29–42	HOUTL	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the PUMP wall and liquid outside the PUMP wall.

Columns	Variable	Description
43–56	HOUTV	HTC (W m^{-2} K^{-1}, ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the PUMP wall and the gas outside the PUMP wall.
57–70	TOUTL	Liquid temperature (K, °F) outside the PUMP wall.

Note: See PIPE input description (Section 6.3.7.3.) for further comments on the HOUTL, HOUTV, TOUTL, and TOUTV (Card Number 7) heat-transfer parameters.

Card Number 7. (Format 2E14.4) TOUTV, EFFM

Columns	Variable	Description
1–14	TOUTV	Gas temperature (K, °F) outside the PUMP wall.
15–28	EFFMI	Effective moment of inertia (kg m^2, lb$_m$ ft^2). Input a negative value if an alternate effective moment of inertia EFFMI1 (Word 1 on Card Number 10) is to be used for pump-impeller rotational speeds below OMTEST (Word 5 on Card Number 10).

Card Number 8. (Format 5E14.4) TFR0, TFR1, TFR2, TFR3, TFRB

Columns	Variable	Description
1–14	TFR0	Zero-order coefficient in the PUMP frictional torque correlation [Pa m^3 (N m), lb$_f$ ft].
15–28	TFR1	First-order coefficient in the PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).
29–42	TFR2	Second-order coefficient in the PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).
43–56	TFR3	Third-order coefficient in the PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).
57–70	TFRB	Low-speed frictional torque break speed (PUMP speed below which TRAC-M switches to low-speed frictional torque correlation defined on the next card) (rad s^{-1}, rpm).

Card Number 9. (Format 4E14.4) TFRL0, TFRL1, TFRL2, TFRL3

Columns	Variable	Description
1–14	TFRL0	Zero-order coefficient in the low-speed PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).

Columns	Variable	Description
15–28	TFRL1	First-order coefficient in the low-speed PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).
29–42	TFRL2	Second-order coefficient in the low-speed PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).
43–56	TFRL3	Third-order coefficient in the low-speed PUMP frictional torque correlation (Pa m^3, lb$_f$ ft).

Card Number 10. (Format 5E14.4) EFFMI1, AEFFMI, BEFFMI, CEFFMI, OMTEST

Note: Input Card Number 10 if variable EFFMI (Word 2 on Card Number 7) is negative.

Columns	Variable	Description
1–14	EFFMI1	The alternate effective moment of inertia that is used after the pump-impeller rotational speed falls below OMTEST (kg m^2, lb$_m$ ft^2).
15–28	AEFFMI	The coefficient for the (OMEGA/ROMEGA)^2 term in the calculation of the variable moment of inertia (kg m^2, lb$_m$ ft^2).
29–42	BEFFMI	The coefficient for the (OMEGA/ROMEGA) term in the calculation of the variable moment of inertia (kg m^2, lb$_m$ ft^2).
43–56	CEFFMI	The constant term in the calculation of the variable moment of inertia (kg m^2, lb$_m$ ft^2).
57–70	OMTEST	The pump-impeller rotational speed below which EFFMI1 (the alternate effective moment of inertia) is used (rad s^{-1}, rpm).

Card Number 11. (Format I14) IPMPS

Note: Input Card Number 11 if variable EFFMI (Word 2 on Card Number 7) is negative.

Columns	Variable	Description
1–14	IPMPS	Variable flag to indicates whether or not the pump-impeller rotational speed previously has dropped below OMTEST (Word 5 on Card Number 10). 0 = the pump-impeller rotational speed has been greater than OMTEST; 1 = the pump-impeller rotational speed at some time has dropped below OMTEST.

Card Number 12. (Format 5E14.4) RHEAD, RTORK, RFLOW, RRHO, ROMEGA

Columns	Variable	Description
1–14	RHEAD	Rated head {(Pa m^3, kg^{-1}, m^2 s^{-2}, or N m kg^{-1}), lb$_f$ ft lb$_m^{-1}$}. Head is defined as $\Delta P\,\rho^{-1}$.
15–28	RTORK	Rated torque (Pa m^3, lb$_f$ ft).
29–42	RFLOW	Rated volumetric flow (m^3 s^{-1}, gpm).
43–56	RRHO	Rated density (kg m^{-3}, lb$_m$ ft^{-3}).
57–70	ROMEGA	Rated pump-impeller rotational speed (rad s^{-1}, rpm).

Card Number 13. (Format 4E14.4,I14) OMEGAN, OMGOFF, ROMGMX, OMGSCL, NPMPSD

Columns	Variable	Description
1–14	OMEGAN	Initial pump-impeller rotational speed (rad s^{-1}, rpm) when NPMPSD = 0 (Word 5 on Card Number 13).
15–28	OMGOFF	Pump-impeller rotational speed (rad s^{-1}, rpm) when the controlling trip is OFF after being ON [maintain the last pump-impeller rotational speed evaluated when the trip was ON if OMGOFF $\leq -10^{19}$ rad s^{-1} (-9.55×10^{19} rpm)] [used only when IPMPTR $\neq 0$ (Word 1 on Card Number 4)].
29–42	ROMGMX	The maximum rate of change of the pump-impeller rotational speed (rad s^{-2}, rpm s^{-1}).
43–56	OMGSCL	Scale factor for the pump-impeller rotational-speed table (–). The dependent variable in the table, defined by Card Set 61 (array PMPTB), is multiplied by OMGSCL to obtain the absolute pump-impeller rotational speed (rad s^{-1}, rpm).
57–70	NPMPSD	The ID number of the signal-variable parameter or control-block parameter that defines the pump-impeller rotational speed initially when the controlling trip is OFF [input NPMPSD = 0 if the initial pump-impeller rotational speed is to be defined by OMEGAN (Word 1 on Card Number 13)].

Card Number 14. (Format 4E14.4) QP3IN, QP3OFF, RQP3MX, QP3SCL

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 14.

Columns	Variable	Description
1–14	QP3IN	Initial power (W, Btu h^{-1}) deposited in (to) the wall and distributed according to the QPPP array. If QP3IN > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QP3IN < 0.0 W (0.0 Btu h^{-1}), the initial power to the wall in each cell is $|$QP3IN$|$ and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELLS (Word 1 on Card Number 2) power values. Each data pair of the power-to-the-wall table [for QP3IN < 0.0 W (0.0 Btu h^{-1})] has 1+NCELLS values [an independent-variable value and NCELLS power values for cells 1 through NCELLS]. When the power-to-the-wall table is not being evaluated, the same power value of $|$QP3IN$|$ or QP3OFF [if QP3OFF > -10^{19} W (-3.41×10^{19} Btu h^{-1})] is applied at each of the NCELLS cells.
15–28	QP3OFF	Power (W, Btu h^{-1}) to the wall when the controlling trip is OFF after being ON [not used when IQP3TR = 0; use the last table-evaluated power when the trip was ON if QP3OFF ≤ -10^{19} W (-3.41×10^{19} Btu h^{-1})].
29–42	RQP3MX	The maximum rate of change of the power to the wall (W s^{-1}, Btu h^{-1} s^{-1}) [RQP3MX ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QP3SCL	Scale factor (–) for the power-to-the-wall table. The dependent variable in the table, defined by Card Set 63 (array QP3TB), is multiplied by QP3SCL to obtain the absolute power (W, Btu h^{-1}) to the wall.

Card Number 15. (Format I14) OPTION

Columns	Variable	Description
1–14	OPTION	Pump-curve option. 0 = user-specified pump curves input defined by Card Sets 16 to 37; 1 = use built-in semiscale pump curves; 2 = use built-in LOFT pump curves.

Card Sets 16 to 19 and the Pump Curve Cards are input only if OPTION = 0. If OPTION = 1 or 2, go to the PUMP Array Cards that start with Card Set 38. The user is referred to the pump model description in Section Section for definitions of the terms used below. Each homologous curve is defined by four curve segments. Each curve segment is denoted by the number appended to the curve name. The segments are defined by Table Section in Section 4.6.

Under certain conditions for OPTION = 0, some curves will not be used. However, to avoid confusion, we recommend that all curves be defined. NDATA(i) must be greater than zero for at least i = 1, 4.

For IPMPTY = 1 and IPM = 0, curves HSP1 through HSP4 are required and the remaining curves are not used.

For IPMPTY = 1 and IPM = 1, curves HSP1 through HSP4, HTP1 through HTP4, and HDM are required, and the remaining curves are not used.

For IPMPTY = 2 and IPM = 0, curves HSP1 through HSP4 and TSP1 through TSP4 are required, and the remaining curves are not used.

For IPMPTY = 2 and IPM = 1, all curves are required.

Card Sets 16 to 19. (Format 5I14) [NDATA(I), I = 1, 16], NHDM, NTD

Card Set 16.

Columns	Variable	Description
1–14	NDATA(1)	Number of data pairs defining the HSP1 curve.
15–28	NDATA(2)	Number of data pairs defining the HSP2 curve.
29–42	NDATA(3)	Number of data pairs defining the HSP3 curve.
43–56	NDATA(4)	Number of data pairs defining the HSP4 curve.
57–70	NDATA(5)	Number of data pairs defining the HTP1 curve.

Card Set 17.

Columns	Variable	Description
1–14	NDATA(6)	Number of data pairs defining the HTP2 curve.
15–28	NDATA(7)	Number of data pairs defining the HTP3 curve.
29–42	NDATA(8)	Number of data pairs defining the HTP4 curve.
43–56	NDATA(9)	Number of data pairs defining the TSP1 curve.
57–70	NDATA(10)	Number of data pairs defining the TSP2 curve.

Card Set 18.

Columns	Variable	Description
1–14	NDATA(11)	Number of data pairs defining the TSP3 curve.
15–28	NDATA(12)	Number of data pairs defining the TSP4 curve.
29–42	NDATA(13)	Number of data pairs defining the TTP1 curve.
43–56	NDATA(14)	Number of data pairs defining the TTP2 curve.
57–70	NDATA(15)	Number of data pairs defining the TTP3 curve.

Card Set 19.

Columns	Variable	Description
1–14	NDATA(16)	Number of data pairs defining the TTP4 curve.
15–28	NHDM	Number of data pairs defining the HDM curve.
29–42	NTDM	Number of data pairs defining the TDM curve.

PUMP Curve Cards. Input up to 18 Card Sets, one set for each curve listed in Card Sets 16 to 19 that has a positive number of data pairs. Use LOAD format. Data are entered in pairs $(x,y)_i$, $i = (1, \text{NDATA})$, where x is the independent variable and y is the dependent variable. The x_i values must increase monotonically from –1.0 to 1.0 for the homologous curves and from 0.0 to 1.0 for the multiplier curves. If information for a particular curve does not exist or if you desire to input a curve that will not be used, we suggest that the four points (–1.0, 0.0, 1.0, 0.0) be input. The suggested two data pairs for HDM and TDM are (0.0, 0.0, 1.0, 0.0).

Card Sets 20 to 37.

Variable	Dimension		Description
HSP1	2×NDATA(1)	HSP1 curve	Single-phase homologous head
HSP2	2×NDATA(2)	HSP2 curve	curves.
HSP3	2×NDATA(3)	HSP3 curve	
HSP4	2×NDATA(4)	HSP4 curve	
HTP1	2×NDATA(5)	HTP1 curve	Fully-degraded homologous head
HTP2	2×NDATA(6)	HTP2 curve	curves.

Variable	Dimension		Description
HTP3	2×NDATA(7)	HTP3 curve	
HTP4	2×NDATA(8)	HTP4 curve	
TSP1	2×NDATA(9)	TSP1 curve	Single-phase homologous torque curves.
TSP2	2×NDATA(10)	TSP2 curve	
TSP3	2×NDATA(11)	TSP3 curve	
TSP4	2×NDATA(12)	TSP4 curve	
TTP1	2×NDATA(13)	TTP1 curve	Fully-degraded homologous torque curves.
TTP2	2×NDATA(14)	TTP2 curve	
TTP3	2×NDATA(15)	TTP3 curve	
TTP4	2×NDATA(16)	TTP4 curve	
HDM	2×NHDM	Head-degradation multiplier curve.	
TDM	2×NTDM	Torque-degradation multiplier curve.	

PUMP Array Cards. Twenty-six Card Sets, one set for each of the following array. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 38 to 43.

Variable	Dimension	Description
DX	NCELLS	Cell lengths (m, ft).
VOL	NCELLS	Cell volumes (m^3, ft^3).
FA	NCELLS+1	Cell-edge flow areas (m^2, ft^2).
FRIC	NCELLS+1	Additive loss coefficients (–) [FRIC(2) must be 0.0] (see PIPE input description, Section 6.3.7.3.).
GRAV	NCELLS+1	Gravity terms (– or m, ft) (see PIPE input description, Section 6.3.7.3.).
HD	NCELLS+1	Hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 44. If NAMELIST variable ICFLOW = 0 or ICFLOW = 1, do not input Card Set 44 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 45.

Variable	Dimension	Description
NFF	NCELLS+1	Friction-factor correlation option (see PIPE input description, Section 6.3.7.3.).

Card Set 46. If NCCFL = 0 (Word 5 Main-Data Card 6) do not input Card Set 46 (array LCCFL)

Variable	Dimension	Description
LCCFL	NCELLS+1	Countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 47 to 53. If NCCFL = 0 (Word 5 Main-Data Card 6) do not input Card Set 47 (array LCCFL)

Variable	Dimension	Description
ALP	NCELLS	Initial gas volume fractions (–).
VL	NCELLS+1	Initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELLS+1	Initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELLS	Initial liquid temperatures (K, °F).
TV	NCELLS	Initial gas temperatures (K, °F).
P	NCELLS	Initial pressures (Pa, psia).
PA	NCELLS	Initial noncondensable-gas partial pressures (Pa, psia).

Card Set 54. If NAMELIST variable MWFL = 0, do not input Card Set 54 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELLS+1	Wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 55. If NAMELIST variable MWFV = 0, do not input Card Set 55 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELLS+1	Wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 56 to 58. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 56 to 58 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELL	A relative power profile (–) in the PUMP wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES; etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power profile to have a volume-averaged value of unity {each QPPP(I) is normalized to have the value QPPP(I) × $[\Sigma_K$ VOL(K)]/ $[\Sigma_K$ QPPP(K) × VOL(K)]}. Filling the array with zeros results in no power being deposited in the wall regardless of the values of QP3IN, QP3TB, etc.
MATID	NODES-1	Wall-material ID array, which specifies material ID between radial nodes. Dimension is 1 if NODES = 1 and 0 if NODES = 0. (See available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input.). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the PUMP component.
TW	NODES × NCELL	Initial wall temperatures (K, °F) (input in the same order as QPPP).

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Card Set 59. If ICONC = 0 (Word 2 on Card Number 3), do not input Card Set 59 (array CONC).

Variable	Dimension	Description
CONC	NCELLS	Initial ratio of solute mass to liquid coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 60. If ICONC = 0 or 1 (Word 2 on Card Number 3), do not input Card Set 60 (array S).

Variable	Dimension	Description
S	NCELLS	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 61. If NPMPTB = 0 (Word 3 on Card Number 4), do not input Card Set 61 (array PMPTB).

Variable	Dimension	Description
PMPTB	2×|NPMPTB|	Pump-impeller rotational speed vs independent-variable-form table [(*, rad s^{-1}), (*, rpm)]. Input |NPMPTB| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IPMPSV (Word 2 on Card Number 4), pump-impeller rotational speed].

Card Set 62. If NPMPTB = 0 (Word 3 on Card Number 4) or NPMPRF = 0 (Word 5 on Card Number 4), do not input Card Set 62 (array PMPRF).

Variable	Dimension	Description
PMPRF	2×|NPMPRF|	Rate-factor table (*,–) for the pump-impeller rotational-speed table's independent variable. Input |NPMPRF| (Word 5 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NPMPSV (Word 4 on Card Number 4), rate factor to be applied to the pump-impeller rotational-speed table independent variable].

Card Set 63. If NQP3TB = 0 (Word 3 on Card Number 5), do not input Card Set 63 (array QP3TB).

Variable	Dimension	Description
QP3TB	2×|NQP3TB| when QP3IN > 0.0; (1+NCELLS) × |NQP3TB| when QP3IN < 0.0.	Power-to-the-wall vs independent-variable-form table [(*, W), (*, Btu h^{-1})]. Input |NQP3TB| (Word 3 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by IQP3SV (Word 2 on Card Number 5), power to the wall]. If QP3IN > 0.0 W (0.0 Btu h^{-1}), the dependent variable specifies the total power to the entire wall; if QP3IN < 0.0 W (0.0 Btu h^{-1}), the dependent variable is a power shape that specifies the power to the wall at each cell from cell 1 to cell NCELLS.

Card Set 64. If NQP3TB = 0 (Word 3 on Card Number 5) or NQP3RF = 0 (Word 5 on Card Number 5), do not input Card Set 64 (array QF3RF).

Variable	Dimension	Description
QF3RF	2×|NQP3RF|	Rate-factor table (*,–) for the power-to-the-wall table independent variable. Input |NQP3RF| (Word 5 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by NQP3SV (Word 4 on Card Number 5), rate factor].

6.3.7.7. SEPD component.

Note: The current SEPD (separator) component is no longer supported, and it will be replaced with a new model in future TRAC-M/F90 development. Use of the current SEPD in either TRAC-M/F77 or F90 is not recommended.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–4	TYPE	Component type (SEPD left justified).
15–28	NUM	Component ID number (must be unique for each component, 1 ≤ NUM ≤ 999).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 3I14,2E14.4) JCELL, NODES, ICHF, COST, EPSW

Columns	Variable	Description
1–14	JCELL	Main-tube cell number, which has the side tube connected to it.
15–28	NODES	Number of radial heat-transfer nodes in the wall. A value of zero specifies no wall heat transfer.
29–42	ICHF	CHF calculation option. 0 = no; 1 = yes.
43–56	COST	Cosine of the angle from the low-numbered cell portion of the main tube to the side tube.
57–70	EPSW	Wall surface roughness (m, ft).

Card Number 3. (Format 2I14,2E14.4) NSEPS, ISTAGE, XCO, XCU

Columns	Variable	Description
1–14	NSEPS	Number of physical separators modeled; used only if mechanistic separator option (ISTAGE = –3, –2, 2, or 3) is selected.
15–28	ISTAGE	Separator-type option. –3 = three-stage mechanistic separator that uses default geometric data (three-stage GE-BWR separator); –2 = two-stage mechanistic separator that uses default geometric data (two-stage GE-BWR separator); 0 = ideal separator, uses constant user-input values of XCO and XCU; 1 = separator carryover and carryunder determined by control-block variables ICBS1 and ICBS2 on Card Number 4. **Note:** The user must provide the performance data for the modeled separators; 2 = two-stage mechanistic separator where the user inputs the geometric data (two-stage GE-BWR separator); 3 = three-stage mechanistic separator where the user inputs the geometric data (three-stage GE-BWR separator).
29–42	XCO	Separator carryover (–), the liquid mass flow divided by the total mass flow evaluated at the JCELL + 1 interface. If XCO < 0.0, the default value of 0.03 is used.

Columns	Variable	Description
43–56	XCU	Separator carryunder (–), the vapor mass flow divided by the total mass flow, evaluated at the NCELL1 + 2 internal-junction interface. If XCU < 0.0, the default value of 0.005 is used.

Card Number 4. (Format 2I14) ICBS1, ICBS2

Note: If ISTAGE ≠ 1 (Word 2 on Card Number 3), do not input Card Number 4.

Columns	Variable	Description
1–14	ICBS1	Control-block ID number (ICBS1 < 0) which defines the separator carryover [the liquid mass flow divided by the total mass flow evaluated at the JCELL + 1 (Word 1 on Card Number 2) interface].
15–28	ICBS2	Control-block ID number (ICBS2 < 0) which defines the separator carryunder [the vapor mass flow divided by the total mass flow evaluated at the NCELL1 + 2 (Word 2 on Card Number 6) internal-junction interface].

Card Number 5. (Format 5E14.4) AI, AN, RH, THETA, RR1

Note: If ISTAGE < 2 (Word 2 on Card Number 3), do not input Card Number 5.

Columns	Variable	Description
1–14	AI	Standpipe flow area (m², ft²). If AI 0.0 m² (0.0 ft²), the default value of 1.8637×10^{-2} m² (2.0061×10^{-1} ft²) is used.
15–28	AN	Nozzle-exit area (m², ft²). If AN 0.0 m² (0.0 ft²), the default value of 1.4411×10^{-2} m² (1.5512×10^{-1} ft²) is used.
29–42	RH	Radius (m, ft) of separator hub at inlet. If RH 0.0 m (0.0 ft), the default value of 8.09585×10^{-2} m (2.65612×10^{-1} ft) is used.
43–56	THETA	Angle (rad, deg) of separator swirling vane. If THETA ≤ 0.0 rad (0.0 deg), the default value of 8.3776×10^{-1} rad (4.8000×10^{1} deg) is used.
57–70	RR1	Radius (m, ft) of separator pickoff ring. If RR1 0.0 m (0.0 ft), the default value of 8.57208×10^{-2} m (2.81236×10^{-1} ft) is used.

Card Number 6. (Format 5I14) ICONC1, NCELL1, JUN1, JUN2, IPOW1

Columns	Variable	Description
1–14	ICONC1	Solute in the main-tube liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC1 > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
15–28	NCELL1	Number of fluid cells in the main tube.
29–42	JUN1	Junction number for the junction-interface adjacent to cell 1.
43–56	JUN2	Junction number for the junction-interface adjacent to cell NCELL1 (Word 2 on Card Number 6).
57–70	IPOW1	Power deposited in (to) the main-tube coolant option. 0 = no; 1 = yes.

Card Number 7. (Format 5I14) IPWTR1, IPWSV1, NPWTB1, NPWSV1, NPWRF1

Note: If IPOW1 = 0 (Word 5 on Card Number 6), do not input Card Number 7.

Columns	Variable	Description
1–14	IPWTR1	Trip ID number that controls the evaluation of the power-to-the-fluid table defined by Card Set 41 (array POWTB1) for the main tube ($|\text{IPWTR1}| \leq 9999$). (input IPWTR1 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IPWSV1	The independent-variable ID number for the power-to-the-fluid table for the main tube. IPWSV1 > 0 defines the ID number for a signal-variable parameter; IPWSV1 < 0 defines the ID number for a control-block output parameter.
29–42	NPWTB1	The number of power-to-the-fluid table data pairs for the main tube (defined by the absolute value of NPWTB1). NPWTB1 > 0 defines the table independent-variable form to be the IPWSV1 parameter; NPWTB1 < 0 defines the table independent-variable form to be the sum of the change in the IPWSV1 parameter over each timestep

Columns	Variable	Description
		times the trip set-status value ISET during that timestep (when the main-tube power-to-the-fluid table is trip controlled); NPWTB1 = 0 defines the power to the fluid to be the IPWSV1 parameter.
43–56	NPWSV1	The independent-variable ID number for the rate factor that is applied to the main-tube power-to-the-fluid table independent variable. NPWSV1 > 0 defines the ID number for a signal-variable parameter; NPWSV1 < 0 defines the ID number for a control-block output parameter; NPWSV1 = 0 (when NPWRF1 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-fluid table is trip controlled.
57–70	NPWRF1	The number of rate-factor table data pairs (defined by the absolute value of NPWRF1). The rate factor is applied as a factor to the main-tube power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPWSV1 and NPWRF1 are both zero. NPWRF1 > 0 defines the rate-factor table independent variable to be the NPWSV1 parameter; NPWRF1 < 0 defines it to be the sum of the change in the NPWSV1 parameter over each timestep times the trip set-status value ISET during that timestep (when the main-tube power-to-the-fluid table is trip controlled); NPWRF1 = 0 defines the rate factor to be the NPWSV1 parameter.

Card Number 8. (Format 5I14) IQPTR1, IQPSV1, NQPTB1, NQPSV1, NQPRF1

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 8.

Columns	Variable	Description
1–14	IQPTR1	Trip ID number that controls the evaluation of the power-to-the-wall table defined by Card Set 43 (array QP3TB1) for the main tube (|IQPTR1| ≤ 9999). (Input IQPTR1 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IQPSV1	The independent-variable ID number for the main-tube power-to-the-wall table. IQPSV1 > 0 defines the ID number for a signal-variable parameter; IQPSV1 < 0 defines the ID number for a control-block output parameter.

Columns	Variable	Description
29–42	NQPTB1	The number of power-to-the-wall table data pairs for the main tube (defined by the absolute value of NQPTB1). NQPTB1 > 0 defines the table independent-variable form to be the IQPSV1 parameter; NQPTB1 < 0 defines the table independent-variable form to be the sum of the change in the IQPSV1 parameter over each timestep times the trip set-status value ISET during that timestep (when the main-tube power-to-the-wall table is trip controlled); NQPTB1 = 0 defines the power to the wall to be the IQPSV1 parameter.
43–56	NQPSV1	The independent-variable ID number for the rate factor that is applied to the main-tube power-to-the-wall table independent variable. NQPSV1 > 0 defines the ID number for a signal-variable parameter; NQPSV1 < 0 defines the ID number for a control-block output parameter; NQPSV1 = 0 (when NQPRF1 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQPRF1	The number of rate-factor table data pairs (defined by the absolute value of NQPRF1). The rate factor is applied as a factor to the main-tube power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQPSV1 and NQPRF1 are both zero. NQPRF1 > 0 defines the rate-factor table independent variable to be the NQPSV1 parameter; NQPRF1 < 0 defines it to be the sum of the change in the NQPSV1 parameter over each timestep times the trip set-status value ISET during that timestep (when the main-tube power-to-the-wall table is trip controlled); NQPRF1 = 0 defines the rate factor to be the NQPSV1 parameter.

Card Number 9. (Format 5E14.4) RADIN1, TH1, HOUTL1, HOUTV1, TOUTL1

Columns	Variable	Description
1–14	RADIN1	Inner radius (m, ft) of the main-tube wall.
15–28	TH1	Wall thickness (m, ft) of the main-tube wall.
29–42	HOUTL1	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the main-tube wall and the liquid outside the main-tube wall.
43–56	HOUTV1	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the main-tube wall and the gas outside the main-tube wall.
57–70	TOUTL1	Liquid temperature (K, °F) outside the main-tube wall.

Note: See PIPE input description, Section 6.3.7.3., for further comments on the HOUTL1, HOUTV1, TOUTL1, and TOUTV1 (Card Number 10) heat-transfer parameters

Card Number 10. (Format 5E14.4) TOUTV1, PWIN1, PWOFF1, RPWMX1, PWSCL1.

Columns	Variable	Description
1–14	TOUTV1	Gas temperature (K, °F) outside the main-tube wall.
15–28	PWIN1	Initial total power (W, Btu h^{-1}) deposited in (to) the main-tube fluid [not used when IPOW1 = 0 (Word 5 on Card Number 6)]. The power is distributed uniformly along the main-tube length.
29–42	PWOFF1	Total power (W, Btu h^{-1}) to the main-tube fluid when the controlling trip is OFF after being ON [not used if IPOW1 = 0 (Word 5 on Card Number 6) or IPWTR1 = 0 (Word 1 on Card Number 7)]. If PWOFF1 $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
43–56	RPWMX1	The maximum rate of change of the main-tube power to the fluid (W s^{-1}, Btu h^{-1} s^{-1}) [RPWMX1 ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used if IPOW1 = 0 (Word 5 on Card Number 6)].
57–70	PWSCL1	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table, defined by Card Set 41 (array POWTB1), is multiplied by PWSCL1 to obtain the absolute power (W, Btu h^{-1}) deposited in the fluid [not used if IPOW1 = 0 (Word 5 on Card Number 6) or NPWTB1 = 0 (Word 3 on Card Number 7)].

Card Number 11. (Format 4E14.4) QPIN1, QPOFF1, RQPMX1, QPSCL1

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 11.

Columns	Variable	Description
1–14	QPIN1	Initial power (W, Btu h^{-1}) deposited in (to) the main-tube wall and distributed according to the QPPP array. If QPIN1 > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QPIN1 < 0.0 W (0.0 Btu h^{-1}), the power to the wall in each cell is $|$QPIN1$|$, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELL1 (Word 2 on Card Number 6) powers. Each data pair of the power-to-the-wall table [for QPIN1 < 0.0 W (0.0 Btu h^{-1})] has 1+NCELL1 values (an independent-variable value and NCELL1 power values for cells 1 through NCELL1). When the power-to-the-wall table is not being evaluated, the same power value of $|$QPIN1$|$ or QPOFF1 [if QPOFF1 > -10^{19} W (-3.41×10^{19} Btu h^{-1})] is applied at each of the NCELL1 cells.
15–28	QPOFF1	Power (W, Btu h^{-1}) to the main-tube wall when the controlling trip is OFF after being ON [not used if IQPTR1=0 (Word 1 on Card Number 8); use the last table-evaluated power when the trip was ON if QPOFF1 ≤ -10^{19} W (-3.41×10^{19} Btu h^{-1})].
29–42	RQPMX1	Maximum rate of change of the power to the wall (W s^{-1}, Btu h^{-1} s^{-1}) for the main tube [RQPMX1 ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QPSCL1	Scale factor (–) for the power-to-the-wall table for the SEPD main tube. The dependent variable in the table defined by Card Set 43 (array QP3TB1) is multiplied by QPSCL1 to obtain the absolute power (W, Btu h^{-1}) to the wall.

Card Number 12. (Format 4I14) ICONC2, NCELL2, JUN3, IPOW2

Columns	Variable	Description
1–14	ICONC2	Solute in the side-tube liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC2 > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
15–28	NCELL2	Number of fluid cells in the side tube.
29–42	JUN3	Junction number at the external-junction end of the side tube adjacent to cell NCELL2.
43–56	IPOW2	Power deposited in (to) the side-tube coolant option. 0 = no; 1 = yes.

Card Number 13. (Format 5I14) IPWTR2, IPWSV2, NPWTB2, NPWSV2, NPWRF2

Note: If IPOW2 = 0 (Word 4 on Card Number 12), do not input Card Number 13.

Columns	Variable	Description
1–14	IPWTR2	Trip ID number that controls evaluation of the power-to-the-fluid table defined by Card Set 68 (array POWTB2) for the side tube ($|IPWTR2| \leq 9999$). [input IPWTR2 = 0 if there is to be no trip control and the table is to be evaluated every timestep in the transient calculation].
15–28	IPWSV2	The independent-variable ID number of side-tube power-to-the-fluid table. IPWSV2 > 0 defines the ID number for a signal-variable parameter; IPWSV2 < 0 defines the ID number for a control-block output parameter.
29–42	NPWTB2	The number of power-to-the-fluid table data pairs for the side tube (defined by the absolute value of NPWTB2). NPWTB2 > 0 defines the table independent-variable form to be the IPWSV2 parameter; NPWTB2 < 0 defines the table independent-variable form to be the sum of the change in the IPWSV2 parameter over each timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-fluid table is trip

Columns	Variable	Description
		controlled); NPWTB2 = 0 defines the power to the fluid to be the IPWSV2 parameter.
43–56	NPWSV2	The independent-variable ID number for the rate factor that is applied to the side-tube power-to-the-fluid table independent variable. NPWSV2 > 0 defines the ID number for a signal-variable parameter; NPWSV2 < 0 defines the ID number for a control-block output parameter; NPWSV2 = 0 (when NPWRF2 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-fluid table is trip controlled.
57–70	NPWRF2	The number of rate-factor table data pairs (defined by the absolute value of NPWRF2). The rate factor is applied as a factor to the side-tube power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPWSV2 and NPWRF2 are both zero. NPWRF2 > 0 defines the rate-factor table independent variable to be the NPWSV2 parameter; NPWRF2 < 0 defines it to be the sum of the change in the NPWSV2 parameter over the last timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-fluid table is trip controlled); NPWRF2 = 0 defines the rate factor to be the NPWSV2 parameter.

Card Number 14. (Format 5I14) IQPTR2, IQPSV2, NQPTB2, NQPSV2, NQPRF2

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 14.

Columns	Variable	Description
1–14	IQPTR2	Trip ID number that controls the evaluation of the power-to-the-wall table defined by Card Set 70 (array QP3TB2) for the side tube [	IQPTR2	≤ 9999]. (input IQPTR2 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IQPSV2	The independent-variable ID number for the side-tube power-to-the-wall table. IQPSV2 > 0 defines the ID number for a signal-variable parameter; IQPSV2 < 0 defines the ID number for a control-block output parameter.

Columns	Variable	Description
29–42	NQPTB2	The number of power-to-the-wall table data pairs for the side tube (defined by the absolute value of NQPTB2). NQPTB2 > 0 defines the table independent-variable form to be the IQPSV2 parameter; NQPTB2 < 0 defines the table independent-variable form to be the sum of the change in the IQPSV2 parameter over each timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-wall table is trip controlled); NQPTB2 = 0 defines the power to the wall to be the IQPSV2 parameter.
43–56	NQPSV2	The independent-variable ID number for the rate factor that is applied to the side-tube power-to-the-wall table independent variable. NQPSV2 > 0 defines the ID number for a signal-variable parameter; NQPSV2 < 0 defines the ID number for a control-block output parameter; NQPSV2 = 0 (when NQPRF2 ¦ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQPRF2	The number of rate-factor table data pairs (defined by the absolute value of NQPRF2). The rate factor is applied as a factor to the side-tube power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQPSV2 and NQPRF2 are both zero. NQPRF2 > 0 defines the rate-factor table independent variable to be the NQPSV2 parameter; NQPRF2 < 0 defines it to be the sum of the change in the NQPSV2 parameter over each timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-wall table is trip controlled); NQPRF2 = 0 defines the rate factor to be the NQPSV2 parameter.

Card Number 15. (Format 5E14.4) RADIN2, TH2, HOUTL2, HOUTV2, TOUTL2

Columns	Variable	Description
1–14	RADIN2	Inner radius (m, ft) of the side-tube wall.
15–28	TH2	Wall thickness (m, ft) of the side tube.
29–42	HOUTL2	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the side-tube wall and the liquid outside the side-tube wall.

Columns	Variable	Description
43–56	HOUTV2	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the side-tube wall and the gas outside the side-tube wall.
57–70	TOUTL2	Liquid temperature (K, °F) outside the side-tube wall.

Note: See the PIPE input description, Section 6.3.7.3., for further comments on the HOUTL2, HOUTV2, TOUTL2, and TOUTV2 (Card Number 16) heat-transfer parameters .

Card Number 16. (Format 5E14.4) TOUTV2, PWIN2, PWOFF2, RPWMX2, PWSCL2.

Columns	Variable	Description
1–14	TOUTV2	Gas temperature (K, °F) outside the side-tube wall.
15–28	PWIN2	Initial total power (W, Btu h^{-1}) deposited in (to) the side-tube fluid [not used if IPOW2 = 0 (Word 4 on Card Number 12)]. The power is distributed uniformly along the side-tube length.
29–42	PWOFF2	Total power (W, Btu h^{-1}) to the side-tube fluid when the controlling trip is OFF after being ON [not used if IPOW2 = 0 (Word 4 on Card Number 12) or IPWTR2 = 0 (Word 1 on Card Number 13)]. If PWOFF2 $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
43–56	RPWMX2	Maximum rate of change of the side-tube power to the fluid (W s^{-1}, Btu h^{-1} s^{-1}) [RPWMX1 ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used if IPOW2 = 0 (Word 4 on Card Number 12)].
57–70	PWSCL2	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table, defined by Card Set 68 (array POWTB2), is multiplied by PWSCL2 to obtain the absolute power (W, Btu h^{-1}) to the fluid [not used if IPOW2 = 0 (Word 4 on Card Number 12) or NPWTB2 = 0 (Word 3 on Card Number 13)].

Card Number 17. (Format 4E14.4) QPIN2, QPOFF2, RQPMX2, QPSCL2

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 17.

Columns	Variable	Description
1–14	QPIN2	Initial power (W, Btu h^{-1}) deposited in (to) the side-tube wall and distributed according to the QPPP array. If QPIN2 > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QPIN2 < 0.0 W (0.0 Btu h^{-1}), the power to the wall in each cell is $|$QPIN2$|$, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELL2 (Word 2 on Card Number 12) powers. Each data pair of the power-to-the-wall table [for QPIN2 < 0.0 W (0.0 Btu h^{-1})] has 1+NCELL2 values (an independent-variable value and NCELL2 power values for cells 1 through NCELL2). When the power-to-the-wall table is not being evaluated, the same power value of $|$QPIN2$|$ or QPOFF2 [if QPOFF2 > -10^{19} W (-3.41×10^{19} Btu h^{-1})] is applied at each of the NCELL2 cells.
15–28	QPOFF2	Power (W, Btu h^{-1}) to the side-tube wall when the controlling trip is OFF after being ON [not used if IQPTR2 (Word 1 on Card Number 14); use the last table-evaluated power when the trip was ON if QPOFF2 $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1})].
29–42	RQPMX2	Maximum rate of change of the power to the wall (W s^{-1}, Btu h^{-1} s^{-1}) for the side tube [RQPMX2 $\geq$ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QPSCL2	Scale factor (–) for the power-to-the-wall table for the side tube. The dependent variable in the table defined by Card Set 70 (array QP3TB2) is multiplied by QPSCL2 to obtain the absolute power (W, Btu h^{-1}) to the wall.

SEPD Array Cards. Sixty-two Card Sets, one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Note: Model no flow-area change between cell JCELL and cells JCELL ±1 and between the internal-junction interface and the side-tube first cell. A VOL/DX flow-area change between cell JCELL and cells JCELL±1 and their interface FA and between side-tube cell 1 and the internal-junction interface will not have any evaluated effect on flow from the current JCELL-interface momentum equations evaluated by TRAC-M.

Card Sets 18 to 23.

Variable	Dimension	Description
DX	NCELL1	Main-tube cell lengths (m, ft).
VOL	NCELL1	Main-tube cell volumes (m^3, ft^3).
FA	NCELL1+1	Main-tube cell-edge flow areas (m^2, ft^2).
FRIC	NCELL1+1	Main-tube additive loss coefficients (–) (see PIPE input description, Section 6.3.7.3.).
GRAV or ELEV	NCELL1+1	Main-tube gravity or elevation terms [(– or m), (– or ft)] (see PIPE input description, Section 6.3.7.3.).
HD	NCELL1+1	Main-tube hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 24. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 24 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Main-tube cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 25.

Variable	Dimension	Description
NFF	NCELL1+1	Main-tube friction-factor correlation option (see PIPE input description, Section 6.3.7.3.). Input NFF ≥ 0 for the JCELL and JCELL+1 interfaces.

Card Set 26. If NCCFL = 0 (Word 5 Main-Data Card 6), do not input Card Set 26 (array LCCFL)

Variable	Dimension	Description
LCCFL	NCELLS+1	Main-tube countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 27 to 33.

Variable	Dimension	Description
ALP	NCELL1	Main-tube initial gas volume fractions (–).
VL	NCELL1+1	Main-tube initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELL1+1	Main-tube initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELL1	Main-tube initial liquid temperatures (K, °F).
TV	NCELL1	Main-tube initial gas temperatures (K, °F).
P	NCELL1	Main-tube initial pressures (Pa, psia).
PA	NCELL1	Main-tube initial noncondensable-gas partial pressures (Pa, psia).

Card Set 34. If NAMELIST variable MWFL = 0, do not input Card Set 34 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELL1+1	Main-tube wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 35. If NAMELIST variable MWFV = 0, do not input Card Set 35 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELL1+1	Main-tube wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 36 to 38. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 36 to 38 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELL1	A relative power profile (–) in the main-tube wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES, etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power shape to have a volume-averaged value of unity (each QPPP(I) is normalized to have the value QPPP(I) × [Σ_K VOL(K)]/[Σ_K QPPP(K) × VOL(K)]). Filling the array with zeros results in no power being deposited in the wall regardless of the values of QP3IN, QP3TB, etc.
MATID	NODES-1	Wall-material ID array that specifies material ID between radial nodes in the main tube. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (see available built-in properties listed under array MATRD in the HTSTR component input, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input). **Note:** Material properties ID numbers 1–5 and 11 are not available for the SEPD component.
TW	NODES × NCELL1	Initial wall temperatures (K, °F) in the main tube that are input in the same order as QPPP.

Card Set 39. If ICONC1 = 0 (Word 1 on Card Number 6), do not input Card Set 39 (array CONC).

Variable	Dimension	Description
CONC	NCELL1	Initial ratio of solute mass to liquid-coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m$$^{-1}$(liquid)] in the main tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 40. If ICONC1 = 0 or 1 (Word 1 on Card Number 6), do not input Card Set 40 (array S).

Variable	Dimension	Description
S	NCELL1	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}) in the main tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 41. If NPWTB1 = 0 (Word 3 on Card Number 7), do not input Card Set 41 (array POWTB1).

Variable	Dimension	Description
POWTB1	2×|NPWTB1|	Power-to-the-fluid vs independent-variable-form table [(*,W), (*,Btu h⁻¹)] for the main tube. Input |NPWTB1| (Word 3 on Card Number 7) table-defining data pairs having the following form [independent-variable form defined by IPWSV1 (Word 2 on Card Number 7), power to the fluid]. The power is deposited directly into the main-tube fluid with a uniform volumetric power density along the main tube length.

Card Set 42. If NPWTB1 = 0 or NPWRF1 = 0 (Words 3 and 5 on Card Number 7), do not input Card Set 42 (array POWRF1).

Variable	Dimension	Description
POWRF1	2×|NPWRF1|	Rate-factor table (*,–) for the main-tube power-to-the-fluid table independent variable. Input |NPWRF1| (Word 5 on Card Number 7) table-defining data pairs having the following form [independent-variable form defined by NPWSV1 (Word 4 on Card 7), rate factor to be applied to the power-to-the-fluid table independent variable].

Card Set 43. If NQPTB1 = 0 (Word 3 on Card Number 8), do not input Card Set 43 (array QP3TB1).

Variable	Dimension	Description
QP3TB1	2×|NQPTB1| when QPIN1 > 0.0; (1+NCELL1) × |NQPTB1| when QPIN1 < 0.0	Power-to-the-wall independent-variable-form table [(*,W), (*,Btu h⁻¹)] for the main tube. Input |NQBTB1| (Word 3 on Card Number 8) table-defining data pairs having the following form [independent-variable form defined by IQPSV1 (Word 2 on Card Number 8), power to the wall]. If QPIN1 > 0.0 W (0.0 Btu h⁻¹), the dependent variable specifies the total power to the entire wall; if QPIN1 < 0.0 W (0.0 Btu h⁻¹), the dependent variable is a power shape that specifies the power to the wall at each cell from cell 1 to cell NCELL1.

Card Set 44. If NQPTB1 = 0 or NQPRF1 = 0 (Words 3 and 5 on Card Number 8), do not input Card Set 44 (array QP3RF1).

Variable	Dimension	Description
QP3RF1	2×|NQPRF1|	Rate-factor table (*,–) for the power-to-the-wall table independent variable for the main tube. Input |NQPRF1| (Word 5 on Card Number 8) table-defining data pairs having the following form [independent-variable form defined by NQPSV1 (Word 4 on Card Number 8), rate factor to be applied to the power-to-the-wall table independent variable].

Card Sets 45 to 50.

Variable	Dimension	Description
DX	NCELL2	Side-tube cell lengths (m, ft).
VOL	NCELL2	Side-tube cell volumes (m³, ft³).
FA	NCELL2+1	Side-tube cell-edge flow areas (m², ft²).
FRIC	NCELL2+1	Side-tube additive loss coefficients (–) (see PIPE input description, Section 6.3.7.3.). Input FRIC > 0.0 for internal-junction interface 1 of the side tube when a VOL/DX flow-area change occurs between JCELL and cell 1 of the side tube.
GRAV or ELEV	NCELL2+1	Side-tube gravity or elevation terms [(– or m), (– or ft)] (see PIPE input description, Section 6.3.7.3.).
HD	NCELL2+1	Side-tube hydraulic diameters (m, ft). See NAMELIST variable NDIA1 for addition input of heat-transfer diameters.

Card Set 51. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 51 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELL2+1	Side-tube cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 52.

Variable	Dimension	Description
NFF	NCELL2+1	Side-tube friction-factor correlation option (see PIPE input description, Section 6.3.7.3.). Input NFF ≥ 0 for the internal-junction interface 1 of the side tube.

Card Set 53. If NCCFL = 0 (Word 5 Main-Data Card 6), do not input Card Set 53 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELL2+1	Side-tube countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 54 to 60.

Variable	Dimension	Description
ALP	NCELL2	Side-tube initial gas volume fractions (–).
VL	NCELL2+1	Side-tube initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELL2+1	Side-tube initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELL2	Side-tube initial liquid temperatures (K, °F).
TV	NCELL2	Side-tube initial gas temperatures (K, °F).
P	NCELL2	Side-tube initial pressures (Pa, psia).
PA	NCELL2	Side-tube initial noncondensable-gas partial pressures (Pa, psia).

Card Set 61. If NAMELIST variable MWFL = 0, do not input Card Set 61 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELL2+1	Side-tube wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 62. If NAMELIST variable MWFV = 0, do not input Card Set 62 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELL2+1	Side-tube wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 63 to 65. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 63 to 65 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELL2	A relative power profile (–) in the side-tube wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES; etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power shape to have a volume-averaged value of unity {each QPPP(I) is normalized to have the value QPPP(I) × $[\Sigma_K \text{VOL}(K)]/[\Sigma_K \text{QPPP}(K) \times \text{VOL}(K)]$}. Filling the array with zeros results in no power being deposited in the wall regardless of the value of QPIN2, QPTB2, etc.
MATID	NODES-1	Wall-material ID array that specifies material ID between nodes in the side tube. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (see available built-in properties listed under array MATRD in the HTSTR component input, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input). **Note:** Material properties ID numbers 1–5 and 11 are not available for the SEPD component.
TW	NODES × NCELL2	Initial wall temperatures (K, °F) in the side tube that are input in the same order as QPPP.

Card Set 66. If ICONC2 = 0 (Word 1 on Card Number 12), do not input Card Set 66 (array CONC).

Variable	Dimension	Description
CONC	NCELL2	Initial ratio of solute mass to liquid coolant mass [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)] in the side tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 67. If ICONC2 = 0 or 1 (Word 1 on Card Number 6), do not input Card Set 67 (array S).

Variable	Dimension	Description
S	NCELL2	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}) in the side tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 68. If NPWTB2 = 0 (Word 3 on Card Number 13), do not input Card Set 68 (array POWTB2).

Variable	Dimension	Description
POWTB2	2×|NPWTB2|	Power-to-the-fluid vs independent-variable-form table [(*,W), (*,Btu h⁻¹)] for the side tube. Input |NPWTB2| (Word 3 on Card Number 13) table-defining data pairs having the following form [independent-variable form defined by IPWSV2 (Word 3 on Card Number 13), power to the fluid]. The power is deposited directly into the side-tube fluid with a uniform power density along the side-tube length.

Card Set 69. If NPWTB2 = 0 or NPWRF2 = 0 (Word 3 and 5 on Card Number 13), do not input Card Set 69 (array POWRF2).

Variable	Dimension	Description
POWRF2	2×|NPWRF2|	Rate-factor table (*,–) for the side-tube power-to-the-fluid table independent variable. Input |NPWRF2| (Word 5 on Card Number 13) table-defining data pairs having the following form [independent-variable form defined by NPWSV2 (Word 4 on Card Number 13), rate factor to be applied to the power-to-the-fluid table independent variable].

Card Set 70. If NQPTB2 = 0 (Word 3 on Card Number 14), do not input Card Set 70 (array QP3TB2).

Variable	Dimension	Description
QP3TB2	2×|NQPTB2| when QPIN2 > 0.0; (1+NCELL2) × |NQPTB2| when QPIN2 < 0.0	Power-to-wall vs independent-variable form table [(*,W), (*,Btu h⁻¹)] for the side tube. Input |NQPTB2| (Word 3 on Card Number 14) table-defining data pairs having the following form [independent-variable form defined by IQPSV2 (Word 2 on Card Number 14), power to the wall]. If QPIN2 > 0.0 W (0.0 Btu h⁻¹), the dependent variable specifies the total power to the entire wall; if QPIN2 < 0.0 W (0.0 Btu h⁻¹), the dependent variable is a power shape that specifies the power to the wall at each cell from cell NCELL1 + 2 to cell NCELL1 + 1 + NCELL2.

Card Set 71. If NQPTB2 = 0 or NQPRF2 = 0 (Words 3 and 5 on Card Number 14), do not input Card Set 71 (array QP3RF2).

Variable	Dimension	Description
QP3RF2	$2 \times |NQPRF2|$	Rate-factor table (*,–) for the power-to-the-wall table independent variable for the side tube. Input $|NQPRF2|$ (Word 5 on Card Number 14) table-defining data pairs having the following form [independent-variable form defined by NQPSV2 (Word 4 on Card Number 14), rate factor to be applied to the power-to-the-wall table independent variable].

Card Sets 72 to 79. If ISTAGE ≠ 2 or 3 (Word 2 on Card Number 3), do not input the remaining Card Sets 72 to 79.

Variable	Dimension	Description
RWS	2 or 3	Inner radius (m, ft) of the wall.
RRS	2 or 3	Inner radius (m, ft) of the pickoff ring.
ADS	2 or 3	Flow area (m^2, ft^2) of the discharge passage.
DDS	2 or 3	Hydraulic diameter (m, ft) of the discharge passage.
HBS	2 or 3	Length (m, ft) of the barrel.
HSK	2 or 3	Axial distance (m, ft) between the discharge and the swirling vane.
CKS	2 or 3	Loss coefficient (–) in the discharge passage.
EFFLD	2 or 3	Effective L/D coefficient (–) at the pickoff ring.

6.3.7.8. TEE component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–3	TYPE	Component type (TEE left justified).
15–28	NUM	Component ID number (must be unique for each component, 1 ≤ NUM ≤ 999).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 3I14,2E14.4) JCELL, NODES, ICHF, COST, EPSW

Columns	Variable	Description
1–14	JCELL	Main-tube cell number that has the side tube connected to it.
15–28	NODES	Number of radial heat-transfer nodes in the wall. A value of zero specifies no wall heat transfer.
29–42	ICHF	CHF-calculation option. 0 = no; 1 = yes.
43–56	COST	Cosine of the angle from the low-numbered cell portion of the main tube to the side tube.
57–70	EPSW	Wall surface roughness (m, ft).

Card Number 3. (Format 5I14) ICONC1, NCELL1, JUN1, JUN2, IPOW1

Columns	Variable	Description
1–14	ICONC1	Solute in the main-tube coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC1 > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
15–28	NCELL1	Number of fluid cells in the main tube.
29–42	JUN1	Junction number for the junction interface adjacent to cell 1.
43–56	JUN2	Junction number for the junction interface adjacent to cell NCELL1.
57–70	IPOW1	Power-to-the-fluid option in the main tube. 0 = no; 1 = yes.

Card Number 4. (Format 5I14) IPWTR1, IPWSV1, NPWTB1, NPWSV1, NPWRF1

Note: If IPOW1 = 0 (Word 5 on Card Number 3), do not input Card Number 4.

Columns	Variable	Description
1–14	IPWTR1	Trip ID number that controls evaluation of the power-to-the-fluid table defined by Card Set 37 (array POWTB1) for the main tube ($|$IPWTR1$| \leq 9999$). [Input IPWTR1 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation].
15–28	IPWSV1	The independent-variable ID number for the power-to-the-fluid table for the main tube. IPWSV1 > 0 defines the ID number for a signal-variable parameter; IPWSV1 < 0 defines the ID number for a control-block output parameter.
29–42	NPWTB1	The number of power-to-the-fluid table data pairs for the main tube (defined by the absolute value of NPWTB1). NPWTB1 > 0 defines the table independent-variable form to be the IPWSV1 parameter; NPWTB1 < 0 defines the table independent-variable form to be the sum of the change in the IPWSV1 parameter each last timestep times the trip set-status value ISET during that timestep (when the power-to-the-fluid table is trip controlled); NPWTB1 = 0 defines the power to the fluid to be the IPWSV1 parameter.
43–56	NPWSV1	The independent-variable ID number for the rate factor that is applied to the main-tube power-to-the-fluid table independent variable. NPWSV1 > 0 defines the ID number for a signal-variable parameter; NPWSV1 < 0 defines the ID number for a control-block output parameter; NPWSV1 = 0 (when NPWRF1 $\neq$ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-fluid table is trip controlled.

Columns	Variable	Description
57–70	NPWRF1	The number of rate-factor table data pairs (defined by the absolute value of NPWRF1). The rate factor is applied as a factor to the main-tube power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPWSV1 and NPWRF1 are both zero. NPWRF1 > 0 defines the rate-factor table independent variable to be the NPWSV1 parameter; NPWRF1 < 0 defines it to be the sum of change in the NPWSV1 parameter over each timestep times the trip set-status value ISET during the timestep (when the main-tube power-to-the-fluid table is trip controlled); NPWRF1 = 0 defines the rate factor to be the NPWSV1 parameter.

Card Number 5. (Format 5I14) IQPTR1, IQPSV1, NQPTB1, NQPSV1, NQPRF1

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 5.

Columns	Variable	Description
1–14	IQPTR1	Trip ID number that controls evaluation of the power-to-the-wall table defined by Card Set 41 (array QP3TB1) for the main tube ($\mid$IQPTR1$\mid \leq 9999$). [Input IQPTR1 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation].
15–28	IQPSV1	The independent-variable ID number for the main-tube power-to-the-wall table. IQPSV1 > 0 defines the ID number for a signal-variable parameter; IQPSV1 < 0 defines the ID number for a control-block output parameter.
29–42	NQPTB1	The number of power-to-the-wall table data pairs for the main tube (defined by the absolute value of NQPTB1). NQPTB1 > 0 defines the table independent-variable form to be the IQPSV1 parameter; NQPTB1 < 0 defines the table independent-variable form to be the sum of the change in the IQPSV1 parameter over each timestep times the trip set-status value ISET during each timestep (when the power-to-the-wall table is trip controlled); NQPTB1 = 0 defines the power to the wall to be the IQPSV1 parameter.

Columns	Variable	Description
43–56	NQPSV1	The independent-variable ID number for the rate factor that is applied to the main-tube power-to-the-wall table independent variable. NQPSV1 > 0 defines the ID number for a signal-variable parameter; NQPSV1 < 0 defines the ID number for a control-block output parameter; NQPSV1 = 0 (when NQPRF1 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQPRF1	The number of rate-factor table data pairs (defined by the absolute value of NQPRF1). The rate factor is applied as a factor to the main-tube power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQPSV1 and NQPRF1 are both zero. NQPRF1 > 0 defines the rate-factor table independent variable to be the NQPSV1 parameter; NQPRF1 < 0 defines it to be the sum of the change in the NQPSV1 parameter over each timestep times the trip set-status value ISET during that timestep (when the main-tube power-to-the-wall table is trip controlled); NQPRF1 = 0 defines the rate factor to be the NQPSV1 parameter.

Card Number 6. (Format 5E14.4) RADIN1, TH1, HOUTL1, HOUTV1, TOUTL1

Columns	Variable	Description
1–14	RADIN1	Inner radius (m, ft) of the main-tube wall.
15–28	TH1	Wall thickness (m, ft) of the main tube.
29–42	HOUTL1	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between outer boundary of the main-tube wall and the liquid outside the main-tube wall.
43–56	HOUTV1	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the main-tube wall and the gas outside the main-tube wall.
57–70	TOUTL1	Liquid temperature (K, °F) outside the main-tube wall.

Note: See PIPE input description, Section 6.3.7.3., for further comments on the HOUTL1, HOUTV1, TOUTL1, and TOUTV1 (Card Number 7) heat-transfer parameters.

Card Number 7. (Format 5E14.4) TOUTV1, PWIN1, PWOFF1, RPWMX1, PWSCL1

Columns	Variable	Description
1–14	TOUTV1	Gas temperature (K, °F) outside the main-tube wall.

Columns	Variable	Description
15–28	PWIN1	Initial total power (W, Btu h^{-1}) deposited in (to) the main-tube fluid [not used when IPOW1 = 0 (Word 5 on Card Number 3)]. The power is distributed uniformly along the TEE main-tube length.
29–42	PWOFF1	Total power (W, Btu h^{-1}) to the main-tube fluid when the controlling trip is OFF after being ON [not used if IPOW1 = 0 (Word 5 on Card Number 3) or IPWTR1 = 0 (Word 1 on Card Number 4)]. If PWOFF1 $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
43–56	RPWMX1	The maximum rate of change of the main-tube power to the fluid (W s^{-1}, Btu h^{-1} s^{-1}) [RPWMX1 ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used if IPOW1 = 0 (Word 5 on Card Number 3)].
57–70	PWSCL1	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table, defined by Card Set 39 (array POWTB1), is multiplied by PWSCL1 to obtain absolute power (W, Btu h^{-1}) deposited in the fluid [not used if IPOW1 = 0 (Word 5 on Card Number 3) or NPWTB1 = 0 (Word 3 on Card Number 4)].

Card Number 8. (Format 4E14.4) QPIN1, QPOFF1, RQPMX1, QPSCL1

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 8.

Columns	Variable	Description
1–14	QPIN1	Initial power (W, Btu h^{-1}) deposited in (to) the main-tube wall and distributed according to the QPPP array. If QPIN1 > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QPIN1 < 0.0 W (0.0 Btu h^{-1}), the initial power to the wall in each cell is $|$QPIN1$|$, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELL1 (Word 2 on Card Number 3) power values. Each data pair of the power-to-the-wall table [for QPIN1 < 0.0 W (0.0 Btu h^{-1})] has 1 + NCELL1 values (an independent-variable value and NCELL1 power values for cells 1 through NCELL1). When the power-to-the-wall table is not being evaluated, the same power value of $|$QPIN1$|$ or QPOFF1 [if QPOFF1 > -10^{19} W (-3.41×10^{19} Btu h^{-1})] is applied at each of the NCELL1 cells.

Columns	Variable	Description
15–28	QPOFF1	Power (W, Btu h^{-1}) to the main-tube wall when the controlling trip is OFF after being ON [not used if IQPTR1 = 0 (Word 1 on Card Number 5); use the last table-evaluated power when the trip was ON if QPOFF1 ≤ –10^{19} W (–3.41 × 10^{19} Btu h^{-1})].
29–42	RQPMX1	Maximum rate of change of the power to the wall for the main tube (W s^{-1}, Btu h^{-1} s^{-1}) [RQPMX1 ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QPSCL1	Scale factor (–) for the power-to-the-wall table for the main tube. The dependent variable in the table defined by Card Set 41 (array QP3TB1) is multiplied by QPSCL1 to obtain the absolute power (W, Btu h^{-1}) to the wall.

Card Number 9. (Format 4I14) ICONC2, NCELL2, JUN3, IPOW2

Columns	Variable	Description
1–14	ICONC2	Solute in the side-tube coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC2 > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
15–28	NCELL2	Number of fluid cells in the side tube.
29–42	JUN3	Junction number at the external-junction end of the side tube adjacent to cell NCELL2.
43–56	IPOW2	Power-to-the-fluid option in the side tube. 0 = no; 1 = yes.

Card Number 10. (Format 5I14) IPWTR2, IPWSV2, NPWTB2, NPWSV2, NPWRF2

Note: If IPOW2 = 0 (Word 4 on Card Number 9), do not input Card Number 10.

Columns	Variable	Description
1–14	IPWTR2	Trip ID number that controls evaluation of the power-to-the-fluid table defined by Card Set 66 (array POWTB2) for the side tube (| IPWTR2 | ≤ 9999). [input IPWTR2 = 0 if there is to be no trip control and the table is to be evaluated every timestep of the transient calculation].

Columns	Variable	Description
15–28	IPWSV2	The independent-variable ID number of the power-to-the-fluid table for the side tube. IPWSV2 > 0 defines the ID number for a signal-variable parameter; IPWSV2 < 0 defines the ID number for a control-block output parameter.
29–42	NPWTB2	The number of power-to-the-fluid table data pairs for the side tube (defined by the absolute value of NPWTB2). NPWTB2 > 0 defines the table independent-variable form to be the IPWSV2 parameter; NPWTB2 < 0 defines the table's independent-variable form to be the sum of the change in the IPWSV2 para-meter over the last timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-fluid table is trip controlled); NPWTB2 = 0 defines the power to the fluid to be the IPWSV2 parameter.
43–56	NPWSV2	The independent-variable ID number for the rate factor that is applied to the side-tube power-to-the-fluid table independent variable. NPWSV2 > 0 defines the ID number for a signal-variable parameter; NPWSV2 < 0 defines the ID number for a control-block output parameter; NPWSV2 = 0 (when NPWRF2 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-fluid table is trip controlled.
57–70	NPWRF2	The number of rate-factor table data pairs (defined by the absolute value of NPWRF2). The rate factor is applied as a factor to the side-tube power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPWSV2 and NPWRF2 are both zero. NPWRF2 > 0 defines the rate-factor table independent variable to be the NPWSV2 parameter; NPWRF2 < 0 defines it to be the sum of the change in the NPWSV2 parameter over the last timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-fluid table is trip controlled); NPWRF2 = 0 defines the rate factor to be the NPWSV2 parameter.

Card Number 11. (Format 5I14) IQPTR2, IQPSV2, NQPTB2, NQPSV2, NQPRF2

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 11.

Columns	Variable	Description
1–14	IQPTR2	Trip ID number that controls evaluation of the power-to-the-wall table defined by Card Set 68 (array QP3TB2) for the side tube ($|IQPTR2| \leq 9999$). (Input IQPTR2 = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IQPSV2	The independent-variable ID number for the side-tube power-to-the-wall table. IQPSV2 > 0 defines the ID number for a signal-variable parameter; IQPSV2 < 0 defines the ID number for a control-block output parameter.
29–42	NQPTB2	The number of power-to-the-wall table data pairs for the side tube (defined by the absolute value of NQPTB2). NQPTB2 > 0 defines the table independent-variable form to be the IQPSV2 parameter; NQPTB2 < 0 defines the table independent-variable form to be the sum of the change in the IQPSV2 parameter over each timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-wall table is trip controlled); NQPTB2 = 0 defines the power to the wall to be the IQPSV2 parameter.
43–56	NQPSV2	The independent-variable ID number for the rate factor that is applied to the side-tube power-to-the-wall table independent variable. NQPSV2 > 0 defines the ID number for a signal-variable parameter; NQPSV2 < 0 defines the ID number for a control-block output parameter; NQPSV2 = 0 (when NQPRF2 ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.

Columns	Variable	Description
57–70	NQPRF2	The number of rate-factor table data pairs (defined by the absolute value of NQPRF2). The rate factor is applied as a factor to the side-tube power-to-the-wall table independent variable when the rate factor is defined. No rate factor is defined when NQPSV2 and NQPRF2 are both zero. NQPRF2 > 0 defines the rate-factor table independent variable to be the NQPSV2 parameter; NQPRF2 < 0 defines it to be the sum of the change in the NQPSV2 parameter over each timestep times the trip set-status value ISET during that timestep (when the side-tube power-to-the-wall table is trip controlled); NQPRF2 = 0 defines the rate factor to be the NQPSV2 parameter.

Card Number 12. (Format 5E14.4) RADIN2, TH2, HOUTL2, HOUTV2, TOUTL2

Columns	Variable	Description
1–14	RADIN2	Inner radius (m, ft) of the side-tube wall.
15–28	TH2	Wall thickness (m, ft) of the side tube.
29–42	HOUTL2	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the side-tube wall and the liquid outside the side-tube wall.
43–56	HOUTV2	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the side-tube wall and the gas outside the side-tube wall.
57–70	TOUTL2	Liquid temperature (K, °F) outside the side-tube wall.

Note: See the PIPE input description, Section 6.3.7.3., for further comments on the HOUTL2, HOUTV2, TOUTL2, and TOUTV2 (Card Number 13) heat-transfer parameters.

Card Number 13. (Format 5E14.4) TOUTV2, PWIN2, PWOFF2, RPWMX2, PWSCL2

Columns	Variable	Description
1–14	TOUTV2	Gas temperature (K, °F) outside the side-tube wall.
15–28	PWIN2	Initial total power (W, Btu h^{-1}) deposited in (to) the side-tube fluid [not used when IPOW2 = 0 (Word 4 on Card Number 9)]. The power is distributed uniformly along the side-tube length.

Columns	Variable	Description
29–42	PWOFF2	Total power (W, Btu h^{-1}) to the side-tube fluid when the controlling trip is OFF after being ON [not used when IPOW2 = 0 (Word 4 on Card Number 9) or IPWTR2 = 0 (Word 1 on Card Number 10)]. If PWOFF2 $\leq$ –10^{19} W (–3.41 × 10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
43–56	RPWMX2	Maximum rate of change of the side-tube power to the fluid (W s^{-1}, Btu h^{-1} s^{-1}) [RPWMX1 $\geq$ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used if IPOW2 = 0 (Word 4 on Card Number 9)].
57–70	PWSCL2	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table defined by Card Set 66 (array POWTB2) is multiplied by PWSCL2 to obtain the absolute power (W, Btu h^{-1}) to the fluid [not used if IPOW2=0 (Word 4 on Card Number 9) or NPWTB2 = 0 (Word 3 on Card Number 10)].

Card Number 14. (Format 4E14.4) QPIN2, QPOFF2, RQPMX2, QPSCL2

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 14.

Columns	Variable	Description
1–14	QPIN2	Initial power (W, Btu h^{-1}) deposited in (to) the side-tube wall and distributed according to the QPPP array. If QPIN2 > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QPIN2 < 0.0 W (0.0 Btu h^{-1}), the initial power to the wall in each cell is $|$QPIN2$|$, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELL2 (Word 2 on Card Number 9) power values. Each data pair of the power-to-the-wall table [for QPIN2 < 0.0 W (0.0 Btu h^{-1})] has 1+NCELL2 values (an independent-variable value and NCELL2 power values for cells 1 through NCELL2). When the power-to-the-wall table is not being evaluated, the same power value of $|$QPIN2$|$ or QPOFF2 [if QPOFF2 > –10^{19} W (–3.41 × 10^{19} Btu h^{-1})] is applied at each of the NCELL2 cells.
15–28	QPOFF2	Power (W, Btu h^{-1}) to the side-tube wall when the controlling trip is OFF after being ON [not used if IQPTR2 = 0 (Word 1 on Card Number 11); the last table-evaluated power when the trip was ON if QPOFF2 $\leq$ –10^{19} W (–3.41 × 10^{19} Btu h^{-1})].
29–42	RQPMX2	Maximum rate of change of the power to the wall for the side-tube (W s^{-1}, Btu h^{-1} s^{-1}) [RQPMX2 $\geq$ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].

Columns	Variable	Description
43–56	QPSCL2	Scale factor (–) for the power-to-the-wall table for the side-tube. The dependent variable in table defined by Card Set 68 (array QP3TB2) is multiplied by QPSCL2 to obtain the absolute power (W, Btu h^{-1}) to the wall.

Card Number 15. (Format I14) IENTRN

Note: If NAMELIST variable IOFFTK = 0, do not input Card Number 15.

Columns	Variable	Description
1–14	IENTRN	Offtake-model option. 0 = off; 1 = on (side tube internal-junction mass flow determined using offtake model).

TEE Array Cards. Input 54 Card Sets, 1 for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of 1 or more cards.

Note: Model no flow-area change between cell JCELL and cells JCELL±1 and between the internal-junction interface and the side-tube first cell. A VOL/DX flow-area change between cell JCELL and cells JCELL±1 and their interface FA and between side-tube cell 1 and the internal-junction interface will not have any evaluated effect on flow from the current JCELL-interface momentum equations evaluated by TRAC-M.

Card Sets 16 to 21.

Variable	Dimension	Description
DX	NCELL1	Main-tube cell lengths (m, ft).
VOL	NCELL1	Main-tube cell volumes (m^3, ft^3).
FA	NCELL1+1	Main-tube cell-edge flow areas (m^2, ft^2).
FRIC	NCELL1+1	Main-tube additive loss coefficients (–) (see PIPE input description, Section 6.3.7.3.).
GRAV or ELEV	NCELL1+1	Main-tube gravity or elevation terms [(– or m), (– or ft)] (see PIPE input description, Section 6.3.7.3.).
HD	NCELL1+1	Main-tube hydraulic diameters (m, ft). (See NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 22. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 22 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Main-tube cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 23.

Variable	Dimension	Description
NFF	NCELL1+1	Main-tube friction-factor correlation option (see PIPE input description, Section 6.3.7.3.). Input NFF ≥ 0 for the JCELL and JCELL+1 interfaces.

Card Set 24. If NCCFL = 0 (Word 5 on Main-Data Card 6), do not input Card Set 24 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELLS+1	Main-tube countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 25 to 31.

Variable	Dimension	Description
ALP	NCELL1	Main-tube initial gas volume fractions (–).
VL	NCELL1+1	Main-tube initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELL1+1	Main-tube initial gas velocities (m s^{-1}, ft s$^{-1)}$.
TL	NCELL1	Main-tube initial liquid temperatures (K, °F).
TV	NCELL1	Main-tube initial gas temperatures (K, °F).
P	NCELL1	Main-tube initial pressures (Pa, psia).
PA	NCELL1	Main-tube initial noncondensable-gas partial pressures (Pa, psia).

Card Set 32. If NAMELIST variable MWFL = 0, do not input Card Set 32 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELL1+1	Main-tube wall-friction multiplier factor for the liquid phase (–) (0.9 ≤ WFMFL ≤ 1.1).

Card Set 33. If NAMELIST variable MWFV = 0, do not input Card Set 33 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELL1+1	Main-tube wall-friction multiplier factor for the gas phase (–) (0.9 ≤ WFMFL ≤ 1.1).

Card Sets 34 to 36. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 34 to 36 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELL1	A relative power shape (–) in the main-tube wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES; etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power shape to have a volume-averaged value of unity {each QPPP(I) is normalized to have the value QPPP(I) × [Σ_K VOL(K)]/{Σ_K QPPP(K) × VOL(K)]}. Filling the array with zeros results in no power being deposited in the wall regardless of the value of QPIN1, QPTB1, etc.
MATID	NODES-1	Wall-material ID array that specifies material ID numbers between radial nodes in the main tube. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (see available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the TEE component.
TW	NODES × NCELL1	Initial wall temperatures (K, °F) in the main tube, which are input in the same order as QPPP.

Card Set 37. If ICONC1 = 0 (Word 1 on Card Number 3), do not input Card Set 37 (array CONC).

Variable	Dimension	Description
CONC	NCELL1	Initial solute mass to liquid-coolant mass ratio [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)] in the main tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 38. If ICONC1 = 0 or 1 (Word 1 on Card Number 3), do not input Card Set 38 (array S).

Variable	Dimension	Description
S	NCELL1	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}) in the main tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 39. If NPWTB1 = 0 (Word 3 on Card Number 4), do not input Card Set 39 (array POWTB1).

Variable	Dimension	Description
POWTB1	2×|NPWTB1|	Power-to-the-fluid vs independent-variable-form table [(*,W) (*,Btu h^{-1})] for the main tube. Input |NPWTB1| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IPWSV1 (Word 2 on Card Number 4), power to the fluid]. The power is deposited directly into the main-tube fluid with a uniform power density along the main-tube length.

Card Set 40. If NPWTB1 = 0 or NPWRF1 = 0 (Words 3 and 5 on Card Number 4), do not input Card Set 40 (array POWRF1).

Variable	Dimension	Description
POWRF1	2×|NPWRF1|	Rate-factor table (*,–) for the main-tube power-to-the-fluid table independent variable. Input |NPWRF1| (Word 5 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NPWSV1 (Word 4 on Card Number 4), rate factor to be applied to the power-to-the-fluid table independent variable].

Card Set 41. If NQPTB1 = 0 (Word 3 on Card Number 5), do not input Card Set 41 (array QP3TB1).

Variable	Dimension	Description
QP3TB1	2×|NQPTB1| when QPIN1 > 0.0; (1+NCELL1) × |NQPTB1| when QPIN1 < 0.0.	Power-to-the-wall independent-variable-form table [(*,W) (*,Btu h^{-1})] for the main tube. Input |NQPTB1| (Word 3 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by IQPSV1 (Word 2 on Card Number 5), power to the wall]. If QPIN1 > 0.0 W (0.0 Btu h^{-1}), the dependent variable specifies the total power to the entire wall; if QPIN1 < 0.0 W (0.0 Btu h^{-1}), the dependent variable is a power shape that specifies the power to the wall at each cell from cell 1 to NCELL1.

Card Set 42. If NQPTB1 = 0 or NQPRF1 = 0 (Word 3 and 5 on Card Number 5), do not input Card Set 42 (array QP3RF1).

Variable	Dimension	Description
QP3RF1	2×|NQPRF1|	Rate-factor table (*,−) for the power-to-the-wall table independent variable for the main tube. Input |NQPRF1| (Word 5 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by NQPSV1 (Word 4 on Card Number 5), rate factor to be applied to the power-to-the-wall table independent variable].

Card Sets 43 to 48.

Variable	Dimension	Description
DX	NCELL2	Side-tube cell lengths (m, ft).
VOL	NCELL2	Side-tube cell volumes (m^3, ft^3).
FA	NCELL2+1	Side-tube cell-edge flow areas (m^2, ft^2).
FRIC	NCELL2+1	Side-tube additive loss coefficients (−) (see PIPE input description, Section 6.3.7.3.) [input FRIC > 0.0 for internal-junction interface 1 of the side tube when a VOL/DX flow-area change occurs between JCELL and cell 1 of the side tube].
GRAV or ELEV	NCELL2+1	Side-tube gravity elevation terms [(− or m), (− or ft)] (see PIPE input description, Section 6.3.7.3.).

Variable	Dimension	Description
HD	NCELL2+1	Side-tube hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 49. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 49 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELL2+1	Side-tube cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 50.

Variable	Dimension	Description
NFF	NCELL2+1	Side-tube friction-factor correlation option (see PIPE input description, Section 6.3.7.3.). Input NFF $\geq$ 0 for the internal-junction interface 1 of the side tube.

Card Set 51. If NCCFL = 0 (Word 5 Main-Data Card 6), do not input Card Set 51 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELL2+1	Side-tube countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 52 to 58.

Variable	Dimension	Description
ALP	NCELL2	Side-tube initial gas volume fractions (–).
VL	NCELL2+1	Side-tube initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELL2+1	Side-tube initial gas velocities (m s^{-1}, ft s$^{-1)}$.
TL	NCELL2	Side-tube initial liquid temperatures (K, °F).
TV	NCELL2	Side-tube initial gas temperatures (K, °F).
P	NCELL2	Side-tube initial pressures (Pa, psia).
PA	NCELL2	Side-tube initial noncondensable-gas partial pressures (Pa, psia).

Card Set 59. If NAMELIST variable MWFL = 0, do not input Card Set 59 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELL2+1	Side-tube wall-friction multiplier factor for the liquid phase (–) ($0.9 \leq$ WFMFL ≤ 1.1).

Card Set 60. If NAMELIST variable MWFV = 0, do not input Card Set 60 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELL2+1	Side-tube wall-friction multiplier factor for the gas phase (–) ($0.9 \leq$ WFMFL ≤ 1.1).

Card Sets 61 to 63. **Wall Heat Conduction.** If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 61 to 63 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELL2	A relative power shape (–) in the side-tube wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES; etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the power shape to have a volume-average value of unity (each QPPP(I) is normalized to have the value QPPP(I) $\times$ [Σ_K VOL(K)]/[Σ_K QPPP(K) $\times$ VOL(K)]). Filling the array with zeros results in no power being deposited in the wall regardless of the values of QPIN2, QPTB2, etc.
MATID	NODES-1	Wall-material ID array that specifies material ID numbers between nodes in the side tube. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (see available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the TEE component.
TW	NODES × NCELL2	Initial wall temperatures (K, °F) in the side tube, which are input in the same order as QPPP.

Card Set 64. If ICONC2 = 0 (Word 1 on Card Number 9), do not input Card Set 64 (array CONC).

Variable	Dimension	Description
CONC	NCELL2	Initial solute mass to liquid-coolant mass ratio [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)] in the side tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 65. If ICONC2 = 0 or 1 (Word 1 on Card Number 9), do not input Card Set 65 (array S).

Variable	Dimension	Description
S	NCELL2	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}) in the side tube. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 66. If NPWTB2 = 0 (Word 3 on Card Number 10), do not input Card Set 66 (array POWTB2).

Variable	Dimension	Description
POWTB2	2×|NPWTB2|	Power-to-the-fluid vs independent-variable-form table [(*,W), (*,Btu h^{-1})] for the side tube. Input |NPWTB2| (Word 3 on Card Number 10) table-defining data pairs having the following form [independent-variable form defined by IPWSV2 (Word 2 on Card Number 10), power to the fluid]. The power is deposited directly into the side-tube fluid with a uniform volumetric power density along the TEE side-tube length.

Card Set 67. If NPWTB2 = 0 or NPWRF2 = 0 (Words 3 and 5 on Card Number 10), do not input Card Set 67 (array POWRF2).

Variable	Dimension	Description
POWRF2	2×|NPWRF2|	Rate-factor table (*,–) for the side-tube power-to-the-fluid table independent variable. Input |NPWRF2| (Word 5 on Card Number 10) table-defining data pairs having the following form [independent-variable form defined by NPWSV2 (Word 4 on Card Number 10), rate factor to be applied to the power-to-the-fluid table independent variable].

Card Set 68. If NQPTB2 = 0 (Word 3 on Card Number 11), do not input Card Set 68 (array QP3TB2).

Variable	Dimension	Description
QP3TB2	2×|NQPTB2| when QPIN2>0.0; (1+NCELL2) × |NQPTB2| when QPIN2<0.0	Power-to-the-wall vs independent-variable form table [(*,W), (*,Btu h⁻¹)] for the side tube. Input |NQPTB2| (Word 3 on Card Number 11) table-defining data pairs having the following form [independent-variable form defined by IQPSV2 (Word 2 on Card Number 11), power to the wall]. If QPIN2 > 0.0 W (0.0 Btu h⁻¹), the dependent variable specifies the total power to the entire wall; if QPIN2 < 0.0 W (0.0 Btu h⁻¹), the dependent variable is a power shape that specifies the power to the wall at each cell from cell NCELL1 + 2 to cell NCELL1 + 1 + NCELL2.

Card Set 69. If NQPTB2 = 0 or NQPRF2 = 0 (Word 3 and 5 on Card Number 11), do not input Card Set 69 (array QP3RF2).

Variable	Dimension	Description
QP3RF2	2×|NQPRF2|	Rate-factor table (*,−) for the power-to-the-wall table independent variable for the side tube. Input |NQPRF2| (Word 5 on Card Number 11) table-defining data pairs having the following form [independent-variable form defined by NQPSV2 and NQPRF2 (Words 4 and 5 on Card Number 11), rate factor to be applied to the power-to-the-wall table independent variable].

6.3.7.9. TURB component.

Note: Turbine Status. Currently, the TURB (turbine)-component model is available only in TRAC-M/F77; it is the model inherited from TRAC-PF1/MOD2 (TRAC-P). After its installation, the TURB component received minimal support during its years in TRAC-P; it should be used with caution, in either TRAC-P or TRAC-M/F77. The TURB component will be replaced in a future TRAC-M/F90 version (post-3.0).

Note: Each turbine stage is modeled as a separate TURB component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1-4	TYPE	Component type (TURB left justified).

Columns	Variable	Description
15–28	NUM	Component ID number (must be unique for each component, $1 \leq \text{NUM} \leq 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 5I14) NCELLS, JUN1, JUN2, ICONC, IPOW

Columns	Variable	Description
1–14	NCELLS	Number of fluid cells in the TURB component.
15–28	JUN1	Junction number for the junction interface adjacent to cell 1.
29–42	JUN2	Junction number for the junction interface adjacent to cell NCELLS.
43–56	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
57–70	IPOW	Power-to-the-fluid option. 0 = no; 1 = yes.

Card Number 3. (Format 5I14) IPOWTR, IPOWSV, NPOWTB, NPOWSV, NPOWRF

Note: If IPOW = 0 (Word 5 on Card Number 2), do not input Card Number 3.

Columns	Variable	Description
1–14	IPOWTR	Trip ID number that controls evaluation of the power-to-the-fluid table defined by Card Set 38 (array POWTB) ($|\text{IPOWTR}| \leq 9999$) (input IPOWTR = 0 if there is to be no trip control and the table is to be evaluated every timestep during the transient calculation).
15–28	IPOWSV	The independent-variable ID number for the power-to-the-fluid table. IPOWSV > 0 defines the ID number for a signal-variable parameter; IPOWSV < 0 defines the ID number for a control-block output parameter.

Columns	Variable	Description
29–42	NPOWTB	The number of power-to-the-fluid table data pairs (defined by the absolute value of NPOWTB). NPOWTB > 0 defines the table independent-variable form to be the IPOWSV parameter; NPOWTB < 0 defines the table independent-variable form to be the sum of the change in the IPOWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-fluid table is trip controlled); NPOWTB = 0 defines the power to the fluid to be the IPOWSV parameter.
43–56	NPOWSV	The independent-variable ID number for the rate factor that is applied to the power-to-the-fluid table independent variable. NPOWSV > 0 defines the ID number for a signal-variable parameter; NPOWSV < 0 defines the ID number for a control-block output parameter; NPOWSV = 0 (when NPOWRF ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power table is trip controlled.
57–70	NPOWRF	The number of rate-factor table data pairs (defined by the absolute value of NPOWRF). The rate factor is applied as a factor to the power-to-the-fluid table independent variable when the rate factor is defined. No rate factor is defined when NPOWSV and NPOWRF are both zero. NPOWRF > 0 defines the rate-factor table independent variable to be the NPOWSV parameter; NPOWRF < 0 defines it to be the sum of the change in the NPOWSV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-fluid table is trip controlled); NPOWRF = 0 defines the rate factor to be the NPOWSV parameter.

Card Number 4. (Format 4E14.4) POWIN, POWOFF, RPOWMX, POWSCL

Note: If IPOW = 0 (Word 5 on Card Number 2), do not input Card Number 4.

Columns	Variable	Description
1–14	POWIN	Initial total power (W, Btu h^{-1}) deposited in (to) the TURB fluid [not used when IPOW = 0 (Word 5 on Card Number 2)]. The power is distributed uniformly along the TURB length.

Columns	Variable	Description
15–28	POWOFF	Total power (W, Btu h^{-1}) to the fluid when the controlling trip is OFF after being ON [not used if IPOWTR = 0 (Word 1 on Card Number 3)]. If POWOFF $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1}), the power to the fluid is held constant at the last table-evaluated power when the trip was ON.
29–42	RPOWMX	Maximum rate of change of power (W s^{-1}, Btu h^{-1} s^{-1}) to the TURB fluid [RPOWMX ≥ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})] [not used when IPOW = 0 (Word 5 on Card Number 2)].
43–56	POWSCL	Scale factor (–) for the power-to-the-fluid table. The dependent variable in the table, defined by Card Set 38 (array POWTB), is multiplied by POWSCL to obtain the absolute power (W, Btu h^{-1}) to the fluid [not used when IPOW = 0 (Word 5 on Card Number 2) or NPOWTB = 0 (Word 3 on Card Number 3)].

Card Number 5. (Format 2I14, E14.4) ISTG, NEFCON, EFFDSN

Columns	Variable	Description
1–14	ISTG	Turbine stage number of this TURB (if there is only one stage in the turbine, ISTG = 1).
15–28	NEFCON	Turbine-stage efficiency option. 0 = computed internally; 1 = treated as a constant.
29–42	EFFDSN	Stage efficiency at design conditions (include windage loss, diaphragm-packing loss, moisture loss, and nozzle-end loss; thus, stage efficiency equals nozzle-bucket efficiency minus all the losses listed above). **Note:** If NEFCON = 1, the EFFDSN value is used for stage efficiency under all conditions. If NEFCON = 0, the stage efficiency at the off-design condition is calculated using EFFDSN. If NEFCON = 0 and EFFDSN = 0.0, TRAC-M calculates a realistic value of EFFDSN from parameters input on Card Numbers 6 to 8 and Card Set 15.

Card Number 6. (Format 5E14.4) PRES1, PRES2, QUALTY, SUPRHT, FLOW

Note: All parameters entered on Card Number 6 should be consistent with the stage efficiency at design conditions, EFFDSN (Word 3 on Card Number 5).

Columns	Variable	Description
1–14	PRES1	Stage upstream design pressure (Pa, psia).
15–28	PRES2	Stage downstream design pressure (Pa, psia).
29–42	QUALTY	Stage upstream design quality of steam (–) (if superheated, QUALTY = 1.0).
43–56	SUPRHT	Stage upstream superheat of steam at design conditions (K, °F) (if wet steam, SUPRHT = 0.0).
57–70	FLOW	Mixture mass flow (kg s^{-1}, lb$_m$ h^{-1}) at design conditions.

Card Number 7. (Format 5E14.4) DIA, COEF1, COEF2, COF3SQ, REACTN

Note: If NEFCON = 1 (Word 2 on Card Number 5), do not input Card Number 7.

Columns	Variable	Description
1–14	DIA	Pitch circle diameter (m, ft) of the buckets.
15–28	COEF1	Nozzle coefficient (–). The nozzle exit velocity is calculated by multiplying the ideal isentropic velocity by COEF1.
29–42	COEF2	Bucket coefficient (–). The bucket exit velocity is calculated by multiplying the ideal isentropic velocity by COEF2.
43–56	COF3SQ	Fraction of reaction energy actually delivered in the entire stage (–) [the reaction loss coefficient is based on the energy (velocity^2) instead of the velocity].
57–70	REACTN	Degree of reaction at design conditions (–) (if impulse stage, REACTN = 0.0).

Card Number 8. (Format I14) NROWS

Note: If NEFCON = 1 (Word 2 on Card Number 5), do not input Card Number 8.

Columns	Variable	Description
1–14	NROWS	Number of rows of moving and stationary blades in turbine-stage ISTG (Word 1 on Card Number 5).

Note: Input for ISTG = 1. If ISTG ≠ 1 (Word 1 on Card Number 5), do not input Card Numbers 9 to 13 and Card Sets Number 14 to 16.

Card Number 9. (Format I14) NSTGES

Columns	Variable	Description
1–14	NSTGES	Total number of stages associated with the entire turbine.

Card Number 10. (Format 5I14) ITRBTR, ITRBSV, NTRBTB, NTRBSV, NTRBRF

Columns	Variable	Description
1–14	ITRBTR	Trip ID number that controls the evaluation of the generator power-demand table ($|\text{ITRBTR}| \leq 9999$) (ITRBTR = 0 implies constant power demand).
15–28	ITRBSV	The independent-variable ID number of the generator power-demand table. ITRBSV > 0 defines the ID number for a signal-variable parameter; ITRBSV < 0 defines the ID number for a control-block output parameter.
29–42	NTRBTB	The number of generator power-demand table data pairs (defined by the absolute value of NTRBTB). NTRBTB > 0 defines the table independent-variable form to be the ITRBSV parameter; NTRBTB < 0 defines the table independent-variable form to be the sum of the change in the ITRBSV parameter over the last timestep times the trip set-status value ISET during that timestep; NTRBTB = 0 defines the generator power-demand to be the ITRBSV parameter.
43–56	NTRBSV	The independent-variable ID number of the rate-factor table. NTRBSV defines the independent-variable parameter for the rate-factor table that is applied as a factor to the generator power-demand table independent variable. NTRBSV > 0 defines the ID number for a signal-variable parameter; NTRBSV < 0 defines the ID number for a control-block output parameter; NTRBSV = 0 (when NTRBRF ≠ 0) defines the difference between the trip signal and the setpoint value that turns the trip OFF.

Columns	Variable	Description
57–70	NTRBRF	The number of rate-factor table data pairs (defined by the absolute value of NTRBRF). The rate factor is applied as a factor to the generator power-demand table independent variable when the rate factor is defined. No rate factor is defined when NTRBSV and NTRBRF are both zero. NTRBRF > 0 defines the rate-factor table's abscissa coordinate to be the NTRBSV parameter; NTRBRF < 0 defines it to be the sum of the change in the NTRBSV parameter over each timestep times the trip set-status value ISET during that timestep; NTRBRF = 0 defines the rate factor to be the NTRBSV parameter.

Card Number 11.　(Format 4E14.4) POWOP, POPOFF, RPOPMX, POPSCL

Columns	Variable	Description
1–14	POWOP	Initial generator operating power (W, Btu h^{-1}).
15–28	POPOFF	Generator operating power (W, Btu h^{-1}) when the generator operating-power controlling trip is OFF after being ON [maintain the last table-evaluated generator operating power when the trip was ON if POPOFF $\leq$ -10^{19} W (-3.41×10^{19} Btu h^{-1}); not used when ITRBTR =0 (Word 1 on Card Number 10)].
29–42	RPOPMX	Maximum rate of change of generator operating power (W s^{-1}, Btu h^{-1} s^{-1}) [RPOPMX $\geq$ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	POPSCL	Scale factor (–) for the generator operating-power table. The dependent variable in the generator operating-power table defined by Card Set 15 (array TRBTB) is multiplied by POPSCL to obtain the absolute generator operating power (W, Btu h^{-1}).

Card Number 12. (Format 4E14.4) POWD, OMEGD, OMEGOP, EFGEN

Columns	Variable	Description
1–14	POWD	Generator design power (W, Btu h^{-1}) [must be consistent with parameters entered on Card Number 6 and EFFDSN (Word 3 on Card Number 5)].
15–28	OMEGD	Turbine/generator design speed (rad s^{-1}, rpm) [must be consistent with POWD, parameters input on Card Number 6, and EFFDSN (Word 3 on Card Number 5)].

Columns	Variable	Description
29–42	OMEGOP	Turbine/generator initial operating speed (rad s⁻¹, rpm).
43–56	EFGEN	Generator efficiency (–).

Card Number 13. (Format 4E14.4) ATORK, BTORK, CTORK, INRTA

Columns	Variable	Description
1–14	ATORK	Turbine/generator friction torque zero-order coefficient (Pa m^3 or N m, lb$_f$ ft) [the friction torque is defined by ATORK + BTORK $\times$ Ω + CTORk Ω^2, where Ω is the turbine generator operating speed (rad s⁻¹, rpm)].
15–28	BTORK	Turbine/generator friction torque first-order coefficient (Pa m^3 s rad⁻¹, lb$_f$ ft rpm⁻¹).
29–42	CTORK	Turbine/generator friction torque second-order coefficient (Pa m^3 s^2 rad⁻², lb$_f$ ft rpm⁻²).
43–56	INRTA	Moment of inertia of the entire turbine/generator assembly (kg m^2, lb$_m$ ft^2).

Card Set 14.

Variable	Dimension	Description
NCOMP	NSTGES–1	Component numbers for the associated stages that complete the entire turbine assembly.

Card Set 15. If NTRBTB = 0 (Word 3 on Card Number 10), do not input Card Set 15 (array TRBTB).

Variable	Dimension	Description
TRBTB	2×|NTRBTB|	Generator power-demand vs independent-variable-form table [(*,W), (*, Btu h⁻¹)]. Input |NTRBTB| (Word 3 on Card Number 10) table-defining data pairs having the following form [independent-variable form defined by ITRBSV (Word 2 on Card Number 10), generator power demand].

Card Set 16. If NTRBTB = 0 or NTRBRF = 0 (Words 3 and 5 on Card Number 10), do not input Card Set 16 (array TRBRF).

Variable	Dimension	Description
TRBRF	2×|NTRBRF|	Rate-factor table (*,–) for the generator power-demand table independent variable. Input |NTRBRF| (Word 5 on Card Number 10) table-defining data pairs having the following form [independent-variable form defined by NTRBSV (Word 4 on Card Number 10), rate factor to be applied to the generator power-demand table independent variable].

Card Set 17. If NEFCON = 1 (Word 2 on Card Number 5), do not input Card Set 17 (array ANGL).

Variable	Dimension	Description
ANGL	2 × NROWS	Nozzle-exit and blade angles (rad, deg). Input as follows: steam-exit angle from the nozzle, first moving-blade exit angle, first stationary-blade exit angle, second moving-blade exit angle, etc., NROWS (Word 1 on Card Number 8) moving-blade exit angle.

TURB Array Cards. Input 22 Card Sets, 1 set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of 1 or more cards.

Card Sets 18 to 23.

Variable	Dimension	Description
DX	NCELLS	Cell lengths (m, ft).
VOL	NCELLS	Cell volumes (m³, ft³).
FA	NCELLS+1	Cell-edge flow areas (m², ft²).
FRIC	NCELLS+1	Additive loss coefficients (–) [FRIC(2) and FRIC(3) must be 0.0] (see PIPE input description, Section 6.3.7.3.).
GRAV or ELEV	NCELLS+1	Gravity or elevation terms [(– or m), (– or ft)] (see PIPE input description, Section 6.3.7.3.).
HD	NCELLS+1	Hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 24. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 24 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.) (suggested value: 0).

Card Set 25.

Variable	Dimension	Description
NFF	NCELLS+1	Friction-factor correlation option (see PIPE input description, Section 6.3.7.3.) (suggested value: 1).

Card Set 26. If NCCFL = 0 (Word 5 Main-Data Card 6), do not input Card Set 26 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELLS+1	Countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 27 to 33.

Variable	Dimension	Description
ALP	NCELLS	Initial gas volume fractions (–).
VL	NCELLS+1	Initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELLS+1	Initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELLS	Initial liquid temperatures (K, °F).
TV	NCELLS	Initial gas temperatures (K, °F).
P	NCELLS	Initial pressures (Pa, psia).
PA	NCELLS	Initial noncondensable-gas partial pressures (Pa, psia).

Card Set 34. If NAMELIST variable MWFL = 0, do not input Card Set 34 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELLS+1	Wall-friction multiplier factor for the liquid phase (–) [$0.9 \leq WFMFL \leq 1.1$].

Card Set 35. If NAMELIST variable MWFV = 0, do not input Card Set 35 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELLS+1	Wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 36. If ICONC = 0 (Word 4 on Card Number 2), do not input Card Set 36 (array CONC).

Variable	Dimension	Description
CONC	NCELLS	Initial solute mass to liquid-coolant mass ratio [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 37. If ICONC = 0 or 1 (Word 4 on Card Number 2), do not input Card Set 37 (array S).

Variable	Dimension	Description
S	NCELLS	Initial macroscopic density of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 38. If IPOW = 0 (Word 5 on Card Number 2) or NPOWTB = 0 (Word 3 on Card Number 3), do not input Card Set 38 (array POWTB).

Variable	Dimension	Description
POWTB	2×|NPOWTB|	Power-to-the-fluid vs independent-variable-form table [(*,W), (*,Btu h^{-1})]. Input |NPOWTB| (Word 3 on Card Number 3) table-defining data pairs having the following form [independent-variable form defined by IPOWSV (Word 2 on Card Number 3), power to the fluid]. The power is deposited directly into the fluid in the turbine with a uniform volumetric power density along the TURB length.

Card Set 39. If IPOW = 0 (Word 5 on Card Number 2), NPOWTB = 0, or NPOWRF = 0 (Words 3 and 5 on Card Number 3), do not input Card Set 39 (array POWRF).

Variable	Dimension	Description
POWRF	2×|NPOWRF|	Rate-factor table (*,–) for the power-to-the-fluid table independent variable. Input |NPOWRF| (Word 5 on Card Number 3) table-defining data pairs having the following form [independent-variable form defined by NPOWSV (Word 4 on Card Number 3), rate factor to be applied to the power-to-the-fluid table independent variable].

6.3.7.10. VALVE component.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–5	TYPE	Component type (VALVE left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \le$ NUM ≤ 999).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 4I14,E14.4) NCELLS, NODES, JUN1, JUN2, EPSW

Columns	Variable	Description
1–14	NCELLS	Number of fluid cells (NCELLS ≥ 2).
15–28	NODES	Number of radial heat-transfer nodes in the VALVE wall. A value of zero specifies no wall heat transfer.
29–42	JUN1	Junction number for junction interface adjacent to cell 1.
43–56	JUN2	Junction number for junction interface adjacent to cell NCELLS.
57–70	EPSW	Wall surface roughness (m, ft).

Card Number 3. (Format 5I14) ICHF, ICONC, IVTY, IVPS, NVTB2

Columns	Variable	Description
1–14	ICHF	CHF-calculation option. 0 = no; 1 = yes.
15–28	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.
29–42	IVTY	Valve-type option. 0 = constant flow area; 1 = flow-area fraction vs independent-variable-form table is evaluated; 2 = relative valve-stem position (0.0 = fully closed, 1.0 = fully opened) vs independent-variable-form table is evaluated; 3 = constant flow area until trip IVTR (Word 1 on Card Number 4) is set ON, then flow-area fraction vs independent-variable-form table is evaluated; 4 = constant relative valve-stem position until trip IVTR (Word 1 on Card Number 4) is set ON, then relative valve-stem position vs independent-variable-form table is evaluated; 5 = valve is to be operated by a special turbine-
43–56	IVPS	Mesh-cell interface number where the VALVE flow area is adjusted (1 < IVPS < NCELLS + 1 unless a BREAK is connected to a VALVE junction; then IVPS can equal that junction interface 1 or NCELLS + 1).
57–70	NVTB2	Number of second valve table data pairs (defined by the absolute value of NVTB2). Input NVTB2 = 0 when IVTY = 0, 1, 2, 5, or 6 (Word 3 on Card Number 3). For IVTY = 3 or 4, NVTB2 > 0 defines the table independent-variable form to be the IVSV (Word 2 on Card Number 4) parameter; NVTB2 < 0 defines the second valve table independent-variable form to be the sum of the change in the IVSV parameter over each timestep times the trip set-status value ISET during that timestep (when the valve table is trip controlled); NVTB2 = 0 [when NVTB1 = 0 (Word 3 on Card Number 4)] defines the valve flow-area fraction or relative valve-stem position to be the IVSV parameter value. When NVTB2= 0and NVTB1 ≠0, no second valve table is defined. Only the first valve table is used.

Columns	Variable	Description
		When NVTB2 ≠ 0, then NVTB1 ¦ 0, and then NVTB2 and NVTB1 must have the same numerical sign, and the first valve table is evaluated when the controlling trip is set to $ON_{Forward}$, and the second valve table is evaluated when the trip is set to $ON_{Reverse}$. NVTB1 = 0, and NVTB2 ≠ 0 is invalid.

Note: Valve-Type Options 5 and 6. For valve-type option IVTY = 5 or 6, variables NVTB2 (Word 5 on Card Number 3) and IVSV, NVTB1, NVSV, and NVRF (Words 2 to 5 on Card Number 4) are defined to be zero or left blank, and the Card Sets 32 to 34 (arrays VTB1, VTB2, and VRF) are not input.

Card Number 4. (Format 5I14) IVTR, IVSV, NVTB1, NVSV, NVRF

Columns	Variable	Description
1–14	IVTR	Trip ID number for valve-type options when IVTY = 3 or 4 (Word 3 on Card Number 3) ($|IVTR| \leq 9999$) or the component number of turbine stage 1 for valve-type options when IVTY = 5 or 6 ($1 \leq IVTR \leq 999$).
15–28	IVSV	The independent variable ID number for the valve table. IVSV > 0 defines the ID number for a signal-variable parameter; IVSV < 0 defines the ID number for a control-block output parameter.
29–42	NVTB1	The number of first valve table data pairs (defined by the absolute value of NVTB1). Input NVTB1 = 0 when IVTY = 0, 5, or 6 (Word 3 on Card Number 3). For IVTY = 1 to 4, NVTB1 > 0 defines the first valve table independent-variable form to be the IVSV (Word 2 on Card Number 4) parameter; NVTB1 < 0 defines the table independent-variable form to be the sum of the change in the IVSV parameter over each timestep times the trip set-status value ISET during that timestep (when the valve table is trip controlled); NVTB1 = 0 defines the valve flow-area fraction or relative valve-stem position (depending on the value of IVTY) to be the IVSV parameter.
43–56	NVSV	The independent-variable ID number for the rate factor that is applied to the first (and second when defined) valve table independent variable. NVSV > 0 defines the ID number for a signal-variable parameter; NVSV < 0 defines the ID number for a control-block output parameter; NVSV = 0 (when NVRF ≠ 0) defines

Columns	Variable	Description
		the difference between the trip signal and the setpoint value that turns the trip OFF when the valve table is trip controlled.
57–70	NVRF	The number of rate-factor table data pairs (defined by the absolute value of NVRF). The rate factor is applied as a factor to the first (and second when defined) valve table independent variable when the rate factor is defined. No rate factor is defined when NVSV and NVRF are both zero. NVRF > 0 defines the rate-factor table independent variable to be the NVSV parameter; NVRF < 0 defines it to be the sum of the change in the NVSV parameter over each timestep times the trip set-status value ISET during that timestep (when the valve table is trip controlled); NVRF = 0 defines the rate factor to be the NVSV parameter.

Card Number 5. (Format 5I14) IQP3TR, IQP3SV, NQP3TB, NQP3SV, NQP3RF

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 5.

Columns	Variable	Description
1–14	IQP3TR	Trip ID number that controls the evaluation of the power-to-the-wall table defined by Card Set 37 (array QP3TB) [	IQP3TR	≤ 9999]. [input IQP3TR = 0 when there is to be no trip control and the table is to be evaluated every timestep during the transient calculation].
15–28	IQP3SV	The independent-variable ID number for the power-to-the-wall table. IQP3SV > 0 defines the ID number for a signal-variable parameter; IQP3SV < 0 defines the ID number for a control-block output parameter.
29–42	NQP3TB	The number of power-to-the-wall table data pairs (defined by the absolute value of NQP3TB). NQP3TB > 0 defines the table independent-variable form to be the IQP3SV parameter; NQP3TB < 0 defines the table independent-variable form to be the sum of the change in the IQP3SV parameter over each timestep times the trip set-status value ISET during that timestep (when the power-to-the-wall table is trip controlled); NQP3TB = 0 defines the power to the wall to be the IQP3SV parameter.

Columns	Variable	Description
43–56	NQP3SV	The independent-variable ID number for the rate factor that is applied to the power-to-the-wall table's independent variable. NQP3SV > 0 defines the ID number for a signal-variable parameter; NQP3SV < 0 defines the ID number for a control-block output parameter; NQP3SV = 0 (when NQP3RF ≠ 0) defines the independent variable to be the difference between the trip signal and the setpoint value that turns the trip OFF when the power-to-the-wall table is trip controlled.
57–70	NQP3RF	The number of rate-factor table data pairs (defined by the absolute value of NQP3RF). The rate factor is applied as a factor to the power-to-the-wall table's (QP3TB) independent variable when the rate factor is defined. No rate factor is defined when NQP3SV and NQP3RF are both zero. NQP3RF > 0 defines the rate-factor table's independent variable to be the NQP3SV parameter; NQP3RF < 0 defines it to be the change in the NQP3SV parameter over the last timestep times the trip set-status value ISET when the power-to-the-wall table is trip controlled; NQP3RF = 0 defines the rate factor to be the NQP3SV parameter.

Card Number 6. (Format 2I14) IVTROV, IVTYOV

Columns	Variable	Description
1–14	IVTROV	Trip ID number that overrides valve adjustments with or without trip ID number IVTR (Word 1 on Card Number 4) control and opens (ON$_{Forward}$) or closes (ON$_{Reverse}$) the valve at the constant rate RVOV (Word 2 on Card Number 7) when trip ID number IVTROV is ON [input IVTROV = 0 when IVTY = 5 or 6 (Word 3 on Card Number 3)] ($|$IVTROV$|$ ≤ 9999).
15–28	IVTYOV	The type of flow-area adjustment by RVOV when the overriding trip ID number IVTROV is ON (not used when IVTY = 5 or 6). 0 = flow-area fraction per second; 1 = relative valve-stem position per second.

Card Number 7. (Format 4E14.4) RVMX, RVOV, FMINOV, FMAXOV

Columns	Variable	Description
1–14	RVMX	Maximum rate of VALVE flow-area fraction or relative valve-stem position adjustment (s^{-1}).
15–28	RVOV	Rate of VALVE flow-area adjustment (s^{-1}) when the overriding trip ID number IVTROV (Word 1 on Card Number 6) is ON (not used when IVTY = 5 or 6).
29–42	FMINOV	The minimum flow-area fraction (IVTYOV = 0) or minimum relative valve-stem position (IVTYOV = 1) during valve adjustment by the overriding trip ID number IVTROV ($0.0 \leq$ FMINOV < FMAXOV).
43–56	FMAXOV	The maximum flow-area fraction (IVTYOV = 0) or maximum relative valve-stem position (IVTYOV = 1) during valve adjustment by the overriding trip ID number IVTROV (FMINOV < FMAXOV ≤ 1.0).

Card Number 8. (Format 5E14.4) RADIN, TH, HOUTL, HOUTV, TOUTL

Columns	Variable	Description
1–14	RADIN	Inner radius (m, ft) of the VALVE wall.
15–28	TH	Wall thickness (m, ft) of the VALVE wall.
29–42	HOUTL	Heat-transfer coefficient (HTC) (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the VALVE wall and the liquid outside the VALVE wall.
43–56	HOUTV	HTC (W m^{-2} K^{-1}, Btu ft^{-2} °F^{-1} h^{-1}) between the outer boundary of the VALVE wall and the gas outside the VALVE wall.
57–70	TOUTL	Liquid temperature (K, °F) outside the VALVE wall.

Note: See the PIPE input description, Section 6.3.7.3., for further comments on the HOUTL, HOUTV, TOUTL, and TOUTV (Card Number 9) heat-transfer parameters.

Card Number 9. (Format 5E14.4) TOUTV, AVLVE, HVLVE, FAVLVE, XPOS

Columns	Variable	Description
1–14	TOUTV	Gas temperature (K, °F) outside the VALVE wall.
15–28	AVLVE	VALVE adjustable-interface flow area (m^2, ft^2) when the VALVE adjustable-interface IVPS is at a flow-area fraction or relative valve-stem position of 1.0 corresponding to 100% open.

Columns	Variable	Description
29–42	HVLVE	VALVE adjustable-interface hydraulic diameter (m, ft) when the VALVE adjustable-interface is 100% open.
43–56	FAVLVE	Initial flow-area fraction at the VALVE adjustable-interface IVPS (Word 4 on Card Number 3) ($0.0 \leq$ FAVLVE ≤ 1.0). If FAVLVE < 0.0 or FAVLVE > 1.0 is input, a consistent value of FAVLVE is evaluated internally by TRAC-M based on the input value of XPOS.
57–70	XPOS	Initial relative valve-stem position at the VALVE adjustable-interface IVPS (0.0 = no flow area, valve closed; 1.0 = AVLVE flow area, valve 100% opened). If $0.0 \leq$ FAVLVE ≤ 1.0 is input, a consistent value for XPOS is evaluated internally by TRAC-M based on the valve stem controlling a guillotine closure of a circular flow-area cross section. Otherwise, a consistent value of FAVLVE is evaluated internally by TRAC-M based on $0.0 \leq$ XPOS ≤ 1.0 that is input.

Card Number 10. (Format 4E14.4) QP3IN, QP3OFF, RQP3MX, QP3SCL

Note: If NODES = 0 (Word 2 on Card Number 2), do not input Card Number 10.

Columns	Variable	Description
1–14	QP3IN	Initial power (W, Btu h^{-1}) deposited in (to) the wall and distributed according to the QPPP array. If QP3IN > 0.0 W (0.0 Btu h^{-1}), it is the total power to the entire wall. When QP3IN < 0.0 W (0.0 Btu h^{-1}), the initial power to the wall in each cell is $|$QP3IN$|$, and the negative sign indicates the power to the wall is to be a cell-dependent array of NCELLS (Word 1 on Card Number 2) powers. Each data pair of the power-to-the-wall table [for QP3IN < 0.0 W (0.0 Btu h^{-1})] has 1 + NCELLS values (an independent-variable value and NCELLS power values for cells 1 through NCELLS). When the power-to-the-wall table is not being evaluated, the same power value of $|$QP3IN$|$ or QP3OFF [if QP3OFF $> -10^{19}$ W (-3.41×10^{19} Btu h^{-1})] is applied at each of the NCELLS cells.
15–28	QP3OFF	Power (W, Btu h^{-1}) to the wall when the controlling trip is OFF after being ON [not used if IQP3TR = 0 (Word 1 on Card Number 5); use the last table-evaluated power when the trip was ON if QP3OFF $\leq -10^{19}$ W (-3.41×10^{19} Btu h^{-1})].

Columns	Variable	Description
29–42	RQP3MX	Maximum rate of change of the power to the wall (W s^{-1}, Btu h^{-1} s^{-1}) [RQP3MX $\geq$ 0.0 W s^{-1} (0.0 Btu h^{-1} s^{-1})].
43–56	QP3SCL	Scale factor (–) for the power-to-the-wall table. The dependent variable in the table defined by Card Set 37 (array QP3TB) is multiplied by QP3SCL to obtain the absolute power (W, Btu h^{-1}) to the wall.

VALVE Array Cards. Input 28 Card Sets, one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 11 to 16.

Variable	Dimension	Description
DX	NCELLS	Cell lengths (m, ft).
VOL	NCELLS	Cell volumes (m^3, ft^3).
FA	NCELLS+1	Cell-edge flow areas (m^2, ft^2).
FRIC	NCELLS+1	Additive loss coefficients (–) (see PIPE input description, Section 6.3.7.3.).
GRAV or ELEV	NCELLS+1	Gravity or elevation terms [(– or m), (– or ft)] (see PIPE input description, Section 6.3.7.3.).
HD	NCELLS+1	Hydraulic diameters (m, ft) (see NAMELIST variable NDIA1 for additional input of heat-transfer diameters).

Card Set 17. If NAMELIST variable ICFLOW = 0 or 1, do not input Card Set 17 (array ICFLG).

Variable	Dimension	Description
ICFLG	NCELLS+1	Cell-edge choked-flow model option (see PIPE input description, Section 6.3.7.3.).

Card Set 18.

Variable	Dimension	Description
NFF	NCELLS+1	Friction-factor correlation option (see PIPE input description, Section 6.3.7.3.).

Card Set 19. If NCCFL = 0 (Word 5 on Main-Data Card 6), do not input Card Set 19 (array LCCFL).

Variable	Dimension	Description
LCCFL	NCELLS+1	Countercurrent flow limitation option (see PIPE input description, Section 6.3.7.3.).

Card Sets 20 to 26.

Variable	Dimension	Description
ALP	NCELLS	Initial gas volume fractions (–).
VL	NCELLS+1	Initial liquid velocities (m s^{-1}, ft s^{-1}).
VV	NCELLS+1	Initial gas velocities (m s^{-1}, ft s^{-1}).
TL	NCELLS	Initial liquid temperatures (K, °F).
TV	NCELLS	Initial gas temperatures (K, °F).
P	NCELLS	Initial pressures (Pa, psia).
PA	NCELLS	Initial noncondensable-gas partial pressure (Pa, psia).

Card Set 27. If NAMELIST variable MWFL = 0, do not input Card Set 27 (array WFMFL).

Variable	Dimension	Description
WFMFL	NCELLS+1	Wall-friction multiplier factor for the liquid phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Set 28. If NAMELIST variable MWFV = 0, do not input Card Set 28 (array WFMFV).

Variable	Dimension	Description
WFMFV	NCELLS+1	Wall-friction multiplier factor for the gas phase (–) [0.9 ≤ WFMFL ≤ 1.1].

Card Sets 29 to 31. Wall Heat Conduction. If NODES = 0 (Word 2 on Card Number 2), do not input Card Sets 29 to 31 (arrays QPPP, MATID, and TW).

Variable	Dimension	Description
QPPP	NODES × NCELLS	A relative power shape (–) in the VALVE wall. Input values for cell 1, node 1 through NODES; then cell 2, node 1 through NODES; etc. If the array is filled with the same nonzero constant, a uniform volumetric heat source in the wall results. TRAC-M internally normalizes the shape to have a volume-average value of unity {each QPPP(I) is normalized to have the value $QPPP(I) \times [\Sigma_K VOL(K)]/[\Sigma_K QPPP(K) \times VOL(K)]$}. Filling the array with zeros results in no power being deposited in the wall regardless of the values of QP3IN, QP3TB, etc.
MATID	NODES–1	Wall-material ID array that specifies material ID numbers between radial nodes. Dimension is 1 if NODES = 1 and 0 if NODES = 0 (see available built-in properties listed under array MATRD in the HTSTR component input description, Section 6.3.7.2., or see Section 6.3.3. for user-specified material properties that are input). **Note:** Material-properties ID numbers 1–5 and 11 are not available for the VALVE component.
TW	NODES × NCELLS	Initial wall temperatures (K, °F) in the VALVE that are input in the same order as QPPP.

Card Set 32. If ICONC = 0 (Word 2 on Card Number 3), do not input Card Set 32 (array CONC).

Variable	Dimension	Description
CONC	NCELLS	Initial solute mass to liquid-coolant mass ratios [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m$$^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 33. If ICONC = 0 or 1 (Word 2 on Card Number 3), do not input Card Set 33 (array S).

Variable	Dimension	Description
S	NCELLS	Initial macroscopic densities of plated-out solute (kg m^{-3}, lb$_m$ ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 34. If NVTB1 = 0 (Word 3 on Card Number 4), do not input Card Set 34 (array VTB1).

Variable	Dimension	Description
VTB1	2×|NVTB1|	First valve-adjustment table (*,–). Input |NVTB1| (Word 3 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by IVSV (Word 2 on Card Number 4), flow-area fraction or relative valve-stem position]. Table VTB1 is used when IVTY = 1 to 4.

Card Set 35. If NVTB2 = 0 (Word 5 on Card Number 3), do not input Card Set 35 (array VTB2).

Variable	Dimension	Description
VTB2	2×|NVTB2|	Second valve-adjustment table (*,–). Input |NVTB2| (Word 5 on Card Number 3) table-defining data pairs having the following form [independent-variable form defined by IVSV (Word 2 on Card Number 4), flow-area fraction or relative valve-stem position]. If NVTB2 ≠ 0 when IVTY = 3 or 4, define the flow-area fraction or relative valve-stem position values in the second valve-adjustment table to vary in the same direction as they do in the first valve adjustment tableVTB1; that is, if the flow-area fraction or relative valve-stem position increases in going from left to right in the first valve-adjustment table, define them in the second valve-adjustment table to increase in going from left to right as well.

Card Set 36. If NVTB1 = 0 or NVRF = 0 (Words 3 and 5 on Card Number 4), do not input Card Set 36 (array VRF).

Variable	Dimension	Description
VRF	2×|NVRF|	Rate-factor table (*,–) for the first (and second if NVTB2 ≠ 0) valve-adjustment table independent variable. Input |NVRF| (Word 5 on Card Number 4) table-defining data pairs having the following form [independent-variable form defined by NVSV (Word 4 on Card Number 4), rate factor to be applied to the valve-adjustment table independent variable].

Card Set 37. If NQP3TB = 0 (Word 3 on Card Number 5), do not input Card Set 37 (array QP3TB).

Variable	Dimension	Description
QP3TB	2×|NQP3TB| when QP3IN > 0.0; (1+NCELLS) × |NQP3TB| when QP3IN < 0.0.	Power-to-the-wall independent-variable-form table [(*,W), (*,Btu h^{-1})]. Input |NQP3TB| (Word 3 on Card Number 5) table-defining data pairs having the following form [independent-variable form defined by IQP3SV (Word 2 on Card Number 5), power to the wall]. If QP3IN > 0.0 W (0.0 Btu h^{-1}), the dependent variable specifies the total power to the entire wall; if QP3IN < 0.0 W (0.0 Btu h^{-1}), the dependent variable is a power shape that specifies the power to the wall at each cell from cell 1 to cell NCELLS.

Card Set 38. If NQP3TB = 0 or NQP3RF = 0 (Words 3 and 5 on Card Number 5), do not input Card Set 38 (array QP3RF).

Variable	Dimension	Description
QP3RF	2×|NQP3RF|	Rate-factor table (*,–) for the power-to-the-wall table independent variable. Input |NQP3RF| table-defining data pairs having the following form [independent-variable form defined by NQP3SV (Word 4 on Card Number 5), rate factor to be applied to the power-to-the-wall table independent variable].

6.3.7.11. VESSEL component.

Note: FILL, BREAK, and PLENUM components cannot be connected to VESSEL component source-connection junctions.

Card Number 1. (Format A14,2I14,A30) TYPE, NUM, ID, CTITLE

Columns	Variable	Description
1–6	TYPE	Component type (VESSEL left justified).
15–28	NUM	Component ID number (must be unique for each component, $1 \leq NUM \leq 999$).
29–42	ID	User ID number (arbitrary).
43–72	CTITLE	Hollerith component description.

Card Number 2. (Format 5I14) NASX, NRSX, NTSX, NCSR, IVSSBF

Columns	Variable	Description
1–14	NASX	Number of axial (z-direction) cells (levels).
15–28	NRSX	Number of radial (r-direction) cells (rings) or x-direction cells. [IGEOM (Word 1 on Card Number 5) defines cylindrical or Cartesian geometry].
29–42	NTSX	Number of azimuthal (θ-direction) cells (sectors) or y-direction cells.
43–56	NCSR	Number of 1D hydraulic-component (but not BREAK, FILL, or PLENUM component) junction connections to VESSEL-component cell interfaces. Each of the six VESSEL-cell interfaces can have any number of 1D hydraulic-component junction connections.
57–70	IVSSBF	Axial boundary-condition option [IVSSBF > 0 requires additional input of level data for axial cells (levels) 0 and NASX + 1 to define their constant FILL or BREAK cell boundary condition].

Note: The r- or x-directional and the θ- or y-directional boundaries below axial cell (level) 1 and above axial cell (level) NASX are no-flow walls.

0 = no-flow wall below axial cell (level) 1 and above axial cell (level) NASX (default);

2 = axial cell (level) 0 defines a FILL and axial cell (level) NASX + 1 defines a BREAK boundary condition;

20 = axial cell (level) 0 defines a BREAK boundary condition and axial cell (level) NASX + 1 defines a FILL boundary condition;

22 = both axial cells (levels) 0 and NASX+1 define a BREAK.

Card Number 3. (Format 5I14) IDCU, IDCL, IDCR, ICRU, ICRL

Columns	Variable	Description
1–14	IDCU	Axial cell (level) number at which its upper interface is the downcomer upper-boundary elevation. If no downcomer is present, input IDCU = 0 (this is the necessary and sufficient condition to indicate no downcomer is present in the VESSEL component as far as TRAC-M setting downcomer-interface flow areas to zero internally).

Columns	Variable	Description
15–28	IDCL	Axial-cell (level) number at which its upper interface is the downcomer lower-boundary elevation. If IDCU = 0, input IDCL = 0.
29–42	IDCR	Radial-cell (ring) number at which its outer interface is the downcomer inner-radial boundary. If IDCU = 0, input IDCR = 0.
43–56	ICRU	Axial-cell (level) number at which its upper interface is the reactor-core region upper-boundary elevation. If no reactor-core region is present, input ICRU = 0.
57–70	ICRL	Axial-cell (level) number at which its upper interface is the reactor-core region lower-boundary elevation. If no reactor-core region is present, input ICRL = 0.

Card Number 4. (Format 5I14) ICRR, ILCSP, IUCSP, IUHP, ICONC

Columns	Variable	Description
1–14	ICRR	Radial-cell (ring) number at which its outer interface is the reactor-core outer-radial boundary. ICRR is used to define the reactor-core region with ICRU and ICRL as well as with ILCSP and IUCSP. If no reactor-core region is defined by both ICRU and ICRL as well as ILCSP and IUCSP, input ICRR = 0.
15–28	ILCSP	Axial-cell (level) number at which its upper interface is the core-region lower-boundary support-plate elevation to be used for evaluating graphics output. Defaults to the value of ICRL (Word 5 on Card Number 3) if ILCSP = 0 is input.
29–42	IUCSP	Axial-cell (level) number at which its upper interface is the core-region upper-boundary support-plate elevation to be used for evaluating graphics output. Defaults to the value of ICRU (Word 4 on Card Number 3) if IUCSP = 0 is input.
43–56	IUHP	Axial-cell (level) at which its upper interface is the upper-head support-plate elevation to be used for evaluating graphics output. Defaults to the value of IDCU (Word 1 on Card Number 3) if IUHP = 0 is input.

Columns	Variable	Description
57–70	ICONC	Solute in the liquid coolant option. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6) when ICONC > 0. 0 = no; 1 = dissolved solute only; 2 = both dissolved and plated-out solute.

Card Number 5. (Format 4(I14)) IGEOM, NVENT, NVVTB, NSGRID

Columns	Variable	Description
1–14	IGEOM	VESSEL geometry option. 0 = cylindrical geometry; 1 = Cartesian geometry.
15–28	NVENT	Number of vent valves in the VESSEL. No vent valve or a maximum of one vent valve per radial interface between VESSEL cells is allowed; therefore, actual valves may have to be lumped together for each cell interface.
29–42	NVVTB	Number of vent-valve resistance table data pairs. If NVVTB = 0, the maximum and minimum vent-valve pressure drops and flow-loss resistances are input. If NVVTB > 0, the flow-loss resistance vs pressure drop table is input on Card Set 15.
43–56	NSGRID	Number of spacer grids present in the core region. Spacer grids are modeled only when the reflood model has been selected by inputting NAMELIST variable NEWRFD = 1 (they also can be modeled with the new TRAC-M/F77 reflood model that is described in Appendix M).
		Note: Use of TRAC-M's spacer grid model (F77 of F90) is not currently recommended.
57–70	IEXT	Specifies if this component input was generated by the postprocessor EXTRACT. 0 = no (default); 1 = yes.

Card Number 6. (Format 2E14.4) SHELV, EPSW

Columns	Variable	Description
1–14	SHELV	Elevation (m,ft) of the bottom interface of axial cell (level) 1 in the VESSEL (used only when NAMELIST variable IELV = 1 is input).

Columns	Variable	Description
15–28	EPSW	WALL surface roughness (m, ft).

VESSEL Geometry Cards. Input three Card Sets, one set for each of the following arrays. Use LOAD format. Each array has its element values defined by a Card Set of one or more cards.

Card Sets 7 to 9.

Variable	Dimension	Description
Z	NASX	Axial upper-interface locations (elevations) (m, ft) of the z-direction axial-cells (levels) [referenced to a 0.0 m (0.0 ft) (elevation) value at the bottom interface of the first axial-cell (level) in the VESSEL].
R or X	NRSX	Radii or x outer-interface locations (m,ft) of the r- or x-directional cells [referenced to a 0.0 m (0.0 ft) value at the inner interface of cell 1].
T or Y	NTSX	Azimuthal angle θ or y outer-interface locations of the θ- or y-direction cells (referenced to a 0.0 rad or m (0.0 deg or ft) value at the inner interface of the first cell). For cylindrical geometry [IGEOM = 0 (Word 1 on Card Number 5)] and input data in SI units [NAMELIST variable IOINP = 0], the azimuthal angles θ can be input in either degree (0.0 deg < T $\le$ 360.0 deg) or radian (0.0 rad < T $\le$ 2 π = 6.2832 rad) units. For cylindrical geometry [IGEOM = 0 (Word 1 on Card Number 5)] and input data in English units [NAMELIST variable IOINP = 1], the azimuthal angles must be input in degree units. A full-geometry cylinder VESSEL model requires that the last azimuthal angle T(NTSX) = 360.0 deg or 6.2832 rad. Rotational symmetries of 30.0 deg (0.5236 rad), 45.0 deg (0.7854 rad), 60.0 deg (1.0472 rad), 90.0 deg (1.5708 rad), 120.0 deg (2.0944 rad), or 180.0 deg (3.1426 rad) can be defined by inputting T(NTSX) with one of these rotational-sector angles. A partial-geometry cylinder VESSEL model with any other last azimuthal angle less than 360.0 deg or 6.2832 rad can be defined but requires that Card Set 32 array FA-T input data have 0.0 values for all the NTSX azimuthal interfaces of the NRSX radial cells [(NTSX)ht value for radial cell 1, (2*NTSX)th value for radial cell 2,...., (NRSX*NTSX)th value for radial cell NRSX].

Card Sets 10 & 11. If NAMELIST variable NEWRFD = 0, do not input Card Sets 10 and 11 (arrays FUNH and NHSCA) for the core-reflood model.

Note: Card Sets 10 and 11 apply to the reflood models in both TRAC-M/F90 (TRAC-P model) and TRAC-M/F77 (top-down/bottom-up and TRAC-P).

Variable	Dimension	Description
FUNH	NTSX × NRSX	Fractions of the HTSTR component ROD or SLAB element surface in each of the NTSX x NRSX horizontal-plane mesh-cell columns, which are unheated.
NHSCA	NTSX × NRSX	The HTSTR component numbers that define the primary powered average (power) ROD or SLAB element in each of the NTSX × NRSX horizontal-plane mesh-cell columns.

Card Number 12. (Format 4E14.4) GC, GYTC, GXRC, GZ

Note: If NAMELIST variable NVGRAV = 0, do not input Card Number 12.

Columns	Variable	Description
1–14	GC	Gravitational-acceleration constant [when GC ≤ 0.0 m s^{-2} (0.0 ft s^{-2}) is input, GC is defined internally by TRAC-M with the value 9.80665 m s^{-2} (32.17405 ft s^{-2})]. The GC value from the last VESSEL component input also is used for the one-dimensional components.
15–28	GYTC	The θ- or y-direction component (–) of the gravity unit vector located at the center of mesh cell (1,1,1).
29–42	GXRC	The r- or x-direction component (–) of the gravity unit vector located at the center of mesh cell (1,1,1).
43–56	GZC	The z-direction component (–) of the gravity unit vector located at the center of mesh cell (1,1,1).

Note: The values of GYTC, GXRC, and GZC range between –1.0 and 1.0 and must satisfy the requirement that

$$GYTC \times GYTC + GXRC \times GXRC + GZC \times GZC = 1.0$$

(all three input values are normalized with the same factor to satisfy this requirement). For gravity acceleration in the downward axial direction,

$$GYTC = 0.0, \; GXRC = 0.0, \; and \; GZC = -1.0$$

Note: Vent Valve Data. If NVENT = 0 (Word 2 on Card Number 5), do not input Card Number 13 and 14 and Card Set 15.

Card Number 13. (Format 2I14,E14.4) IZV, KV, AVENT

VESSEL Vent-Valve Location and Area Cards. Input NVENT cards of Card Number 13.

Columns	Variable	Description
1–14	IZV	Axial-cell (level) number of the vent-valve interface location.
15–28	KV	Horizontal-plane relative-cell number [J + NTSX × (I–1) where I is the r- or x-direction cell number and J is the θ- or y-direction cell number] of the vent-valve interface location on the outer radial or x interface of the cell.
29–42	AVENT	Maximum flow area (m^2, ft^2) of the vent valve located on the outer radial or x interface of the cell.

Card Number 14. (Format 4E14.4) DPCVN, DPOVN, FRCVN, FROVN

Note: If NVVTB ≠ 0 (Word 3 on Card Number 5), do not input Card Number 14.

VESSEL Vent-Valve Pressure-Drop and Friction-Loss Cards. Input NVENT cards of Card Number 14.

Columns	Variable	Description
1–14	DPCVN	Maximum pressure drop (Pa, psid) between the inner and outer radial or x-direction cells when the vent valve is closed.
15–28	DPOVN	Minimum pressure drop (Pa, psid) between the inner and outer radial or x-direction cells when the vent valve is opened.
29–42	FRCVN	Flow-loss resistance (–) of the vent valve in its closed position.
43–55	FROVN	Flow-loss resistance (–) of the vent valve in its open position.

Card Set 15.

Note: If NVVTB = 0 (Word 5 on Card Number 6), do not input Card Set 15.

VESSEL Vent-Valve Flow-Loss Resistance Table. Input a table of vent-valve flow-loss resistance vs pressure drop across the vent valve. Use LOAD format. Only one table is input for all vent valves.

Variable	Dimension	Description
VVTAB	$2 \times |\text{NVVTB}|$	Vent-valve FRIC flow-loss resistance table [(Pa,–), (psid, –)]. [input $|\text{NVVTB}|$ (Word 3 on Card Number 5) table-defining data pairs having the following form (pressure drop across the vent valve, FRIC flow-loss resistance of the vent valve)].

Note: The vent-valve FRIC flow-loss resistance input must be of the form $K_{i+1/2} D_{hi+1/2}/(\Delta r_i + \Delta r_{i+1})$ or $K_{i+1/2} D_{hi+1/2}/(\Delta x_i + \Delta x_{i+1})$, where $K_{i+1/2}$ is the K-factor form-loss coefficient, $D_{hi+1/2}$ is the $i+1/2$ interface hydraulic diameter, and Δr_i and Δr_{i+1} or Δx_i and Δx_{i+1} are the radial or x-direction lengths of the fluid cells on each side of the vent-valve interface. Note that the NAMELIST variable IKFAC, which determines how the additive-loss coefficient is defined for input, does not affect the vent-valve FRIC flow-loss resistance form.

Note: The hydraulic diameter in the radial direction, HD-R (Card Set 37), must be the value corresponding to the vent valve for each cell connected to a vent valve.

Card Set 16.

Note: If NSGRID = 0 (Word 4 on Card Number 5), do not input the Vessel Spacer-Grid Elevation Cards.

VESSEL Spacer Grid Elevation Cards. Use LOAD format. The ZSGRID array elements are defined by a Card Set of one or more cards.

Variable	Dimension	Description
ZSGRID	NSGRID	Axial z-direction location (elevation) (m, ft) of each spacer grid in the core region as measured from the VESSEL bottom [consistent with the Z array (Card Set 7)].

Card Set 17. (Format 4I14) LISRL, LISRC, LISRF, LJUNS

Note: If NCSR=0 (Word 4 on Card Number 2), do not input the Vessel Source-Connection Cards defined by Card Set 17.

VESSEL Source-Connection Cards. Input one card for each of the NCSR (Word 4 on Card Number 2) source connections of a one-dimensional component to a VESSEL cell interface. See VESSEL description in Section Section

Columns	Variable	Description
1–14	LISRL	Axial-cell (level) number of the source connection.
15–28	LISRC	Horizontal-plane relative-cell number associated with the source connection [cell numbering in a VESSEL level counts through the NTSX (Word 3 on Card Number 2) θ- or y-direction cells while considering each of the r- or x-direction cells from 1 to NRSX (Word 2 on Card Number 2)].
29–42	LISRF	Face number associated with the source connection. A positive number indicates a connection to the upper or outer face of the cell; a negative number indicates a connection to the lower or inner face of the cell. 1 = θ or y direction; 2 = axial z direction; 3 = r or x direction.
43–56	LJUNS	Junction number associated with the source connection of a VESSEL cell interface to a 1D component.

VESSEL Level Cards. Input Card Sets 18 to 56. Use LOAD format. These 39 Card Sets are input as a group for each axial cell (level) number in increasing numerical order from 1 to NASX (Word 1 on Card Number 2) if IVSSBF = 0 (Word 5 on Card Number 2) or from 0 to NASX+1 if IVSSBF > 0. If desired, the data from a level already input can be repeated by a single REPEAT LEVEL card for another level (see description after the level data description.)

Note: The following parameters [dimensioned NTSX x NRSX (Words 3 and 2 on Card Number 2)] are input for each (r,θ) or (x,y) mesh cell in each axial level; that is, these cells extend over the entire VESSEL plane perpendicular to the axial direction for each axial cell (level). Because a separate group of 39 Card Sets is input for each axial cell (level), these parameters are specified for all mesh cells in the VESSEL. If IVSSBF > 0 (Word 5 on Card Number 2), input data also must be defined for the 0 and NASX+1 levels to provide boundary-condition information.

Note: Abrupt Expansion/Contraction Form Loss. Inputting a negative value for CFZLYT, CFZLZ, or CFZLXR results in TRAC-M internally evaluating an abrupt expansion/contraction form loss (for when the mesh-cell flow area changes between mesh cells adjacent to each other), which then is added to the absolute value of the input values of CFZLYT, CFZLZ, and CFZLXR and to the positive value of the input values of CFZVYT, CFRLYT, CFRVYT, CFZVZ, CFRLZ, CFRVZ, CFZVXR, CFRLXR, and CFRVXR.

Card Sets 18 to 23. If NAMELIST variable IKFAC = 1, K-factors rather than FRIC additive-friction-loss coefficients are input. Forward-flow direction flow-resistance parameters are defined by Card Sets 18 to 23 when NAMELIST variable NFRC3 = 2.

Variable	Dimension	Description
CFZLYT	NTSX × NRSX	Liquid additive-friction-loss coefficients (–) in the θ or y direction.
CFZLZ	NTSX × NRSX	Liquid additive-friction-loss coefficients (–) in the z direction.
CFZLXR	NTSX × NRSX	Liquid additive-friction-loss coefficients (–) in the r or x direction.
CFZVYT	NTSX × NRSX	Gas additive-friction-loss coefficients (–) in the θ or y direction.
CFZVZ	NTSX × NRSX	Gas additive-friction-loss coefficients (–) in the z direction.
CFZVXR	NTSX × NRSX	Gas additive friction-loss coefficients (–) in the r or x direction.

Card Sets 24 to 29. If NAMELIST variable IKFAC = 1, K-factors rather than FRIC additive-friction-loss coefficients are input. Reverse-flow direction flow-resistance parameters are defined by Card Sets 24 to 29.
If NAMELIST variable NFRC3 = 1 (default value), do not input Card Sets 24 to 29.

Variable	Dimension	Description
CFRLYT	NTSX × NRSX	Liquid reverse-flow direction additive-friction-loss coefficients (–) in the θ or y direction.
CFRLZ	NTSX × NRSX	Liquid reverse-flow direction additive-friction-loss coefficients (–) in the z direction.
CFRLXR	NTSX × NRSX	Liquid reverse-flow direction additive-friction-loss coefficients (–) in the r or x direction.

Variable	Dimension	Description
CFRVYT	NTSX × NRSX	Gas reverse-flow direction additive-friction-loss coefficients (–) in the θ or y direction.
CFRVZ	NTSX × NRSX	Gas reverse-flow direction additive-friction-loss coefficients (–) in the z direction.
CFRVXR	NTSX × NRSX	Gas reverse-flow direction additive-friction-loss coefficients (–) in the r or x direction.

Card Sets 30 to 48. If NCCFL = 0, (Word 5 Main-Data Card 6), do not input Card Set 30 (array LCCFL).

Variable	Dimension	Description
LCCFL	NTSX × NRSX	Countercurrent flow limitation option (see PIPE input definition, Section 6.3.6.4).
FRVOL	NTSX × NRSX	Cell fluid-volume fractions (–) ($0.0 \leq VOL \leq 1.0$).
FRFAYT	NTSX × NRSX	Cell-edge flow-area fractions (–) in the θ or y direction ($0.0 \leq FA\text{-}T \leq 1.0$).
FRFAYZ	NTSX × NRSX	Cell-edge flow-area fractions (–) in the z direction ($0.0 \leq FA\text{-}Z \leq 1.0$).
FRFAXR	NTSX × NRSX	Cell-edge flow-area fractions (–) in the r or x direction ($0.0 \leq FA\text{-}R \leq 1.0$).
HDYT	NTSX × NRSX	Hydraulic diameters (m, ft) in the θ or y direction.
HDZ	NTSX × NRSX	Hydraulic diameters (m, ft) in the z direction [for heat-transfer purposes, do not input the axial-direction hydraulic diameter with a value of 0.0 m (0.0 ft)].
HDXR	NTSX × NRSX	Hydraulic diameters (m, ft) in the r or x direction.
ALPN	NTSX × NRSX	Initial gas volume fractions (–).
VVNYT	NTSX × NRSX	Initial gas velocities (m s^{-1}, ft s^{-1}) in the θ or y direction.
VVNZ	NTSX × NRSX	Initial gas velocities (m s^{-1}, ft s^{-1}) in the z direction.
VVNXR	NTSX × NRSX	Initial gas velocities (m s^{-1}, ft s^{-1}) in the r or x direction.
VLNYT	NTSX × NRSX	Initial liquid velocities (m s^{-1}, ft s^{-1}) in the θ or y direction.
VLNZ	NTSX × NRSX	Initial liquid velocities (m s^{-1}, ft s^{-1}) in the z direction.
VLNXR	NTSX × NRSX	Initial liquid velocities (m s^{-1}, ft s^{-1}) in the r or x direction.

Variable	Dimension	Description
TVN	NTSX × NRSX	Initial gas temperatures (K, °F).
TLN	NTSX × NRSX	Initial liquid temperatures (K, °F).
PN	NTSX × NRSX	Initial pressures (Pa, psia).
PAN	NTSX × NRSX	Initial noncondensable-gas partial pressure (Pa, psia).

Card Sets 49 to 51. If NAMELIST variable MWFL = 0, do not input Card Sets 49 to 51 (arrays VWFMLY, VWFMLZ, and VWFMLX).

Variable	Dimension	Description
VWFMLY	NTSX × NRSX	Wall-friction multiplier factor for the liquid phase in the θ or y direction (–) $(0.9 \leq \text{VWFMLY} \leq 1.1)$.
VWFMLZ	NTSX × NRSX	Wall-friction multiplier factor for the liquid phase in the z direction (–) $(0.9 \leq \text{VWFMLZ} \leq 1.1)$.
VWFMLX	NTSX × NRSX	Wall-friction multiplier factor for the liquid phase in the r or x direction (–) $(0.9 \leq \text{VWFMLX} \leq 1.1)$.

Card Sets 52 to 54. If NAMELIST variable MWFV = 0, do not input Card Sets 52 to 54 (arrays VWFMVY, VWFMVZ, and VWFMVX).

Variable	Dimension	Description
VWFMVY	NTSX × NRSX	Wall-friction multiplier factor for the gas phase in the θ or y direction (–) $[0.9 \leq \text{VWFMVY} \leq 1.1]$.
VWFMVZ	NTSX × NRSX	Wall-friction multiplier factor for the gas phase in the z direction (–) $[0.9 \leq \text{VWFMVZ} \leq 1.1]$.
VWFMVX	NTSX × NRSX	Wall-friction multiplier factor for the gas phase in the r or x direction (–) $[0.9 \leq \text{VWFMVX} \leq 1.1]$.

Card Set 55. If ICONC = 0 (Word 5 on Card Number 4), do not input Card Set 55 (array CONC).

Variable	Dimension	Description
CONC	NTSX × NRSX	Initial solute mass to liquid-coolant mass ratios [kg(solute) kg^{-1}(liquid), lb$_m$(solute) lb$_m$$^{-1}$(liquid)]. Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

Card Set 56. If ICONC = 0 or 1 (Word 5 on Card Number 4), do not input Card Set 56 (array S).

Variable	Dimension	Description
S	NTSX × NRSX	Initial macroscopic densities of plated-out solute (kg m^{-3}, lb_m ft^{-3}). Requires ISOLUT = 1 (Word 3 on Main-Data Card 6).

REPEAT LEVEL Card. (Format A12,2X,I4) This card can be used to repeat the data from a level already input or repeated to define the data for the next level. Each REPEAT LEVEL card can repeat only the data from a level with a lesser level number that was input before it (level numbers are specified sequentially). These cards may be used consecutively.

Columns	Variable	Description
1–12	AREP	The character string: REPEAT$_\wedge$LEVEL (where $_\wedge$ indicates a blank space).
15–18	NLEV	Input the number of the level whose data is to be repeated.

6.3.8.   End-of-Component-Input End Card

After all the component data input is read, a single card containing the characters "end" in columns 1 to 3 must be input for both initial and restart calculations. An "end" card is not needed when the input data is not in the FREE format (see Main-Data Card 1) for an initial calculation.

6.3.9.   Timestep Data

The last data block of input information is the timestep data cards for controlling the calculation and output edits. The problem time span to be evaluated is separated into time domains. Each domain (specified by two cards) may have different minimum and maximum timestep sizes and output-edit time intervals. Any number of time domains may be input. TEND from the previous time domain is the ending time of the calculation when DTMIN < 0.0. The format of each set of two timestep cards follows.

Card Number 1. (Format 5E14.4) DTMIN, DTMAX, TEND, RTWFP, POWERC

Columns	Variable	Description
1–14	DTMIN	Minimum timestep size (s) for this time domain.
15–28	DTMAX	Maximum timestep size (s) for this time domain.
29–42	TEND	End time (s) for this time domain.

| 43–56 | RTWFP | Ratio between heat-transfer and fluid-dynamics timestep sizes (a positive value is used during steady-state calculations; a negative value results in |RTWFP| being used during transient as well as steady-state calculations; suggested value = 10.0). |
| 57–70 | POWERC | Maximum convection-power difference (W, Btu h^{-1}) between what goes into the fluid and what comes from the wall in the convection heat-transfer calculation. Define POWERC > 0.0 W or Btu h^{-1}. If its value is ≤ 0.0 or not input (the field is left blank), its value is set to 1.0 × 10^{20} W or Btu h^{-1}, which effectively sets no control over the convection-power difference. This convection-energy-error controller reduces the timestep size until the convection-power difference for all HTSTR-component surface nodes is less than POWERC. Specifying too small a value for POWERC may result in a significant increase in the calculative effort. |

Card Number 2. (Format 4E14.4) EDINT, GFINT, DMPINT, SEDINT

Columns	Variable	Description
1–14	EDINT	Long-printout-edit time interval (s) for this time domain.
15–28	GFINT	Graphics-edit time interval (s) for this time domain.
29–42	DMPINT	Dump/restart-edit time interval (s) for this time domain.
43–56	SEDINT	Short-printout-edit time interval (s) for this time domain.

6.3.10. End-of-Input Endflag Card
The TRAC input is terminated by an endflag card that has the value of -1.0.

6.4.   LOAD Subroutine

TRAC-M uses the subroutine LOAD to read most subscripted array variables. The arrays may be read in floating point or integer format. The input-card image for subscripted arrays consists of up to six fields. Each of the first five fields consists of an operation symbol E, F, I, M, R, or S (A1 format), a repeat count for the operation symbols I, M, or R (I2 format), and a floating point or integer data constant (E11.4 or I11 format). If one of the five fields has an E or S operation symbol, the remaining fields on the card are blank or have a "* comment". The sixth field can be used only for the operation symbol E (A1 format) if the array data end in the fifth field. In FREE-format input-data files, cards with an asterisk in column 1 are ignored and may be used for spacers or for comments. On data cards, the columns after a "*" or between "*"s can be used for a comment. Seven operation symbols are defined. The LOAD operations they perform are:

Operation Symbol	Description
blank	No action.
E	End of the data array (must be followed by at least one blank column).
F	Fill the array starting at current element index with the data constant.
I	Interpolate between the following data constant and the succeeding data constant with I2 intervening values with the same difference.
M	Multiple repeat. Repeat the data constant 10 × I2 times.
R	Repeat the data constant I2 times.
S	Skip to the next card.

Some restrictions in the use of the LOAD format are:

1. the end of data for an array must be signaled by an E,
2. over filling or partial filling of an array is not allowed,
3. integer interpolation is not allowed, and
4. data for different arrays must be on different card records.

The following are examples of the use of the operations listed above to fill an array of dimension 11 with data.

EXAMPLE 1. Fill an integer array with a value of 61.

F^^^^^^^^^^61E

EXAMPLE 2. Use of the repeat operation to fill an array with a value of 1.2345.

R11^^^^^1.2345E

EXAMPLE 3. Use of the skip operation.

R^2^^^^^^^^^15^^^^^^^^^^^16S

R05^^^^^^^^^17^^^^^^^^^^^18^^^^^^^^^^^19^^^^^^^^^^^20E

EXAMPLE 4. Use of the multiple repeat operation to fill the array.

M01^^^1.556E-2^^^^^^^^0.0156E

EXAMPLE 5. Use of the interpolation operation to get the values 1.0, 2.0, 3.0, ..., 11.0.

I^9^^^^^^^^1.0^^^^^^^^^^^11.0E

6.5. FREE Format

Appendix E shows a TRACIN file in FREE format that illustrates the points discussed here. Section 6.3. gives the TRAC-M input specifications for TRAC-formatted input. When the FREE-format option is selected on the first card (record) of the TRACIN file, TRAC-P internally converts the FREE-format TRACIN file to a new file in TRAC-M format named TRCINP. Then file TRCINP is read by the standard input subroutines.

To use the FREE-format option, all cards must be kept in the same order as specified in Section 6.3., and all variables must stay in the same order on those cards. Input records may be up to 80 columns long. All data that are not read by subroutine LOAD must be delimited by at least one blank column. Data may start in column 1 except for NAMELIST data, which starts in column 2, and data may end in column 80. Array data to be read by subroutine LOAD may be blank delimited; delimited by any of the LOAD control characters E, F, I, M, R, S; or delimited by the two-digit repeat count. Integer 0 or real 0.0 should be entered explicitly. As with the TRAC-format input, FREE-format arrays read by subroutine LOAD are limited to a maximum of five data fields per input-card record. No data field may be longer than 11 characters (i.e., the format E11, F11, or I11 is used).

The following are examples of FREE-format and TRAC-format input.

In FREE and TRAC-M format

F∧∧∧∧∧∧1.0E+07E

In FREE format

F∧1.0E+07∧E

F∧∧1.0E+07E

F1.E7E

F∧∧∧∧∧∧∧∧∧∧∧1.0E+07∧∧∧∧∧E

etc.

In FREE and TRAC-M format (both modes read 10 repeats and 2 repeats)

R10∧∧∧∧1.0E+07R∧2∧∧∧∧1.1E+07E

In FREE and TRAC-M format (FREE format reads 1 repeat; TRAC-M format reads 10 repeats)

R1∧∧∧∧∧1.0E+07

In FREE format (all three read 10 repeats and two repeats)

R∧10∧1.0E+07∧∧R∧2∧1.1E+07

R∧∧∧∧10∧∧∧1.0E+07R2∧∧∧1.1E+07

R∧∧∧101.0E+07∧∧∧R∧2∧1.1E+07

etc.

In the R∧∧∧101.0E+07 example, the FREE-format parser scans to the first character after the R. It includes the next character in the repeat count if that character is a nonblank numeric. There is one exception to this rule: a situation such as R∧112.3456E+07, where the control character R is followed by one space, a two-digit repeat count, and a nonblank column. To facilitate conversion of existing TRAC-format files, this field is assumed to indicate 1 repeat of 12.3456E+07, not 11 of 2.3456E+07 (because there is not a blank column after the 11). The following examples give 11 repeats:

R11∧2.3456E+07

R∧11∧2.3456E+07

R∧∧112.3456E+07

R112.3456E+07

The E character is recognized by subroutine LOAD as part of the string 'E∧∧∧' so the three columns after the E must be blank. The E can appear in column 78, 79, or 80 with any remaining columns blank.

A LOAD data constant must be 11 characters or less but non-LOAD data constants must be 14 characters or less.

The requirement to blank-delimit data carries with it the requirement that embedded and significant trailing zeros be entered explicitly as zero. The user of the FREE-format option needs to be aware that to use TRAC-format input that has all-blank 14-column fields meant to represent zero, the zero must be entered explicitly in that field. This is not necessary, however, for trailing blank fields.

The NAMELIST input format is essentially free, but there are a few restrictions that are discussed in Section 6.6.

6.5.1. FREE-Format Comments, Problem Title Cards, and Hollerith Component Descriptions

FREE-format TRACIN files may be annotated with user comments. These comments must be delimited by asterisks (*s) in unbroken strings of any length. The first card of the TRACIN file is an exception to this requirement. Comments and their delimiters are

equivalent to blank columns in a data field. When an input record has an odd number of comment delimiters (where *, **, ***, ****, etc., are all considered to be a single delimiter), everything on the record to the right of the last delimiter is considered a comment. The code will attempt to read input data after even-numbered comment delimiters and before odd-numbered comment delimiters. Entire records may be comments, for example, by making the first nonblank character an asterisk and not inserting any more comment delimiters on the line. Comments may appear anywhere in the input-data file except

1. before Main-Data Card 1,
2. after Main-Data Card 2 and before the NUMTCR problem title cards, and
3. within the NAMELIST variable defining records (see additional comments on NAMELIST input in Section 6.6.).

The NUMTCR problem title cards immediately following Main-Data Card 2 are written to the TRCINP file exactly as they are read: asterisks, blank cards, and all. Blank and comment cards may appear between the first two Main-Data cards and immediately after the NUMTCR problem title cards but not within the NUMTCR problem title cards following Main-Data Card 2 without their being considered title cards.

Hollerith component descriptions of individual components (the CTITLE information) are written to the TRCINP file, left justified, starting in column 43. Asterisk strings in component descriptions are treated as comment delimiters.

6.5.2. FREE-Format Input-Error Handling

The FREE-format option provides advantages over the TRAC-format option in handling many types of input errors. FREE-format input-error handling occurs during two stages: first as the TRACIN file is being converted to the TRCINP file and later as the TRCINP file is being read. In the first stage, when an error is detected (such as detectable errors that might arise from failure to blank-delimit data properly; for example, using 1.0E^07 instead of 1.0E07 or 1.0E+07), processing of the record in question is halted, subroutine ERROR is called to output a warning message, and the record is flagged with "*ERROR" (starting in column 75) before it is written to the TRCINP file. Currently, the outputting of warning messages stops after 50 cards have been detected to be in error, but input-data processing continues. In the second stage, under most circumstances, a fatal FORTRAN input-data error will not force an immediate execution abort. The entire input-data file will be processed and appropriate error messages issued before problem execution is terminated. An exception to this occurs in the case of fatal NAMELIST-data errors. In situations where there are no errors detected but input-processing difficulties are suspected, it is suggested that the user inspect the TRCINP file where faulty records may be apparent.

6.6.   NAMELIST Format

Note: NAMELIST-input is used by TRAC-M/F77 and by TRAC-M/F90, in the same format. NAMELIST is a non-standard, but generally available, extension to Fortran 77. NAMELIST is a standard part of Fortran 90.

The NAMELIST capability is an extremely useful Fortran-statement feature that can be used to input values selectively to variables named within the program. The user-convenience features controlled by NAMELIST variable input are described in Section 6.3. The reader is referred to a Fortran manual for details on NAMELIST format. Although NAMELIST is essentially in free format, there are certain restrictions. At present these restrictions apply to all TRAC-M input files, whether or not the FREE-format option is used. NAMELIST restrictions include the following:

1. hollerith constants are not allowed,
2. the first column of all physical records is ignored (the terminating dollar "$" or ampersand "&" sign can appear in any column except the first column),
3. there must be no embedded blanks in the string $INOPTS or &INOPTS where INOPTS is the NAMELIST group name, the initial $ or & must appear in column 2, and there must be at least one trailing blank after $INOPTS or &INOPTS, and
4. FREE-format asterisk-delimited user comments are not allowed on NAMELIST data cards (FREE-format comment cards are not allowed among the physical records of a NAMELIST group record, although blank cards are allowed).

For example, the following five cards might be used to input data for the TRAC-M NAMELIST group INOPTS (described in Section 6.3.).

```
          1         2         3         4         5
1234567890123456789012343567890123456789012345678901234567890123456  . . .

^$INOPTS^IELV=1,^^IKFAC^=^1,

^^^ISTOPT=2,

^ALP=0.,VL=0.,VV=0.,TL=550.,TV=550.0,

^^P=1.55E+07,PA=0.0,QPPP=0.,TW=5.5E2,HSTN=550.,

^$END
```

6.7. Input and Output Files

Figure 6-4 shows the input and output files read and written by TRAC-M during a problem evaluation. The TRACIN input-data file was discussed in Section 6.1., the TRCRST restart-data file in Section 6.2., the FREE-format option output and input file TRCINP in Section 6.5., and the data-dump output file, TRCDMP, in Section 6.2. This section describes the remaining four output files: TRCMSG, TRCOUT, TRCXTV, and INLAB.

The TRCMSG file contains calculational-status information and warning error messages that are produced by input and the computational subroutines within TRAC. These messages, written with formatted input/output (I/O), indicate the status of the problem evaluation and any difficulty with the input-data provided and the evaluation of the numerical solution. NAMELIST variable IADDED provides an edit option to the TRCMSG file of calculational-behavior parameters every IADDEDth timestep. The unit symbols of all real variables are printed if IUNOUT = 1 (default) or are not printed if NAMELIST variable IUNOUT = 0. The units are SI if NAMELIST variable IOOUT = 0 (default) or English if IOOUT = 1.

The TRCOUT file contains the input-data echo and the short and large edit output. This file is produced with standard FORTRAN write statements programmed in the various component output subroutines. The input-data echoed was read by the TRAC-M component subroutines beginning with the letters R and RE. The short and large edits are produced with a frequency specified on the timestep data cards by subroutine EDIT that calls component subroutines beginning with the letter W. Each large edit at a specific time includes results from the control-procedure parameters and from each component in the system model. The component output includes thermal-hydraulic parameter results such as pressures and temperatures. TRAC-M warning error messages (if generated) are written to the TRCOUT file as well as the TRCMSG file. Appendix L lists all these messages with a brief explanation of each message. Section Section gives further information on individual component output parameters. The unit symbols of all real variables are printed if IUNOUT = 1 (default) or are not printed if NAMELIST variable IUNOUT = 0. The units are SI if NAMELIST variable IOOUT = 0 (default) or English if IOOUT = 1.

File TRCXTV contains TRAC-M's output that is used by graphics-analysis tools, such as XTV and XMGR5 (these graphics packages are described separately). The file consists of header information in text format and a series of graphics data edits in binary format; the edit frequency is controlled by the user via the time-domain cards at the end of file TRACIN.

Note: In TRAC-M/F77, the information in file TRCXTV is contained in two separate files, called XTVGR.T (text header information), and XTVGR.B (binary data-edits). This output is not compatible with XMGR5.
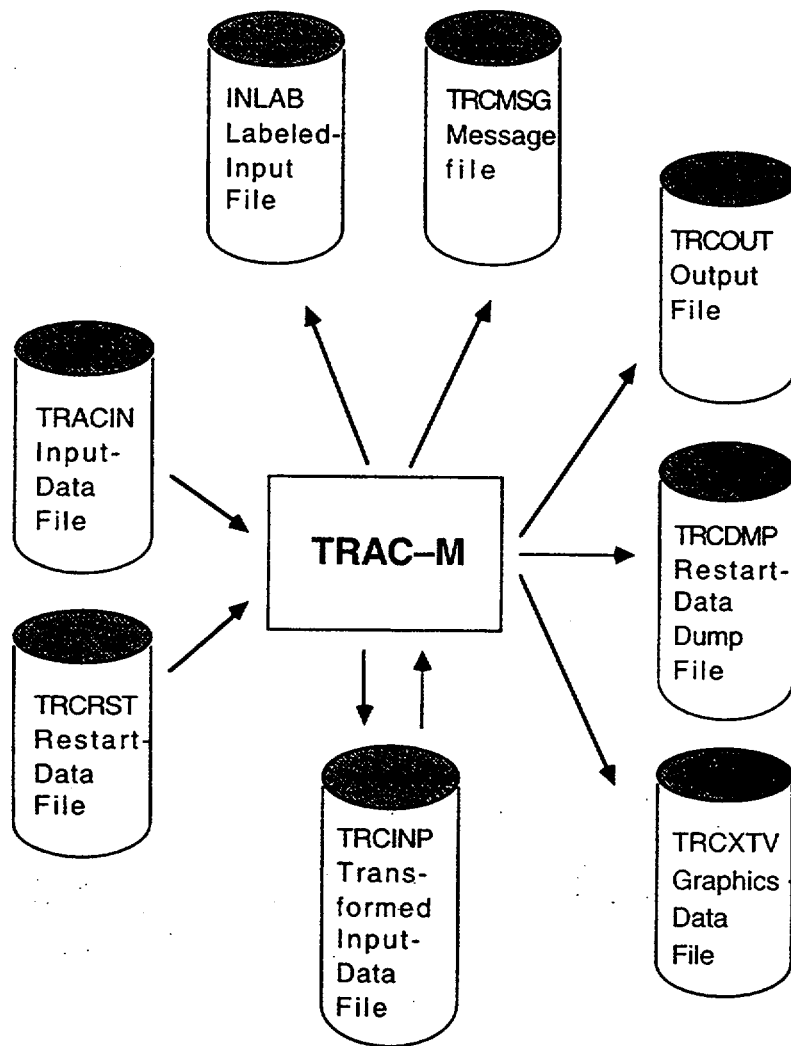
Fig. 6-4.   TRAC-M input- and output-data files.

The data that are written to file TRCXTV are described in Appendix K. The data can be output in either SI units (NAMELIST input-variable IOGRF=0) or English units (IOGRF=1). Axis-labels for dependent variables are provided in the corresponding units.

The INLAB file is an optional output file that is generated when NAMELIST variable INLAB = 3. File INLAB has the TRAC-format contents of file TRCINP but is in FREE format with all the TRAC-M variables names (as specified in the TRAC-M input-data format of Section 6.3.) provided within asterisk-delimited comments. The comment label for scalar variables is on a comment record above the record containing their values; the comment labels for the array variables read by subroutine LOAD are asterisk delimited in a left-justified nine-column field on each record having load-format data. Asterisk-delimited comments in the TRACIN file (that provides the input data written to the TRCINP and INLAB files) are not written to the INLAB file. The input-data parameter values are in SI units if NAMELIST variable IOLAB = 0 or English units if IOLAB = 1.

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6.8. Conversion of TRAC-PF1/MOD1 Input-Data Files

A user may wish to use an input-data file that was developed for TRAC-PF1/MOD1 for calculations with the current version of TRAC-M. There are several changes that must be made to convert from a MOD1 input-data TRACIN file. The following guidelines are provided to aid in the conversion process.

Namelist variables – Namelist variables CNDAM, CNDBS, CNDSP, CNDST, FIFAM, FIFBL, FIFBS, FIFST, ICCFL, IEXVSS, IPRCPV, IWINK, IWILS, LEVSTG, NCRG, NDIA3, NORMDP, NORMRS, NVSLMX, and STANT are no longer used.

Main-Data cards – EPSI (Word 2) should be eliminated from Card Number 5. IITMAX (Word 2) should be eliminated and NCCFL (Word 5) added to Card Number 6.

ACCUM – This component does not exist in TRAC-M. A PIPE component should be used to model an accumulator with a top end (JUN1 junction) FILL component no-flow boundary condition.

BREAK – Do not input IVDV (Word 4) on Card Number 2.

CORE – This component does not exist in TRAC-M. A PIPE, TEE, or VESSEL components and the HTSTR component RODs or SLAB elements should be used to model the reactor-core region.

HTSTR (ROD or SLAB elements) – This component is needed to model 2D conduction and convection heat transfer in the vessel or steam generator. The HTSTR component input-data parameters were previously defined in the CORE, VESSEL, and STGEN component input data. Many new features and options have been added to the HTSTR component that were not provided by the built-in component models. TRAC-M users also may wish to use 2D HTSTR components to replace 1D wall conduction and convection heat-transfer calculations in PIPE, PRIZER, PUMP, SEPD, TEE, and VALVE components. The hydraulic-component wall heat-transfer model is no longer being supported.

PIPE – Remove MAT (Word 5) from and add EPSW (Word 5) to Card Number 2.

PLENUM – Add JUNS1 and JUNS2 (Words 3 and 4) to Card Number 2.

PRIZER – Remove MAT (Word 5) from Card Number 2.

PUMP – Remove MAT (Word 5) from and add EPSW (Word 5) to Card Number 2. Remove TFR1 and TFR2 (Words 3 and 4) from Card Number 7.

STGEN – This component does not exist in TRAC-M. Use HTSTR, PIPE, and TEE components to model a steam generator.

TEE – Remove MAT (Word 3) from, add EPSW (Word 5) to, and change the order of Card Number 2 parameters.

VALVE – Replace MAT (Word 5) from and add EPSW (Word 5) to Card Number 2.

VESSEL – This component has undergone a major revision. Most of the heat-transfer and hydraulic parameters that were input for the CORE component also were input for the VESSEL component. The heat-transfer parameters are now input to the HTSTR component for ROD or SLAB elements. Only the hydraulic parameters and new input parameters for the reflood model are input for the MOD2 VESSEL component.

The TRAC-M user may wish to modify and/or add additional input to take advantage of new features and options that have been added to the code since TRAC-PF1/MOD1.

REFERENCES

6-1   R. A. Nelson, Jr., D. A. Pimentel, S. J. Jolly-Woodruff, and J. W. Spore, "Reflood Completion Report, Volume I: A Phenomenological Thermal-Hydraulic Model of Hot Rod Bundles Experiencing Simultaneous Bottom and Top Quenching and an Optimization Methodology for Closure Development," Los Alamos National Laboratory report LA-UR-98-3043 (April, 1998).

6-2   B. E. Boyack, J. F. Lime, D. A. Pimentel, J. W. Spore, and T. D. Knight, "Reflood Completion Report, Volume II: Developmental Assessment of a New Reflood Model for the TRAC-M/F77 Code," Los Alamos National Laboratory report LA-UR-98-3043 (April, 1998).