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TRAC-PF1/MOD2 Code Manual

Programmer's Guide

Prepared by
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Los Alamos National Laboratory

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AUTHORS AND ACKNOWLEDGMENTS

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TRAC-PF1/MOD2

VOLUME III. PROGRAMMER'S GUIDE

by

L. A. Guffee, S. B. Woodruff, R. G. Steinke, and J. W. Spore

ABSTRACT

The Transient Reactor Analysis Code (TRAC) was developed to provide advanced best-estimate predictions of postulated accidents in light-water reactors. The TRAC-PF1/MOD2 program provides this capability for pressurized water reactors and for many thermal-hydraulic test facilities. The code features either a one- or a three-dimensional treatment of the pressure vessel and its associated internals, a two-fluid nonequilibrium hydrodynamics model with a noncondensable gas field and solute tracking, flow-regime-dependent constitutive equation treatment, optional reflood tracking capability for bottom-flood and falling-film quench fronts, and consistent treatment of entire accident sequences including the generation of consistent initial conditions. The stability-enhancing two-step numerical algorithm is used in both the one- and three-dimensional hydrodynamics and permits violation of the material Courant condition. This technique permits large time steps and, hence, reduced running time for slow transients.

In addition to the components contained in previous TRAC versions, TRAC-PF1/MOD2 includes a heat-structure component that allows the user to accurately model complicated geometries. An improved reflood model based on mechanistic and defensible models has been added. The new code also contains improved constituative models and additions and refinements for several components.

This manual is the third volume of a four-volume set of documentation on TRAC-PF1/MOD2. This guide was developed to assist the TRAC programmer and contains information on the TRAC code and data structure, the TRAC calculational sequence, memory management, and various machine configurations supported by TRAC.

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1. INTRODUCTION

This guide has been developed to assist the Transient Reactor Analysis Code (TRAC) programmer. Much of the information presented here is included as appendices. These appendices are self-contained and are meant to be used as references. Topics of discussion addressed in this manual include the TRAC code structure and data structures, the TRAC calculational sequence, memory management, and various machine configurations supported by TRAC.

2. CODE ARCHITECTURE

The description of the TRAC code architecture given here is divided into two areas of discussion: code structure and data structure. Because the data structure for the one-dimensional components differs from that of the three-dimensional VESSEL component, these structures are detailed separately in the discussion that follows.

2.1. Code Structure

In an effort to strive for a code structure that minimizes the problems of maintaining and extending the code, TRAC was developed in a modular fashion. This modularity manifests itself in two important ways. First, because TRAC analyzes reactor systems that consist of specific component types, the code is written to utilize subroutines that handle specific component types. For example, data and calculations pertaining to a PIPE component are handled separately from VESSEL data and VESSEL calculations. The different TRAC components are described in greater detail in the TRAC-PF1/MOD2 User's Guide, which is the second volume in the MOD2 documentation. Second, the TRAC program is written to be functionally modular; that is, each TRAC subprogram performs a specific function. Some of the low-level subprograms are used by all components, thereby strengthening this modularity. Appendix A is a complete list of TRAC subroutines and function routines and their descriptions. Appendix B lists for each subroutine all routines from which it is called and all routines that it calls.

Functional modularity within TRAC is taken a step further by division into overlays. Figure 1 displays a calling-tree representation of the TRAC overlays. Table 1 gives a brief description of each overlay's function. The use of an overlay structure originally was mandated by computer-size limitations, but this is no longer the case. The overlay structure is maintained using UPDATE/HISTORIAN *DEFINEs for the convenience of users with smaller memory machines and as a starting point for future efforts in the area of parallelization. Overlays are loaded at Los Alamos by declaring the entry routine for each overlay, then satisfying all subsequent subroutine references from a global binary library of TRAC routines. Whereas the CRAY version of TRAC does not need to be overlaid, we recommend that the user keep the input and initialization overlays to minimize memory charges.

The overall sequence of calculations is directed by the main program TRAC. Overlay INPUT always is invoked at the start of each TRAC execution to read control and component input data. The component data are initialized by the overlay INIT. The steady-state calculation (if requested) is performed by subroutine STEADY. During the steady-state calculation, the reactor power is initially zero and is set on after the fluid flow rates have been established. This is to prevent high rod temperatures early in the steady-state calculation when the flow rates generally are small. The transient calculation is performed by subroutine TRANS. Overlays EDIT, GRAF, and DMPIT are called during the steady-state calculation by subroutine STEADY and during the transient calculation by subroutine TRANS calling subroutine PSTEPQ to generate output as required. Overlay CLEAN is called to close all output files at the end of the problem or when a fatal error occurs.

2.2. Data Structure

TRAC divides the data for each component into four blocks: the fixed-length table, the variable-length table, the pointer table, and the array data. The first three of these blocks are

TABLE 1

TRAC OVERLAYS

Overlay	Description
CLEAN	Closes all output files.
DUMP	Performs restart dumps.
EDIT	Adds an edit at the current time to the file TRCOUT.
GRAF	Adds a graphics edit at the current time to the file TRCGRF.
ICMP	Initializes component data.
IGRF	Initializes graphics table.
INIT	Controls initialization of component data and graphics tables.
INPUT	Controls reading input and restart files and analyzes piping loops.
TRAC	Controls overall flow of calculation. (Also contains many service routines used throughout the code.)
OUTER	Controls one complete outer iteration for all components.
OUT1D	Performs one outer iteration on the basic finite-difference flow equations for all one-dimensional components.
OUT3D	Performs one outer iteration for all VESSEL components.
POST	Performs postpass for all components.
PREP	Performs prepass for all components.
PRP1D	Performs the prepass calculations for one-dimensional components.
PRP3D	Performs prepass calculation for all three-dimensional VESSEL components.
RDIN1	Inputs and stores one-dimensional component data.
RDIN3	Inputs and stores VESSEL component data.
RDRES	Reads and stores data from a restart dump file.
TRIPS	Evaluates signal variables, control blocks, and trips.

stored in memory as copies of the COMMON blocks, FLTAB, VLTAB, and PTAB, respectively. The structure of the COMMON area FLTAB is the same for all components. The variables in the VLTAB and PTAB COMMON areas differ from one component to another. Appendix C describes the fixed-length, variable-length, and pointer tables for each component.

The array data are stored in memory within the dynamic storage array or A array. For a one-dimensional component, the location of an individual variable array is determined by the value of its pointer in the pointer table. For a VESSEL component, however, the pointer methodology is not used. Instead, EQUIVALENCE statements are used to locate VESSEL array data in the A array. Dynamic storage of data arrays permits effective use of space for many different problems. Aspects of memory management are discussed further in Sec. 4.

In addition to the data that refer to a particular component, TRAC uses many variables to describe the overall solution state of the calculation. These variables are grouped according to their use into several other COMMON areas. Appendix D documents these COMMON blocks and lists their variables and corresponding definitions.

2.2.1. One-Dimensional Data Structure

The pointer tables for all one-dimensional components have a similar structure consisting of four main groups of pointers and one special group. The first main group of pointers is contained within the comdeck DUALPT and locates dual-time hydrodynamic and thermodynamic information. The second main group of pointers locates remaining single-time hydrodynamic and thermodynamic information and is contained in the comdeck HYDROPT. Any integer data are located using the third main group of pointers from the comdeck INTPT. A fourth main group of pointers is used to locate data for wall heat transfer in those components that support the wall heat-transfer calculation, and these pointers are contained in the comdeck HEATPT. Array data that is specific to a particular component type, if any exists, is located using the last special group of pointers in the pointer table. This pointer table information is summarized in Appendix C for each component type.

2.2.1.1. Adding a One-Dimensional Database Variable

In order to add a new variable to all one-dimensional components, standard guidelines are followed. These guidelines are given below. A sample update, provided as Appendix E, adds a new variable to each of the four main groups discussed above using these guidelines.

1. Create new pointer names for the new variables and add them to the pointer tables of the appropriate comdecks.
   a. If the new variable requires both old-time and new-time storage, then two new pointers must be added to the DUALPT comdeck. If the pointers become the first two pointers of the DUALPT comdeck due to alphabetic considerations, the EQUIVALENCE statement in DUALPT must be changed to reflect this.
   b. If the new variable with a single-time value is associated with the hydrodynamic calculation, its new pointer is added to the HYDROPT comdeck.
   c. If the new variable is an integer variable with a single-time value, its new pointer is added to the INTPT comdeck.

d. If the new variable with a single-time value is associated with the wall heat-transfer calculation, its new pointer is added to the HEATPT comdeck.

2. Initialize the new pointers.

   a. If new pointers were added to DUALPT, these new pointers are initialized in subroutine S1DPTR in the DUALPT pointer section.

      If the new variable is one for which old-time and new-time values are the same at the start of the OUTER code block (that is, the new-time value is reset to the old-time value in the event of a back-up due to one-dimensional component water packing for instance), then the new old-time pointer should be initialized *after* the LALP pointer but *before* the LVV pointer. Similarly, the new new-time pointer should be initialized *after* the LALPN pointer but *before* the LVVN pointer in the same relative position as the new old-time pointer.

      If the new variable is one for which old-time and new-time values are *not* the same at the start of the OUTER code block (that is, the new-time value is *not* reset to the old-time value in the event of a back-up due to one-dimensional component water packing for instance), then the new old-time pointer should be initialized *after* the LBIT pointer but *before* the LVVTO pointer. Similarly, the new new-time pointer should be initialized *after* the LBITN pointer but *before* the LVVT pointer in the same relative position as the new old-time pointer.

      Adjust the value of the pointer initialized array directly after each new pointer you add to correctly reflect the lengths of its storage requirement. Increment the value of LENPTR *in the* DUALPT *pointer section of* S1DPTR *only* by the number of pointers added to the DUALPT comdeck.

   b. If a new pointer was added to HYDROPT, it is initialized in subroutine S1DPTR. The new pointer should be added *just before* the LNXT pointer in the HYDROPT section of S1DPTR. Adjust the value of the LNXT pointer to reflect the length of the array storage of the newly added pointer. Increment the value of the variable LENPTR by one *in the* HYDROPT *pointer section of* S1DPTR *only*.

   c. If a new pointer was added to INTPT, it is initialized in subroutine S1DPTR. The new pointer should be added *just before* the LNXT pointer in the INTPT section of S1DPTR. Adjust the value of the LNXT pointer to reflect the length of the array storage of the newly added pointer. Increment the value of the variable LENPTR by one *in the* INTPT *pointer section of* S1DPTR *only*.

   d. If a new pointer was added to HEATPT, it is initialized in subroutine S1DPTR. The new pointer should be added *just before* the LNXT pointer in the HEATPT section of S1DPTR. Adjust the value of the LNXT pointer to reflect the length of the array storage of the newly added pointer. Increment the value of the variable LENPTR by one *in the* HEATPT *pointer section of* S1DPTR *only*.

3. If the new variables are to be graphed, set up the graphics catalogs by adding calls to GRFPUT in subroutine IGCOMP for each variable to be graphed. At this time, it is not possible to graph an integer array variable.

4. If the new variables are to be written to the dump file, include a call to BFOUT in subroutine DCOMP for each variable to be dumped. If the new variable being dumped is a cell-edge quantity with a length of NCELLS+1, then increment LVEDGE by one. If the new variable being dumped is a cell-center quantity with a length of NCELLS, then increment LVCNTR by one. If the new variable has dimensions other than NCELLS or NCELLS+1, increase LCOMP by the length of the new array variable.

5. To read in the new variables from the dump file for restarting, add calls to BFIN in subroutine RECOMP in the same order as the BFOUT calls were added to DCOMP. (Note that RECOMP *must* be changed if DCOMP is changed.)

6. Add the new variables to the argument list of the subroutines in which they will be calculated. Also include DIMENSION statements. Perform the necessary calculations to determine the new variables within the subroutines.

7. Add the new variables to the argument list of all calling statements to the subroutines in which the new variables are calculated.

8. A special note about adding pointers to HEATPT. The one-dimensional STGEN (steam-generator) component does not use the heat-transfer calculation pointers contained in HEATPT. Instead, the steam generator initializes its own special "generalized" heat-transfer calculation pointers. Therefore, when adding a pointer to HEATPT, the corresponding generalized pointer must be added to the one-dimensional steam-generator routines. This is done as follows.

   a. Create the new generalized heat-transfer calculation pointer name for the new generalized heat-transfer calculation variable being added to the steam-generator routines and add this new pointer name to the steam-generator pointer table STGENPT.

   b. Initialize the new generalized pointer in subroutines RSTGEN and RESTGN in the generalized heat-transfer calculation pointer section. Increment LENPTR by one.

   c. If the new generalized heat-transfer calculation variable is to be graphed, set up the graphics catalog by adding a call to GRFPUT in subroutine IGSTGN.

   d. If the new generalized heat-transfer calculation variable is to be written to the dump file, include a call to BFOUT in subroutine DSTGEN. In addition, increase LEXTRA in subroutine ISTGEN by the length of the new variable array being dumped. Also add a call to BFIN in subroutine RESTGN in the same order as the call to BFOUT was added to DSTGEN.

2.2.2. Three-Dimensional Data Structure

The data structure used for the VESSEL hydrodynamic data in MOD2 is cell-wise, in contrast to the mesh-wise data structure used for the MOD1 VESSEL implementation. In addition, most of the coding is defined directly in terms of three-dimensional arrays. This new data structure was chosen primarily to simplify code development and to improve code readability. Its implementation was designed to reduce the number of locations in the source code where changes have to be made when variables are inserted or deleted. Despite the quite different appearance of the MOD2 VESSEL coding persons familiar with MOD1 should find that the computational flow has not been changed unnecessarily.

2.2.2.1. Mesh-Wise vs Cell-Wise Data Storage

There are two ways to store data defined on a computational mesh: mesh-wise and cell-wise. In mesh-wise storage, all of the values for a given kind of mesh data or a given array (e.g., all of the pressures), are stored contiguously in computer memory. In cell-wise storage, all of the values for the different kinds of data associated with a single mesh cell (e.g., pressure, temperature, volume, etc.), are stored contiguously in computer memory. Reference to consecutive elements of a given array using cell-wise storage will, of course, necessitate use of a stride equal to the number of different kinds of data stored for a cell.

TRAC MOD1 uses a variant of mesh-wise storage for the VESSEL three-dimensional hydrodynamic data: all of the values for a given array for a given axial level are stored contiguously. This is why this data is sometimes called "level" data. The variant method was chosen to simplify the coding used to provide for having only a portion of the VESSEL data in the active computer memory at a given time. However, as computer memories have become larger and cheaper, it is now possible to have all of the VESSEL data in active memory at one time.

Rather than using mesh-wise storage as in MOD1, TRAC MOD2 uses cell-wise storage for the VESSEL three-dimensional data. This methodology was chosen since it has certain advantages over mesh-wise storage. These advantages include simpler code development and code maintenance through the avoidance of large numbers of pointers and long subroutine argument lists. However, cell-wise implementations have drawbacks as well. A discussion of the tradeoffs and the motivation for the change from MOD1 is given in Sec. 4.

2.2.2.2. Cell-Wise Implementation for MOD2 Three-Dimensional Data

MOD2 uses the equivalence method described in Sec. 4 for implementing the cell-wise data storage. In addition, all of the mesh arrays are three-dimensional. For example,

```
real alp(ni,nj,1), rov(ni,nj,1)
equivalence (a(199), alp(1,1,1)), (a(200),rov(1,1,1))
```

Note that when multidimensional arrays appear in an EQUIVALENCE statement, standard FORTRAN requires that the array dimensions of the multi-dimensional arrays not be variable. In the MOD2 implementation of the three-dimensional data, the first two dimensions of the VESSEL mesh arrays, i.e., NI and NJ, are defined in PARAMETER statements. This results in an input limit on the number of radial rings and azimuthal sectors. (There is no limit on the number of axial levels arising from this consideration.) As discussed in Sec. 4, hard-coded array dimensions have both code development and code debugging advantages over variable array dimensions; however, they also have disadvantages, including the possibility of having to change the source code in order to adapt to problem input with a larger dimension requirement.

Although the MOD2 implementation of the VESSEL data may seem very similar to static-memory allocation, the implementation is, in fact, flexible and dynamic in that it allows for an arbitrary number of axial levels in each three-dimensional VESSEL as well as for an arbitrary number of three-dimensional VESSEL components. However, some space may be wasted with a multi-VESSEL input model since the radial and azimuthal array dimensions must be the same for all of three-dimensional VESSEL components in a problem.

We note that most of the implementation difficulties experienced with either cell-wise or mesh-wise storage could be avoided by use of the widely available but non-standard POINTER construct which associates arrays with variable starting addresses. However, the approach taken in TRAC has been to use standard FORTRAN in order to ensure code portability.

2.2.2.2.1. Comdecks EQUIV and PARSET1

All of the three-dimensional array data for the MOD2 VESSEL component are declared in comdeck EQUIV; the associated PARAMETERs are in comdecks PARSET1 and PARSET2. There are two sections to the declaration in EQUIV, the array dimensions and the equivalencing to the dynamically allocated container A array:

```
*cd equiv
      dimension
     1    hla(ni,nj,1),   hva(ni,nj,1),    wat(ni,nj,1),
     2  hlatw(ni,nj,1), hvatw(ni,nj,1), finan(ni,nj,1),
     3   rmem(ni,nj,1),   rom(ni,nj,1),    qrd(ni,nj,1),
     4    sig(ni,nj,1),    am(ni,nj,1),    ....
      equivalence
     1  (a(  1),   hla(1,1,1)), (a(  2),   hva(1,1,1)),
     2  (a(  3),   wat(1,1,1)), (a(  4), hlatw(1,1,1)),
     3  (a(  5), hvatw(1,1,1)), (a(  6), finan(1,1,1)),
     4  (a(  7),  rmem(1,1,1)), (a(  8),   rom(1,1,1)),
     5  (a(  9),   qrd(1,1,1)), (a( 10),   sig(1,1,1)),
     6  (a( 11),    am(1,1,1)), (a( 12),  ....
```

As stated above, the implementation of cell-wise storage with equivalencing results in dynamic memory allocation when the loop limits used in the references to the mesh data are adjusted dynamically. The coding for these loop limits is discussed in Sec. 2.2.2.2.2.

All of the arrays in a given cell-wise storage scheme have to have the same dimension. This is accomplished by the use of the following PARAMETERs defined in the comdeck PARSET1.

NV	The number of different three-dimensional array variables.
NXRMX	The maximum number of radial rings or x-direction cells in the three-dimensional mesh.
NYTMX	The maximum number of azimuthal sectors or y-direction cells in the three-dimensional mesh.
NXBCM	The number of phantom or boundary cells next to radial ring or x-direction cell 1.
NXBCP	The number of phantom or boundary cells next to radial ring or x-direction cell NXRMX.
NYBCM	The number of phantom or boundary cells next to azimuthal θ- or y-direction cell 1.

NYBCP	The number of phantom or boundary cells next to azimuthal θ- or y-direction cell NYTMX.

Combinations of these PARAMETERs are then used to determine the array dimensions, i.e.,:

NICN = NXRMX + NXBCM + NXBCP	The total number of radial or x-direction cells.
NI = NICN*NV	The first dimension of the three-dimensional arrays.
NJ = NYTMX + NYBCM + NYBCP	The total number of azimuthal or y-direction cells and the second dimension of the three-dimensional arrays.

The TRAC user should not change any of these PARAMETERs, except for NV when array variables are added and deleted, and NXRMX and NYTMX if the maximum arrays sizes are either inadequate or too wasteful of computer memory. Further discussion of the use of phantom or boundary cells may be found in Sec. 2.2.2.5.

The second section of the EQUIV comdeck, shown above, contains the EQUIVALENCE statements implementing the cell-wise storage. Cell-wise storage necessarily imposes an order on the variables in a cell, and certain database management coding not related to dynamic memory management relies on this order. Consequently, the TRAC user should neither change the order of the variables nor insert or delete variables into comdeck EQUIV without a thorough understanding of the structure of the database as described in Sec. 2.2.2.3. With respect to the memory management, the only important factor is that each of the different array variables be equivalenced to a different location of the A array (container array) in order to create cell-wise data storage. Obviously, these locations should be consecutive in order to avoid wasting computer memory.

2.2.2.2.2. Loop Limits

All of the loop limit variable names have the same naming convention with the first letter, i.e., I, J, and K, indicating, respectively, the first (radial or x-direction), second (azimuthal or y-direction), and third (axial or z-direction) array dimensions. The letter C in a name denotes a limit suitable for looping over cells and the letter F denotes a limit suitable for looping over cell faces. The convention for cell-face variables in the MOD2 VESSEL is the same as for MOD1: the cell-face data at the "outer," "forward," or "upper" face of a cell has the same index as the data at the cell center. (Note that, as indicated below, cell faces at the VESSEL boundaries are only included in the cell-face loops when their velocities need to be calculated as a result of using the generalized boundary-condition option.)

The numeral 0 in a name denotes a lower limit and the letter X denotes an upper limit. The suffix M denotes a lower limit that includes the phantom cell adjacent to the first physical cell and the suffix MM denotes a lower limit that includes all the low-numbered phantom cells. The suffix P denotes an upper limit that includes the phantom cell adjacent to the last physical cell, and the suffix ALL denotes an upper limit that includes all the high-numbered phantom cells.

The variable names for the the radial or x-direction are:

ICOMM	Lower limit for loop over all radial or x-direction cells in the computational mesh.
ICOM	Lower limit for loop over radial or x-direction cells in the physical mesh and the adjacent low-numbered phantom or boundary radial or x-direction cell.
IC0	Lower limit for loop over all radial or x-direction cells in the physical mesh.
IF0	Lower limit for loop over all radial or x-direction cell faces at which velocities are calculated.
ICX	Upper limit for loop over all radial or x-direction cells in the physical mesh.
IFX	Upper limit for loop over all radial or x-direction cell faces at which velocities are calculated.
ICXP	Upper limit for loop over radial or x-direction cells in the physical mesh including the high-numbered phantom or boundary radial or x-direction cell.
IALL	Upper limit for loop over all radial or x-direction cells in the computational mesh.

The variable names for the azimuthal or y-direction loop limits can be obtained by replacing the leading I with a J and those for the axial loops by replacing the leading I with a K.

Before describing the definition of the loop limits, we want to emphasize that there is no reason why the code developer should have to change any of the coding of the loop limits in either comdeck PARSET2 or in subroutine RVSSL. In fact, this is one of the main advantages of the MOD2 VESSEL data implementation: all of the maintenance of the memory management functionality can be accomplished by changing only three variables in comdeck PARSET1: NV, NXRMX, and NYTMX. The coding of the loop limits is described here merely for completeness.

Certain of the loop limits can, of course, be hard-coded with PARAMETER statements. These are defined as follows in PARSET2:

```
JC0P   = NYBCM + 1
JC0MP  = JC0P  - 1
JC0MMP = JC0P - NYBCM
KC0P   = NZBCM + 1
KC0MP  = KC0P  - 1
KC0MMP = KC0P - NZBCM
```

The suffix P in these names stands for "parameter." These variables are copied to the corresponding COMMON variables JC0, JC0M, JC0MM, KC0, KC0M, and KC0MM using the standard naming convention in subroutine RVSSL.

Additional radial or x-direction, azimuthal or y-direction, and axial lower loop limits as well as all of the upper loop limits are defined dynamically for each three-dimensional VESSEL component in subroutine RVSSL. This coding is reproduced below (in a restructured form) where NXR is the input number of physical radial rings or x-direction cells, NYT is the input number of physical azimuthal sectors or y-direction cells, NZZ is the input number of physical axial levels, IGEOM is zero for cylindrical geometry and one for Cartesian geometry, IGBCXR is nonzero for generalized radial or x-direction boundary conditions, IGBCYT is nonzero for generalized azimuthal or y-direction boundary conditions, and IGBCZ is nonzero for generalized axial boundary conditions. (In the current version of MOD2, IGBCXR and IGBCYT are always zero and IGBCZ is only nonzero when the VESSEL outer boundary-condition input flag, IVSSBF, is nonzero.)

For the second index representing the azimuthal or y-direction:

```
      jcx  = jc0 + nyt - 1
      jcxp = jcx + 1
      jall = jcx + nybcp
C     Calculate NYTV, the number of azimuthal or y-direction
C     cell faces where velocities must be calculated.
      if (igeom .eq. 0) then
         jf0 = jc0
         if (nyt .gt. 1) then
            nytv = nyt
         else
            nytv = 0
         endif
      else
         if (igbcyt .eq. 0) then
            jf0  = jc0
            nytv = nyt - 1
         else
            jf0  = jc0m
            nytv = nyt + 1
         endif
      endif
      jfx = jf0 + nytv - 1
```

For the third index representing the axial direction:

```
      kcx  = kc0 + nz - 1
      kcxp = kcx  + 1
      kall = kcx + nzbcp
C     Calculate NZZV, the number of axial cell faces
C     where velocities must be calculated.
      if (igbcz .eq. 0) then
         kf0  = kc0
```

```
      nzzv = nz - 1
   else
      kf0  = kc0m
      nzzv = nz + 1
   endif
   kfx = kf0 + nzzv - 1
```

Since the first index, i.e., I, is used to determine the dynamic offset into the container A array, all of the loop limits for the first index have to be defined dynamically for each three-dimensional VESSEL component. This is done in RVSSL where IFREE is the first free location in the A array.

For the first index representing the radial or x-direction:

```
      ic0mm = ifree
      ic0   = ic0mm + nxbcm*nv
      ic0m  = ic0 - nv
      icx   = ic0 + (nxr - 1)*nv
      icxp  = icx + nv
      iall  = icx + nxbcp*nv
C     Calculate NXRV, the number of radial or x-direction
C     cell faces where velocities must be calculated.
      if (igeom .eq. 0) then
         if0 = ic0
         if (igbcxr .eq. 0) then
            nxrv = nxr - 1
         else
            nxrv = nxr
         endif
      else
         if (igbcxr .eq. 0) then
            if0 = ic0
            nxrv = nxr - 1
         else
            if0 = ic0m
            nxrv = nxr + 1
         endif
      endif
      ifx = if0 + (nxrv-1)*nv
```

The inclusion of the variable NV in this coding for the radial or x-direction loop limits creates the cell-wise storage. Note that if there is more than one three-dimensional VESSEL component in a problem, these indices are calculated for each VESSEL component. These indices are transferred from the component storage into the VESSEL variable-length table when needed using the standard TRAC data-management protocol.

2.2.2.2.3. Temporary Mesh-Wise Storage for One Variable in One Level

In order to maintain compatibility with the MOD1 input and output procedures, MOD2 has the capability of temporary mesh-wise storage for a single axial level for a single array variable. A temporary mesh-wise array sufficient to hold one level of data for one array is allocated with the pointer LTEMPS in subroutine RVSSL. This temporary array is then used for storing the specified data in mesh-wise form. Subroutine LEVELR is a generic procedure for transferring data from this temporary array to the appropriate locations of a permanent cell-wise array and subroutine LEVELI is a generic procedure for transferring data from a permanent cell-wise array to this temporary array.

As an example of the use of subroutine LEVELR, all of the mesh data input in subroutine RVSSL is read into the temporary array on a level-by-level and array-by-array basis. After each "read," as processed by the LOAD routine, the data is transferred from the temporary array to the indicated permanent cell-wise array via the RLEVEL routine which calls the LEVELR procedure. The LEVELR procedure is also used directly from routine REVSSL to transfer data when reading the restart dump file.

The LEVELI procedure for converting from the cell-wise storage to temporary mesh-wise storage is used by three output procedures: DLEVEL to write a restart dump for one level and one array, GLEVEL to write a graphics dump for one level and one array, and WLEVEL to write to the TRCOUT file for one level and one array. The GLEVEL routine makes use of the position concept discussed in Sec. 2.2.2.4

Routines LEVELR, LEVELI, RLEVEL, DLEVEL, GLEVEL, and WLEVEL are all generic routines and should not need to be modified unless the TRAC user wishes to make a major change in implementation.

2.2.2.3. Classification of Variables

There are two basic categories of variables in the VESSEL hydrodynamic database: single-time and dual-time variables. Both categories have subcategories leading to seven classes of variables:

1. Single-time variables:
   - 1.1 Single-time, cell-centered, single-time (but not old-old-time) variables that are either cell-centered, defined at the higher numbered cell faces, or defined at the lower numbered radial or axial cell faces.
   - 1.2 Old-old-time variables which store values at the start of the previous time step in order to create an ad hoc "triple-time" capability.
   - 1.3 Single-time cell-face variables defined at the backwards or lower numbered azimuthal cell face.
2. Dual-time variable pairs:
   - 2.1 Old-time variables for which the new-time values are calculated prior to the OUTER hydrodynamic stage.
   - 2.2 Old-time variables for which the new-time values are not calculated prior to the OUTER hydrodynamic stage.

2.3 New-time variables for which the values are calculated prior to the OUTER hydrodynamic stage.

2.4 New-time variables for which the values are not calculated prior to the OUTER hydrodynamic stage but may have been incorrectly calculated during OUTER prior to a back-up.

The class of a variable is determined according to how the variable needs to be updated as the calculation progresses. There is currently no provision for variables belonging to more than one class.

Single-time variables in Class 1.1 do not need to be automatically updated. This does not necessarily mean that their values don't change with time. Single-time variables in Class 1.2 (currently only the void fraction) are updated in subroutines TIMUPD and BAKUP in a manner analogous to that for dual-time variables as described below. Single-time variables in Class 1.3 require special logic, implemented in subroutine SETBDT, to ensure that values defined for azimuthal phantom cells have the proper identification with the values for the actual cells.

Dual-time variables are automatically updated, i.e. the old-time variables take on the values of the new-time ones at the start of a time-step calculation. This coding is in subroutine TIMUPD for the VESSEL. (Note that, in fact, this is the only mechanism for defining old-time values.) In addition, the provision for separate classes of dual-time variables allows for the code to back up (repeat a calculation with a different time step or other parameter) starting either at the beginning of a time step or at the beginning of the OUTER hydrodynamic stage. Both backup procedures are in subroutine BAKUP. The differences in the two types of back-ups are discussed more thoroughly in Sec. 3.4.

Although an in-depth discussion of the implementation of the generic procedures applied to the different classes of variables is outside the scope of this section, two aspects of the implementation affect the addition of variables: the current implementation uses the relative position of a variable in the database to determine its classification, and the relative positions of the variables are known to the code through six parameters which rely on the database having a certain structure. In other words, the code developer must insert a new variable in a position appropriate to its class and must ensure the maintenance of the assumed structure.

The relative position in memory of a cell variable is referred to here either as its position or as its position in the database. This position is thus identical to the index into the container array occurring in the EQUIVALENCE statement. (It is obviously convenient from the standpoint of readability for the EQUIVALENCE statements in the source to be ordered by position; however, this is not necessary. In any case, the use of the word position here refers to the relative position in memory when the code is executed, not the position in the source code.)

Implementation procedures used for the VESSEL three-dimensional database rely on a particular structure. This leads to a number of restrictions which must be observed when the code is modified by inserting variables. The major restrictions are related to the classification of the variables and are discussed in the next section. Special restrictions on the elements of array variables are given in Sec. 2.2.2.3.2 and some miscellaneous restrictions are given in Sec. 2.2.2.3.3.

2.2.2.3.1. Relation of Position and Classification and Comdeck PARSET1

The current implementation of the generic procedures described above relies on the fact that the various classes of the VESSEL database are in the following order according to the position of the variables in the class:

1) 1.1 and 1.2 (may be intermixed)
2) 2.1
3) 2.2
4) 2.3 (in one-to-one correspondence with 2.1)
5) 2.4 (in one-to-one correspondence with 2.2)
6) 1.3.

Since the implementation makes implicit use of these restrictions, it is essential that array variables which are added to the code conform to these restrictions. Current releases of MOD2 also allow for Class 1.1 variables immediately before the Class 1.3 variables. We do not recommend this procedure as it complicates code maintenance.

These particular restrictions were chosen to simplify the implementation of the generic procedures, to allow these procedures to be efficient on vector processors, and to reduce the number of PARAMETER constants needed to describe the database. The PARAMETER constants characterizing the structure of the database are:

LALO*	Position of the "old-old" time variable ALPO (corresponding to the variable ALP).
LALM*	Position of the old-time variable ALP (corresponding to the variable ALPO).
LOLD	Position of first old-time category 2.1 variable.
LOLD1	Position of first old-time category 2.2 variable.
LNEW	Position of first new-time category 2.3 variable.
NV	Position of last variable (equal to number of variables).

Depending on the class of the variable, one or more of these six PARAMETER constants will have to be updated when a variable is added. (Refer to Sec. 2.2.2.6 for further details.)

2.2.2.3.2. Special Restrictions on Ordering Elements of Array Variables

For a subset of the cell-face array variables, the coding relies on the three components of the cell-face arrays being contiguous in memory and being ordered with the θ- or y-direction element first, the axial element second, and the radial- or x-direction element third. For example,

*These variables are used to implement an ad hoc "triple-time" capability for the void fraction. Introduction of additional old-old-time variables should use this coding as a model.

```
      equivalence (a( 28), fayt(1,1,1)),  (a( 29), faz(1,1,1)),
     &            (a( 30), faxr(1,1,1))
```

These restrictions also apply to the cell-face variables in comdeck EQUIVF, which are referenced in routine J3D, and to the cell-face signal variables referenced in routine SVSET3. Consequently, insertion of new variables must not change the relative order of the components for these cell-face array variables. We recommend, for readability as well as for prevention of future coding errors, that all cell-face array variables be stored so that the components are contiguous and ordered as above.

2.2.2.3.3. Miscellaneous Restrictions on the Positions of VESSEL Array Variables

Coding in the signal-variable evaluating subroutine SVSET3 relies on variable HLA being the first array variable.

We are not aware of any other restrictions other than those listed here explicitly. However, we recommend that if new variables are added that they not be put as the first variable of their class. Code developers familiar with MOD2 have assumed that they can depend on those variables which are currently first in their class to remain in that relative position.

2.2.2.4. Referencing Three-Dimensional Arrays for VESSEL Coding

All of the VESSEL hydrodynamic routines are coded in MOD2 with direct usage of three-dimensional arrays for the mesh data. This improves readability, i.e., ALP(I,J,K) rather than ALP(IT+(IR−1)×NTSX) (for the K^{th} axial level) as in MOD1. In addition to improving readability and simplifying debugging, this implementation considerably reduces the possibility of coding errors. Naturally, with typical TRAC noding, this use of three-dimensional arrays does not provide long vector lengths for inner do-loops. MOD2 has been coded with the loop over axial levels as the inner loop since that dimension is generally the largest. Achievement of long vector lengths by looping over the entire mesh would require a change to indirect addressing in order to encode the mesh connectivity in a vectorizable manner.

Reference to neighboring cells in the VESSEL mesh is straightforward using three-dimensional arrays. From the standpoint of the cell at (I,J,K), the adjacent cell in the inner radial or x-direction is (I−NV,J,K) and in the outer radial or x-direction is (I+NV,J,K). The necessity for the stride, NV, arises from the cell-wise data storage described in Sec. 2.2.2.2. The adjacent cell in the lower azimuthal or y-direction is (I,J−1,K) and in the higher azimuthal or y-direction is (I,J+1,K). Finally, the next lower cell (level) in the axial direction is (I,J,K−1) and the next higher cell (level) above is (I,J,K+1).

It also is convenient to have an abstract method for referencing individual variables. Such reference is currently used in generating the graphics catalog and in implementing the signal-variable evaluation logic. For one-dimensional data, which still use a mesh-wise data structure, pointers are used for this purpose. For the three-dimensional data, we have chosen to use the position in the database. We emphasize that a position is not a pointer and has to be referenced in a different manner. In particular, if "LPOS" is the position of a particular variable, then the value of that variable in the cell (I,J,K) will be A(I+LPOS−1,J,K) given that the value of I incorporates the offsets in the container or A array as described in Sec. 2.2.2.2.2.

The positions of the VESSEL array variables are defined dynamically in subroutine PTRS, and the identifiers are stored in the "VESSEL level-data pointers" (note mislabeling) section of the comdeck VSSLPT. First, before any hydrodynamic calculations are done, the values of all of the array variables for the first phantom cell are temporarily set to their position in the database using the following coding:

```
      do 10 n = 1, nv
   10 a(ic0mm+n-1) = float(n)
```

Next, the identifiers for those variables needed in the graphics and signal-variable evaluation procedures are defined as in the following example:

```
      lpn   = ifix(  pn(ic0mm,1,1))
      lalpn = ifix(alpn(ic0mm,1,1))
      .
      .
      .
      etc.
```

At the end of PTRS, the values for the first phantom cell are reset to a nominal value.

Unless the TRAC user is adding a new variable to the graphics catalog or to the signal-variable evaluation logic, it is not necessary to define an identifier for the variable in PTRS and to add the identifier to the comdeck VSSLPT. We recommend that, in order to minimize changes to the code as well as to minimize the amount of unused code, that identifiers not be added unless they are to be used.

2.2.2.5 Boundary or Phantom Cells

The VESSEL mesh in MOD2 is constructed with two rows of boundary cells outside the mesh in each of the tree lower-numbered directions and with one row of boundary cells in each of the higher-numbered directions The extra row in the lower-numbered directions is necessary to accommodate the face-centered data. The number of boundary cells in each direction is set by PARAMETER constants as described in Sec. 2.2.2.2.1. The use of boundary cells allows all references from cells within the physical mesh to neighboring cells outside the physical mesh to be valid.

When using a three-dimensional VESSEL component to model a typical cylindrical reactor vessel with outer boundary walls, the data in the bottom and top axial boundary cells and the outer radial boundary cells do not affect the calculation. However, the inner radial boundary cells can be used to incorporate the effect of radial-momentum convection across the center of the vessel. (Such a model was implemented using a different mechanism in MOD1. This model, which is partially implemented in routine VRBD, is not currently activated in MOD2.) The azimuthal boundary cells are used to avoid the special logic necessary to indicate that the first physical azimuthal sector is adjacent to the last physical azimuthal sector. This is accomplished by subroutine SETBDT, which copies the data from the cells in the first and last physical sectors to the appropriate phantom cells.

The boundary-cell implementation makes it simple to include generalized boundary conditions at the bottom and top axial and outer radial boundaries of a cylindrical VESSEL and at all of the external boundaries of a three-dimensional Cartesian-geometry VESSEL. MOD2 contains the appropriate coding in all of the VESSEL hydrodynamic routines to allow for fixed-pressure (BREAK) or fixed-velocity (FILL) boundary conditions independently at any of these boundaries. However, this coding for the radial or x and azimuthal or y boundaries has not yet been tested. In the currently released version of MOD2, there is no input mechanism to activate this coding. There is an input option, IVSSBF, which only activates the generalized boundary conditions at the lower and upper axial faces. There is currently no coding to allow for the generalized boundary conditions to be time dependent. However, implementing such a feature should not require major changes to the current code.

In addition to providing for the new generalized boundary conditions, the use of phantom cells allows for improved implementation of the standard hydrodynamic algorithms. Without the use of phantom cells, special program logic is required to calculate expressions including gradients and fluxes for cells at the edge of the physical mesh. Such logic would increase the probability of coding errors and inhibit vectorization on hardware such as the CRAY computers.

For typical coarse-mesh VESSELs, a large percentage of the cells are at the edges of the mesh. For example, a three-dimensional VESSEL component with four radial rings and four azimuthal sectors on each level actually has only 4 of the 16 cells on a level which have neither a radial nor an azimuthal boundary. Since even straightforward vectorization generally reduces computation time by more than a factor of 5, it is obviously desirable to design implementations which are vectorizable for all cells.

As stated previously, if phantom cells are not used, special logic would be necessary to carry out calculations for cells at the edge of the physical mesh. On the other hand, when phantom cells are used, additional procedures are required to define the values associated with the phantom cells. The amount of code that must be maintained is similar in either case; however, the phantom-cell methodology is more easily modularized.

The major disadvantage in using phantom cells is the potential for significantly increased computer-memory requirements for coarse-mesh VESSELS. For our previous example, a VESSEL with 4 radial rings, 4 azimuthal sectors, and 10 axial levels has only $4 \times 4 \times 10$ or 160 physical mesh cells. However, it will have $(4 + 3) \times (4 + 3) \times (10 + 3)$ or 637 computational mesh cells when including the boundary cells. Naturally, the percentage of boundary cells is smaller for more finely noded problems. The current VESSEL array data contains about 300 different variables; thus, this example would require roughly 200,000 words of computer memory for the array data. However, for most modern computer hardware, this is not a large amount of memory and the cost-benefit ratio of this memory increase when compared with the more efficient coding is extremely favorable.

Since the lowest-numbered rows of phantom cells in each direction are only used in conjuction with the generalized boundary-condition option associated with a fixed pressure boundary condition, it should be possible to reduce the memory requirements by changing the PARAMETER constants defining the number of lower-numbered phantom cells from 2 to 1. However, doing this has not been tested.

2.2.2.6. Adding or Deleting a Three-Dimensional Database Array Variable

There are three steps to adding a variable to the VESSEL hydrodynamic (cell-wise) database; these steps are summarized below. Note that these steps are incomplete for the case of old-old-time array variables.

1. Determine an appropriate position in the database for the new array variable or dual-time array variable pair according to the classification of the array variable and the structure of the database.

2. Insert the necessary EQUIVALENCE and DIMENSION statements for the new array variable(s) into comdeck EQUIV and update any EQUIVALENCE statements for preexisting variables which have their A-array positions changed by the insertion. (Although this can lead to a large amount of retyping, the retyping can be easily automated.)

3. Ensure that the six PARAMETER constants, i.e., LALO, LALM, LOLD, LOLD1, LNEW, and NV, which characterize the structure of the vessel database, are correct.

Once the new VESSEL array variable has been successfully added to the VESSEL hydrodynamic database, one then needs to modify the necessary subroutines to calculate, dump/restart, graph, or output the new variable. The following four guidelines give step-by-step instructions on how this is accomplished.

4. Perform the necessary calculations to determine the value of the new array variable within the appropriate subroutine.

5. If the new array variable is to be written to the dump file for restart purposes, include a call to DLEVEL in routine DVSSL. In addition, increment the variable LV by one in subroutine DVSSL. To read in the new array variable from the dump file when restarting, add calls to BFIN and LEVELR in subroutine REVSSL in the same position that the call was added to subroutine DVSSL. (Note that REVSSL *must* be changed if DVSSL is changed.)

6. If the new array variable is to be graphed, initialize a new graphics identifier in subroutine PTRS. In addition, include the new graphics identifier in comdeck VSSLPT. Include a call to GRFPUT in subroutine IGVSSL for the new graphics identifier. If special provision has to be made to output the new variable, then subroutines IGRAF and GRAF may need to be changed.

7. If the new array variable is to be written to the output file TRCOUT as printed output, add a call to WLEVEL in subroutine WVSSL for the new array variable to be printed.

3. TRAC CALCULATIONAL SEQUENCE

The full TRAC calculational sequence involves several stages: input processing; initialization; prepass, outer-iteration, and postpass calculations; time-step advancement or back-up; and output processing. Each of these stages is discussed in greater detail from a programmer's point of view in the sections that follow. First, a summary of the overall calculational sequences for transient and steady-state calculations is given.

3.1. General Summary

Depending on the values of the input parameters STDYST and TRANSI (Main Data Card 4), TRAC may perform a steady-state calculation, a transient calculation, or both. The general control sequences of each type of calculation are outlined below, and specific details of the calculational sequence are discussed in more detail in the subsections that follow.

The transient calculation is directed by subroutine TRANS. The system state is advanced through time by a sequence of prepass, outer-iteration, and postpass calculations that TRANS requests by invoking subroutines PREP, HOUT, and POST, respectively. In these calculations, one or more sweeps are made through all the components in the system. To provide the output requested by the user, TRANS invokes the EDIT, DUMP, and GRAF overlays by calling subroutine PSTEPQ. Subroutine TRANS is structured as shown in Fig. 2. The major control variables within the time-step loop are: NSTEP, the current time-step number; TIMET, the time since the transient began; DELT, the size of the current time step; and OITNO, the current outer-iteration number. The time-step loop begins with the selection of the time-step size, DELT, by subroutine TIMSTP. A prepass is performed for each component by overlay PREP to evaluate the stabilizer motion equation and phenomenological coefficients. At this point, if the current time-step number is zero, TRANS calls the EDIT overlay to print the system state and the GRAF overlay to generate a graphics edit at the beginning of the transient. Subroutine TRANS then calls subroutine HOUT, which performs one or more outer iterations to solve the basic hydrodynamic equations. Each outer iteration is performed by overlay OUTER and corresponds to one iteration of a Newton-method solution procedure for the fully coupled difference equations of the flow network. The outer-iteration loop ends when the outer-iteration convergence criterion (EPSO on Main-Data Card 5) is met. This criterion is applied to the maximum fractional change in the pressures throughout the system during the last iteration.

The outer-iteration loop alternatively may terminate when the number of outer iterations reaches a user-specified limit (OITMAX on Main-Data Card 6). In this case, TRAC restores the state of all components to that at the beginning of the time step, reduces the time-step size (with the constraint that DELT be greater than or equal to DTMIN), and continues the calculation with the new time-step size. This represents a back-up situation and is discussed in greater detail in Sec. 3.5.

When the outer iteration converges, TRANS calls the POST overlay to perform a postpass evaluation of the stabilizer mass and energy equations and the heat-transfer calculation. Then the time-step number is incremented and TIMET is increased by DELT. The calculation is complete when TIMET reaches the last TEND time specified on the time-step data.

The transient calculation is controlled by a sequence of time domains specified by the user on the time-step data. During each of these time domains, the minimum and maximum time-step sizes and the edit, dump, and graphics intervals are fixed. When the EDIT, DUMP, and GRAF overlays are invoked, they calculate the time when the next output of the associated type is to occur by incrementing the current time by the time interval. When TRANS later finds that TIMET has reached or exceeded the indicated time, the corresponding output overlay is invoked again. Whenever TIMET equals or exceeds the TEND ending time for a time-step data domain, the next time-step data domain is [illegible]n. The output indicators are set to the current time plus the new values of the appropriate intervals.

Subroutine STEADY directs steady-state calculations using the structure detailed in Fig. 3. The calculation sequence of this subroutine is similar to that of the transient driver subroutine TRANS. The same sequence of evaluations used for transient calculations also is used for the steady-state calculation. The main difference is the addition of a steady-state convergence test in STEADY, logic to turn on the steady-state power level, and the optional evaluation of constrained steady-state controllers. To provide output requested by the user, STEADY invokes the EDIT, DUMP, and GRAF overlays by calling subroutine PSTEPQ.

Subroutine STEADY is called by the main program whether or not a steady-state calculation has been requested. If no steady-state calculation is required, STEADY simply returns to the main program.

The time-step control in STEADY is identical to that implemented in TRANS. This includes the selection of the time-step size, the output timing, and the back-up of a time step if the outer-iteration limit is exceeded. In STEADY the input variable SITMAX, from Main-Data Card 6, is used as a delimiter in place of OITMAX. The maximum fractional rates of change of seven parameters are calculated by subroutines TF1DS3 and FF3D. These rates and their locations in the system are transmitted to STEADY through the array variables FMAX and LOK in COMMON block SSCON. Tests for steady-state convergence are performed every 5 time steps and before every large edit. The maximum fractional rates of change and their locations are written to the TRCMSG and TRCOUT files as well as the TTY I/O channel. The minimum value of the flow velocity, MINVEL, and its maximum fractional rate of change, FMXLVZ, in the hydro channels coupled to powered heat structures determine when the steady-state power should be set on. Once MINVEL exceeds 0.5 m/s and FMXLVZ falls below 0.5, the steady-state power is set to its input value, RPOWRI (specified on Card Number 19), for each powered heat structure. The generalized steady-state calculation is completed when all fractional rates of change are below the user-specified convergence criterion, EPSS (on Main-Data Card 5), or when STIME reaches the end of the last time domain specified in the steady-state calculation time-step data.

Both steady-state and transient calculations may be performed in one computer run. The end of the generalized steady-state time-step cards is signified by a single card containing a −1.0 in columns 4-14. The transient time-step input cards should follow immediately. If the generalized steady-state calculation converges before reaching the end of the last time domain, the remaining steady-state time-step data are read in but not used so that the transient calculation proceeds correctly.

3.2. Input Processing

The processing of all TRAC input data (except for the time-step data) is performed by the overlay INPUT and its sub-overlays RDIN1, RDIN3, and RDRES. These data are of two types: input data retrieved from the input file TRACIN and restart data from the dump-restart file TRCRST. In addition to obtaining these input data, these overlays also organize the component data in memory, assign the array pointer variables for each component, analyze the problem loop structure, and allocate the initial A-array space for part of the global data. The remainder of the space necessary within the A array for the global variables is allocated by subroutine INIT in overlay INIT. At the end of each of the overlays, INPUT and INIT, these fixed data segments are moved to the end of the dynamic-memory area.

As the controlling subroutine within the INPUT overlay, subroutine INPUT reads the namelist, main-data, and CCFL-model input from the TRACIN file. Using main-data parameter information, the initial A-array global variable space is allocated. The interactive control-panel-vector input is read and processed by a call to subroutine RCPVEC if the TRAC executable was updated with the interactive label on. The signal-variable, control-block, and trip control-parameter data are read and processed by calling subroutine RCNTL. Subroutine RDCOMP reads and processes the one-dimensional component data and subroutine RDCOM3 performs a similar function for the VESSEL component data from the TRACIN file. Any control-parameter and component data not provided by the TRACIN file are retrieved from the TRCRST restart-data file by subroutine RDREST. Finally, subroutine INPUT utilizes subroutine SRTLP to establish loops and pointers for the network solver, subroutine ASIGN to define the component pointer array, and subroutine SETCPV to initialize the control-panel-vector pointers.

Subroutine RDCOMP invokes component input-processing subroutines to read and process each component type. These routines have names which typically begin with the letter R. For example, the PIPE component input-processing subroutine is called RPIPE. In addition to reading component data from the TRACIN file, these component input-processing routines must also initialize the fixed-length, variable-length, and pointer tables and define the JUN array. Each component input-processing subroutine may utilize a call to subroutine RCOMP, which processes the input data common to most one-dimensional components.

Pointer variables common to most one-dimensional components are initialized with a call to subroutine S1DPTR, and any additional pointers special to a component type are initialized within that component's input-processing subroutine. An example of specialized pointer variables are the many steam-generator generalized heat-transfer pointers initialized in subroutine RSTGEN. When adding a new variable to a one-dimensional component, it is necessary to initialize the new pointer in S1DPTR or in a specific component input-processing routine in addition to performing several other steps. The step-by-step procedure involved is discussed in Sec. 2.2.1.1, and a sample update is included as Appendix E.

The JUN array defined by each component input-processing routine is a doubly subscripted array, JUN(4,2×NJUN). The four values of the first index are defined in Table 2. The second index indicates the order in which the component junction was encountered during input processing.

TABLE 2

FIRST INDEX OF THE COMPONENT-JUNCTION ARRAY, JUN

Index	Description
1	Junction number.
2	Component number.
3	Component type.
4	Junction direction flag 0 = positive flow is into the component at this junction; 1 = positive flow is out of the component at this junction.

Subroutine RDCOM3 invokes the VESSEL component input-processing routine RVSSL. In addition to reading VESSEL input parameters from the TRACIN file, this routine also initializes the fixed-length, variable-length, and pointer tables, reads VESSEL level data, and performs input testing.

Subroutine RDREST opens the restart-data file TRCRST and obtains data from the dump edit corresponding to the requested time-step number (as specified by variable DSTEP on Main Data Card 3 of file TRACIN). If the requested time-step number is negative, RDREST uses the last dump edit available. The dump data initialize the signal-variable, control-block, trip, and component data that were not provided by the TRACIN file. Component data are read in from the TRCRST file by calls to component restart-processing subroutines. These subroutines, whose names typically begin with the letters RE, function in much the same way as the component input-processing subroutines which begin with the letter R. For example, the PIPE component restart-processing subroutine is called REPIPE. The restart data common to most one-dimensional components is processed from the dump using a call to subroutine RECOMP. Details on the structure of the dump-restart file are given in Sec. 3.6.

Subroutine SRTLP sorts through the one-dimensional components of the system and groups them by loops that are isolated from one another by VESSEL components or TEE internal junctions. The IORDER array is rearranged to reflect this grouping and to provide a convenient order within each group for the network solution procedure. The I^{th} element of the array IORDER is the number of the component that is processed after the $(I-1)$ component but before the $(I+1)$ component.

Subroutine ASIGN defines the component pointer array, COMPTR, according to the order of the IORDER array. The I^{th} element of array COMPTR is the starting location in the A array of the fixed-length table data for component IORDER(I).

If the input file TRACIN is in free format (rather than in TRAC format), TRAC creates the additional file TRCINP. The TRACIN data are written into file TRCINP in a TRAC-format form that can be read by the TRAC input routines. File TRCINP is used as the input file rather than file TRACIN.

The user has the option of creating an echo file of the input data contained in file TRACIN by defining NAMELIST variable INLAB = 3. When this option is selected, file INLAB is created during input processing and contains all the input data from file TRACIN along with variable-name comments contained between asterisks. This provides a useful means of labeling an otherwise difficult-to-interpret TRACIN file. It also allows the user to verify the input data being supplied to TRAC.

3.3. Initialization

During the initialization stage performed within overlay INIT, subroutine ICOMP performs the initialization of arrays and variables for each component that are required by TRAC but are not read in directly from files TRACIN and TRCRST. Also during this overlay, subroutine IGRAF controls the initialization of the graphics catalog.

The overall component-initialization subroutine, ICOMP, first defines the junction sequence array JSEQ and velocity sign indicator array VSI and then initializes the data for heat-structure, one-dimensional, and three-dimensional components. The array JSEQ contains junction numbers in the order they are processed as determined by the component order-of-evaluation array IORDER. The I^{th} element of the array VSI is the junction flow-reversal indicator for junction JSEQ(I). Using a call to subroutine SETNET, the array IOU is initialized to contain network junction numbers for the junctions of all components excluding BREAKs and FILLs. Finally, VESSEL source connections are checked to ensure that all connections for a particular loop are in the same direction. This is necessary to ensure that the predictor and stabilizer velocities solved for using FEMOMX, FEMOMY, and FEMOMZ remain independent of one another.

Subroutine CIHTST controls the initialization of all heat-structure components with calls to subroutines IRODL and IROD. Subroutine IRODL initializes arrays that provide information on the location of hydrodynamic data, and subroutine IROD initializes various power-related arrays that are not input.

The one-dimensional component initialization routines have names which typically begin with the letter I. For example, the PIPE component initialization subroutine is called IPIPE. After determining the junction connection and component sequencing, these routines call subroutine VOLFA to calculate volume-averaged cell flow areas and to perform several input tests on valid flow area configurations. Next, subroutine COMPI is called to initialize several variable arrays (e.g., tilde velocities). Thermodynamic properties, transport properties, and stabilizer quantities are initialized with a call to subroutine IPROP. Next, a call to subroutine SETBD initializes the boundary-array data. Junction data consistency then is checked using a call to subroutine CHKBD. Finally, subroutine ELGR is called to compute FRICs and GRAVs from form losses and elevations if these particular input options are selected using the NAMELIST options IKFAC and IELV, respectively.

The boundary data are stored in the doubly-dimensioned array BD(65,NJUN). These data indicate the current solution state of the adjacent component and are evaluated at one of three possible space points: the edge of the mesh cell at the junction, the midpoint of that mesh cell, or the other edge of that mesh cell. The first index signifies the element description as determined by a call to J1D for one-dimensional components, to BDPLEN for plenum components, and to J3D for three-dimensional components. The second index indicates the order in which the junction numbers are processed.

Similarly, subroutine CIVSSL controls the intialization of all VESSEL components by calling subroutine IVSSL. Subroutine IVSSL performs analogous initializations for the VESSEL component as does subroutine IPIPE for the PIPE component. Obviously, due to the differences in the one-dimensional and three-dimensional databases, it is not possible to use many of the same low-level subroutines for both component types.

After component initialization by subroutine ICOMP is complete, subroutine INIT calls subroutine IGRAF. The graphics initialization subroutine, IGRAF, creates the TRCGRF file; writes the header, catalog, and geometric data to the file; and places the file information into a storage area. The catalog data determine what information is to be written to the TRCGRF file during the course of a problem and are defined by calls to component graphics initialization subroutines. These routines, whose names typically start with the letters IG, specify the data to be editted for each component. For example, the PIPE component graphics initialization subroutine is called IGPIPE. The catalog data common to most one-dimensional components are handled by subroutine IGCOMP. A complete listing of the available graphics variables for each component is summarized in Appendix F. In order to graph a new variable, the appropriate graphics catalog edit need only be added to subroutine IGCOMP if the variable is common to most one-dimensional components, to subroutine IGVSSL if the variable is a VESSEL variable, or to a specific graphics initialization routine if the variable is particular to a component type.

3.4. Prepass, Outer-Iteration, and Postpass Calculations

One complete time-step calculation consists of a prepass outer-iteration, and postpass stage. Each stage of the time-step calculation is detailed below.

3.4.1. Prepass Calculation

The prepass calculation uses the modeled-system solution state at the completion of the previous time step to evaluate numerous quantities to be used during the outer-iteration calculation. The prepass begins by evaluating signal variables and control block, and determining the set status of all trips. Each component begins the prepass by moving the values calculated during the last time step into the storage area for old-time values. Next, wall and interfacial friction coefficients are calculated, and an initial forward elimination on the stabilizer motion equations is performed. For components that require heat-transfer calculations, the prepass also evaluates material properties and heat-transfer coefficients (HTCs). A second pass through all one-dimensional components is required to do the backward substitution on the stabilizer equations of motion. The prepass for heat-structure components can be more complex. Besides calculating material properties and HTCs for both average and additional rods, the prepass evaluates quench-front positions and fine-mesh properties if the reflood model has been activated.

The prepass calculation is controlled by overlay PREP, whose entry-point subroutine is of the same name. Subroutine TRIPS controls the evaluation of signal-variable, control-block, and trip data. This is in contrast to subroutine TRIP that interrogates the trip set status in preparation for specific consequences of trips. Then subroutine PREP performs the first pass of the PREP stage for all one-dimensional components by calling PREP1D with IBKS set to 1. All heat-structure components are processed by calling HTSTR1. If the SETS3D method has been selected for all VESSEL components (NAMELIST option NOSETS = 0 or 2 and NSTAB=1), overlay PREP3D is called at this time to evaluate the predictor and stabilizer motion equations. The second pass through the PREP stage performs the backward-substitution for the one-dimensional stabilizer tilde velocities by again calling PREP1D, this time with IBKS set to 2. If the SETS3D method is not selected (NAMELIST option NOSETS = 1 or NSTAB = 0), the prepass is completed with a call to PREP3D to define all tilde velocities by their beginning-of-time-step velocities for the three-dimensional VESSEL components.

Subroutine TRIPS calls subroutines SVSET, CBSET, and TRPSET. Subroutine SVSET uses current values of system-state variables to define the signal variables. Subroutine CONBLK, which is called by subroutine CBSET, evaluates control-block function operators. Subroutine TRPSET uses the current signal-variable and control-block values to determine the set status of trips.

The one-dimensional prepass driver PREP1D calls one-dimensional component prepass routines to perform both steps of the prepass for each one-dimensional component type. The component driver routines have names which typically end with the numeral 1 (see Table 3). For example, the PIPE component prepass subroutine is called PIPE1. On the first pass through

TABLE 3

COMPONENT-DRIVER SUBROUTINES

Component Type	Prepass	Outer	Postpass
ACCUM	ACCUM1	ACCUM2	ACCUM3
BREAK	BREAK1	BREAK2	BREAK3
FILL	FILL1	FILL2	FILL3
PIPE	PIPE1	PIPE2	PIPE3
PLENUM	PLEN1	PLEN2	PLEN3
PRIZER	PRIZR1	PRIZR2	PRIZR3
PUMP	PUMP1	PUMP2	PUMP3
ROD or SLAB	HTSTR1		HTSTR3
STGEN	STGEN1	STGEN2	STGEN3
TEE	TEE1	TEE2	TEE3
TURB	TURB1	TURB2	TURB3
VALVE	VLVE1	VLVE2	VLVE3
VESSEL	VSSL1	VSSL2	VSSL3

the PREP stage, during which the stabilizer motion equations are set up, the one-dimensional component subroutines utilize the common low-level routines SAVBD, PREPER, and SETBD to avoid redundant coding. On the second pass, during which the stabilizer motion equations are solved, the common low-level routine BKMOM is used. The flag index IBKS (1 or 2) indicates the pass being performed.

Subroutine SAVBD retrieves BD-array boundary data from adjacent components, stores it in the appropriate array locations, and moves data for the last completed time step into the old-time arrays. Subroutine PREPER evaluates wall friction by calling FWALL, evaluates material properties by calling MPROP, evaluates HTCs by calling HTPIPE, and evaluates interfacial-shear coefficients and begins the solution of the stabilizer equations of motion by calling FEMOM. For a specific component, any or all of these steps may occur under the control of the PREPER argument list. Subroutine SETBD uses the information in the component data arrays to reset the BD-array boundary data at both ends of the component. Subroutine BKMOM solves the stabilizer equations of motion for the stabilizer velocities for one-dimensional components.

Subroutine HTSTR1 calls subroutine FLTOM to transfer hydrodynamic data into the necessary heat-structure arrays; subroutine CORE1 to evaluate HTCs, fine-mesh properties, and quench-front positions; and subroutine FLTOM again to transfer the resulting heat-transfer information back into the hydrodynamic database. From subroutine CORE1, subroutine RFDBK is called to evaluate reactivity feedback, and subroutine RKIN is called to evaluate the point-reactor kinetics model.

Each VESSEL component is processed by subroutine VSSL1. A time update is performed by calling subroutine TIMUPD. Donor-cell weighting factors are initialized, vent valve calculations are performed, and momentum source terms are defined. Next, subroutine CIF3 is called to evaluate the interfacial shear coefficients, and subroutine PREFWD is called to evaluate wall-shear coefficients. Subroutines FEMOMX, FEMOMY, and FEMOMZ are called to compute the vessel predictor and stabilizer velocities. Finally, subroutine J3D is used to update the BD-array boundary information.

3.4.2. Outer-Iteration Calculation

The hydrodynamic state of the modeled system is analyzed in TRAC by a sequence of Newton iterations that use full inversion of the linearized equations for all one-dimensional component loops and the VESSELs during each iteration. Throughout the sequence of iterations that constitute a time step (each called an outer iteration within TRAC), the properties evaluated during the prepass and the previous postpass remain fixed. These include wall (SLAB and ROD) temperatures, HTCs, wall and interfacial shear coefficients, stabilizer velocities, and quench-front positions. The remaining fluid properties can vary to obtain the hydrodynamic-model solution.

Each call to overlay OUTER completes a single outer (Newton) iteration. Subroutine HOUT, which is the entry-point routine of this overlay, controls the overall structure of an outer iteration, as presented in Fig. 4.

Both the forward-elimination and backward-substitution sweeps through the one-dimensional component loops are performed by subroutine OUT1D and the associated outer-iteration routines. The calculations that these routines perform are controlled by the common variable IBKS, which is set by subroutine OUTER. Subroutine OUT3D solves the hydrodynamic equations for all VESSEL components (IBKS = 0) or updates boundary data (IBKS = 1).

All one-dimensional components in a particular loop are handled by a single call to subroutine OUT1D. This routine loads the data blocks for a component into memory, then calls the appropriate component outer-iteration subroutine. Component outer-iteration subroutines have names that end with the numeral 2 (see Table 3). For example, the PIPE component outer-iteration subroutine is called PIPE2. Subroutine OUT3D works in a similar manner, except that all three-dimensional VESSEL components call subroutine VSSL2.

The outer-iteration subroutines for one-dimensional components utilize subroutine INNER to perform common functions. Subroutine INNER retrieves boundary information from the BD boundary array, tests other boundary information for consistency, calls subroutine TF1D to perform the appropriate hydrodynamic calculation, and resets the BD boundary array by calling subroutine J1D. Subroutine TF1D calls subroutines TF1DS1, TF1DS, and TF1DS3 to solve the basic semi-implicit finite-difference equations.

Subroutine VSSL2 solves the basic semi-implicit finite-difference equations defined by the VESSEL-matrix equation (depending on the value of IBKS) for a single VESSEL component while subroutine OUT3D does the same for a multi-VESSEL component problem. Subroutines TF3DS1 and TF3DS are called to linearize the hydrodynamic equations. Subroutine STDIR sets up the VESSEL-matrix equation for direct inversion. Subroutine MATSOL is called to solve the linear system and subroutine BACIT stores the new-time pressures that are calculated.

3.4.3. Postpass Calculations

After the modeled-system hydrodynamic state has been evaluated by a sequence of outer iterations, TRAC performs a postpass to solve the stabilizer mass and energy equations and to determine both mixture properties and wall temperatures. Overlay POST performs this postpass. The same overlay also implements the time-step back-up procedure, which is explained in detail in the next section.

As the controlling subroutine for this overlay, subroutine POST first processes all one-dimensional components by calling the appropriate one-dimensional component postpass subroutine (see Table 3). Subroutine POST3D is called to handle all three-dimensional VESSEL components, and subroutine HTSTR3 is called to handle all heat-structure components.

The one-dimensional component postpass routines have names that end with the numeral 3. For example, the PIPE component postpass subroutine is called PIPE3. The one-dimensional component postpass subroutines use the low-level routines SAVBD, POSTER, and SETBD to retrieve BD-array boundary conditions; to evaluate the stabilizer equations, wall temperatures, mixture properties, and transport properties; and to reset the BD boundary array, respectively.

The VESSEL postpass routine, VSSL3, is called by POST3D. Within subroutine VSSL3, stabilizer quantities are evaluated by subroutine BKSTB3 or defined by subroutine MIX3D, depending on the status of the VESSEL SETS3D-method flag NSTAB. Subroutines FF3D, FPROP, and J3D are used to complete the hydrodynamic calculation, evaluate transport properties, and update BD-array boundary data, respectively.

Subroutine HTSTR3 controls the postpass for the heat-structure components by calling subroutine CORE3. From within subroutine CORE3, subroutine FROD is called to evaluate temperature profiles and gap heat-transfer coefficients using subroutines RODHT and GAPHT, respectively.

3.5. Time-Step Advancement or Back-up

Upon the successful completion of one time-step calculation (performed by the prepass, outer-iteration, and postpass stages), the modeled-system state is updated to reflect the new-time conditions. This is accomplished at the start of the next PREP stage, and is handled on a component by component basis within the "1" subroutines, i.e., PIPE1. During this step, all dual-time variables are updated by copying the values of the new-time variables into the old-time variables. The prepass, outer-iteration, and postpass steps that follow then attempt to assign new values to the new-time variables, allowing the process to be repeated as time is advanced.

Calculation of a new time-step size takes place just prior to the PREP stage and is controlled by subroutine TIMSTP. Two types of algorithms, inhibitive and promotional, are implemented in subroutine NEWDLT to evaluate the next time-step size. The inhibitive algorithms limit the new time-step size to ensure stability and to reduce finite-difference error. The promotional algorithm increases the time-step size to improve computational efficiency. A new maximum time-step size is calculated based on each of the following conditions: the one- and three-dimensional Courant limits; the VESSEL and total mass error limits; the iteration count; the maximum allowable fractional change in void fraction, temperature, and pressure; the diffusion number for heat transfer; and the maximum allowable fractional change in reactor power and valve area. The actual new time-step size selected is the minimum imposed by the above conditions and the maximum time-step size specified by the user in the time-step data. Each of the conditional maximum time-step sizes are calculated in subroutine NEWDLT with the exception of those based on reactor power level and on valve adjustment. The reactor power maximum time-step size is evaluated by subroutine RKIN, and the valve adjustment maximum time-step size is evaluated by subroutine VLVEX with subroutine HOUT defining those maximum time-step sizes.

In the event that a time-step is not successfully completed, TRAC will back up and try to reevaluate the new-time modeled-system state. Back-ups may occur when either the outer iteration does not converge (necessitating a reduction in the current time-step size) or when a flag indicating an extraordinary condition is activated, thereby requiring the outer iteration to be reevaluated. It is important to understand that there are *two* types of back-up, one corresponding to each of these scenarios. When the outer iteration fails to converge during the OUTER overlay, the current time-step size is reduced and the calculation backs up to the start of the PREP stage. This is necessary because any variable calculated during the prepass and dependent on the time-step size was computed for the original time-step size and not the newly-reduced time-step size. In addition, all new-time variables are reset to reflect their beginning-of-time-step values. This enables TRAC to begin again from the PREP stage in a manner no different than for any other time-step calculation except for having reduced the time-step size during the back-up. If repeated back-ups are performed for the same time steps, the time-step size is halved for each of the first three back-ups, quartered for the fourth and fifth back-up, and tenth thereafter.

The second type of back-up is inititated by a flag being set signalling an extraordinary condition such as a water pack. This indicates that the outer iteration needs to be repeated to account for the extraordinary condition. TRAC resets any new-time variables, that have been potentially evaluated incorrectly by the current attempt through subroutine OUTER, with their old-time values and repeats the outer iteration anew. For this type of back-up, the time-step size does not change, making it unnecessary to repeat the PREP-stage calculation.

The difference between the two types of back-ups is that for a back-up to the start of the PREP stage, the time-step size is adjusted, all new-time variables are reset to their beginning-of-time-step values, and variables evaluated during the PREP stage are reevaluated using the newly adjusted time-step size. For a back-up to the start of the outer iteration, no change occurs in the time-step size and only new-time variables calculated during the outer iteration are reset to reflect their beginning-of-time-step values.

3.6. Output Processing

The TRAC program normally produces five output files: TRCOUT, TRCMSG, TRCGRF, TRCDMP, and TRCINP. TRAC may also produce a labeled input-data file INLAB when NAMELIST option INLAB = 3 is defined. The first of these files is in printer format and contains a user-oriented analysis of the calculation. During the input process, an input data description is placed in this file. At selected times during the calculation, overlay EDIT is invoked to add to this file a description of the current modeled-system state. The TRCMSG file is in printer format and contains diagnostic messages concerning the progress of the calculation. The TRCGRF file is a binary file designed to allow analysis by graphics postprocessing programs like EXCON and TRAP, while the TRCDMP file is a binary file designed for problem restarts by TRAC. The TRCGRF file is created and the header, catalog, and geometric data are written into it during the initialization phase as described in Sec. 3.3. File TRCDMP is created immediately thereafter by overlay DUMP. File TRCINP is created only when the TRACIN input-data file is in free format as discussed in Sec. 3.2.

As the main controlling routine of overlay EDIT, subroutine EDIT calls subroutine WCOMP to direct the addition of a time-step short and long edit to the TRCOUT file. The first edit written to the file TRCOUT occurs during the first time step after the PREP stage, but all subsequent edits are written after the POST stage. Subroutine WCOMP writes general overall data first, then invokes lower level routines to describe the state of each component. The component edit routines, which typically have names that begin with the letter W, add the parameter data that are important for that component to the TRCOUT file in an appropriate format. For example, the PIPE component edit routine is called WPIPE, while the VESSEL component edit routine is called WVSSL. The one-dimensional component edit routines generally utilize a call to subroutine ECOMP to write parameter data common to most one-dimensional components and then write any additional data special to that particular component.

After initialization by subroutine IGRAF, the time-edit data are added to the TRCGRF file by overlay GRAF. This overlay contains the single subroutine GRAF. The TRCGRF file is a structured binary file written with unformatted write statements and containing information for graphics processing. Data contained on the TRCGRF file are divided into four sections: general, catalog, geometric, and time-edit. These data appear on the file in the above order. The general data section of the file contains title cards for problem identification and size information needed to describe the problem and the remainder of the file. The catalog data section contains information that is used to describe the data stored in the time-edit data section. The geometric data section contains information relating to the cell structure of components. The time-edit data section is made up of time-edit blocks of data. Individual arrays within each block are packed to save space. A block is written by each graphics edit performed during the course of a problem. The number of time-edit blocks written on the file is determined by the graphics edit frequency specified by the time-step data. The last time-edit block is followed by a word "EOF" to signify the "end-of-file." Figures 5 through 8 show the structure of the overall graphics file, as well as the general data section, a catalog entry, and the time-edit data section.

The TRCDMP file is a structured binary file written with unformatted write statements. It contains sufficient data to restart the calculation at the time of a dump edit. This file is created by a sequence of calls to overlay DUMP. As the main controlling routine of overlay DUMP, subroutine DMPIT writes the dump header data and then calls the component dump subroutines. These component dump subroutines have names which typically begin with the letter D. For example the PIPE component dump routine is called DPIPE, while the VESSEL component dump routine is called DVSSL. The one-dimensional component dump routines generally utilize a call to subroutine DCOMP to dump data common to most one-dimensional components to the TRCDMP file and then dump any additional data special to that particular component using individual calls to subroutine BFOUT. The VESSEL component dump routine DVSSL also utilizes calls to subroutine BFOUT to dump general VESSEL arrays, but uses subroutine DLEVEL to dump level arrays.

Figures 9 through 11 illustrate various aspects of the dump-file structure. Figure 9 shows the overall dump-file structure with a general data section at the beginning followed by a series of time-edit blocks. A time-edit block is written at each dump time during a problem. The number of time-edit blocks written on the file is determined by the dump-edit frequency specified on the time-step data. The last block is followed by a "EOF" to signify the end-of-file.

The structure of each time-edit block in the dump file is illustrated in Fig. 10. Data from each component is included in the component dump section shown at the bottom of the figure. Figure 11 shows a more detailed structure of the component dump section. The variable LCOMP is calculated in subroutine DCOMP for each one-dimensional component and is the total number of all variable values written to the dump file for each component. This is the sum of the number of the variable values dumped by subroutine DCOMP and its calling routine. The number of any additional variable values special to a particular component and dumped by the component dump routine is reflected by the variable LEXTRA. It is important to remember to increment either the variable LCOMP or LEXTRA accordingly when adding new variables to the dump file.

4. MEMORY MANAGEMENT

In order to understand the data storage in TRAC, it is necessary to consider the memory-management requirements for a large code. First, any code that uses a large amount of memory must allocate that memory flexibly and dynamically during execution. Static dimensioning, i.e., dimensioning at compile time to accommodate the largest possible problem, is at best wasteful of memory and at worst infeasible. The alternative strategy of pre-processing the input to determine array sizes prior to compilation would be extremely cumbersome for a code as complex as TRAC. Static-memory allocation schemes of all types also have the disadvantage that there is no possibility of increasing or decreasing memory requirements during a calculation when the evaluation path changes or when temporary arrays are no longer required.

Second, since standard FORTRAN does not support dynamic-memory allocation, it is necessary to accomplish dynamic-memory allocation by using variable offsets into a single container array. Obviously, any implementation based on this concept will have some degree of awkwardness. On some operating systems, the size of the container array can be changed dynamically. On others, it must be fixed in advance. Although the latter implementation is not, technically speaking, dynamic, it is flexible, and fixing the size of the container array makes a trivial difference in the coding. The bulk of the memory-management implementation in TRAC arises in the computation and management of the offset or pointer variables.

As an example of using a container array for dynamic-memory management, consider the container array, A(*), where the actual dimensioned size of the A array is sufficient for the problem at hand. Now assume that we wish to store two arrays, X(20) and Y(20), somewhere in this container array. There are a number of ways of doing this. One option is to define offset pointers as in this example:

```
IFREE  = 14
NCELLS = 20
LX     = IFREE
LY     = LX + NCELLS
IFREE  = LY + NCELLS
```

These pointer variables are defined in a manner that establishes mesh-wise storage. In this example, the arrays X and Y occupy locations A(14) through A(33) and A(34) through A(53).

respectively. With the use of these pointer variables, X(N) can be referenced as A(LX+N−1) and Y(N) as A(LY+N−1). The referencing can be made more readable by passing A(LX) and A(LY) as actual arguments to a subroutine that uses X and Y as the names for the corresponding local arrays.

Two of the drawbacks of the pointer methodology are the large amount of coding needed to define the pointer variables and the need to use subroutine arguments for readibility. A third drawback arises when using pointer variables in the context of multi-dimensioned array variables: the dimensions must be treated as variable. This complicates the coding and makes dynamic debugging more difficult. Another option for storing into a container array is to use EQUIVALENCE statements. This has the advantage that the variables can appear in COMMON. Using our previous example, we could achieve the same data storage and data structure by writing:

```
PARAMETER (LX = 14, LY = 34)
EQUIVALENCE (A(LX), X(1)), (A(LY), Y(1))
```

However, equivalencing which creates mesh-wise storage, as in this example, cannot be used for dynamic-memory allocation because knowledge of the array sizes as well as their actual memory locations is built into the EQUIVALENCE statement. The answer to using equivalencing for dynamic-memory allocation is to equivalence the arrays according to the cell-wise storage scheme, i.e.,

```
EQUIVALENCE (A(1), X(1)), (A(2), Y(1))
```

The reason that establishment of a cell-wise storage scheme using EQUIVALENCE statements is useful for dynamic memory allocation is that the EQUIVALENCE statements can be treated as determining the relative order of the variables, rather than their actual locations in memory. The location in memory, or offset into the container array, is then defined dynamically in terms of loop limits. Using loop limits NB = 14 and NE = 52 with a stride of NV = 2 in referencing arrays X and Y in the last example would establish a mesh-wise storage occupying the same memory locations in the A array as in the two previous examples but with X and Y elements interspersed.

One of the drawbacks to a cell-wise scheme is the necessity for including the stride in the coding. Another drawback that can arise on certain hardware is inefficiency in referencing vectors with non-unit stride. Finally, this methodology can be cumbersome when combined with the use of temporary arrays which have mesh-wise storage. Nonetheless, our experience with this methodology has been positive in terms of eliminating coding errors resulting from maintenance of pointers and long subroutine argument lists.

5. TRAC FOR VARIOUS MACHINE CONFIGURATIONS

TRAC-PF1/MOD2 for various computer systems is supported by use of UPDATE/HISTORIAN conditional directives (*DEFINEs) in the code's program library. The desired configuration is selected with *DEFINEs when the compiler-ready source deck is created. Appendix G provides a summary of all the possible UPDATE/HISTORIAN *DEFINEs used by TRAC. Our recommendations for specific systems are given below.

5.1. CRAY/CTSS

TRAC is run at Los Alamos on CRAY 1 and CRAY X-MP computers using the Cray Timesharing System (CTSS). We create compiler-ready FORTRAN source decks using the following UPDATE/HISTORIAN *DEFINEs:

CRAY,
EIGHTB,
LANL,
NOLCM,
VDM,
VECTOR.

This CRAY/CTSS implementation uses two system-subroutine calls (to subroutines GETUFL and MEMADJ) for run-time memory expansion, as the input data is read. CRAY sites that do not run CTSS can create a static-memory version (one that has a large but fixed size for the A/ALCM container array) by using the following UPDATE/HISTORIAN *DEFINEs:

CRAY,
EIGHTB,
ASIZE,
NOLCM,
VDM,
VECTOR.

5.2. IBM and IBM-Compatible

TRAC will not run in single precision on computers with a 32-bit word length. There is at present no double-precision implementation in the MOD2 program library. External users with 32-bit word lengths will have to use the following:

ASIZE,
EIGHTB,
HEX,
IBM,
NOLCM,
VDM,
VECTOR.

5.3. CRAY/UNICOS

The recommended UPDATE/HISTORIAN *DEFINEs to use when implementing TRAC on a CRAY machine under the UNICOS operating system are the following:

ASIZE,
CRAY,
EIGHTB,
NOLCM,
UNICOS,
VDM.

5.4. CDC Cyber 205

The recommended UPDATE/HISTORIAN *DEFINEs to use when implementing TRAC on a CDC Cyber 205 computer are the following:

ASIZE,
CYB205,
EIGHTB,
HEX,
NOLCM,
VDM,
VECTOR.

5.5. CDC 7600

An initial effort was made to support the Control Data Corporation's CDC 7600 data structure in MOD2. Most of this work involved data transfers between the 7600's SCM and LCM. It soon became apparent, however, that the 7600's small memory severely restricts effective MOD2 usage. Also, the three-dimensional VESSEL data structure is very limited on a CDC 7600. Therefore, Los Alamos has stopped support for this particular machine configuration.

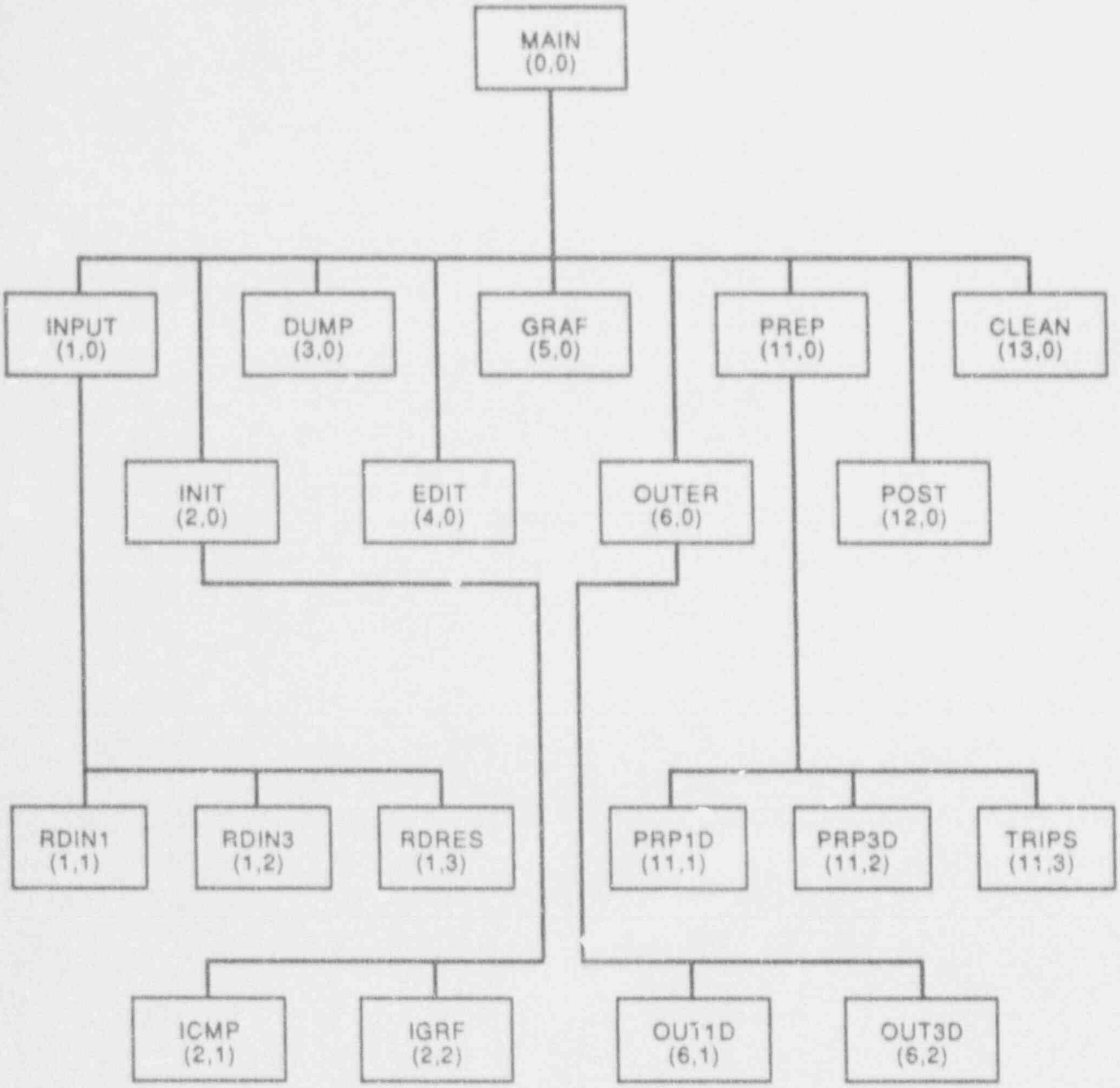


Fig. 1.
TRAC overlay structure.

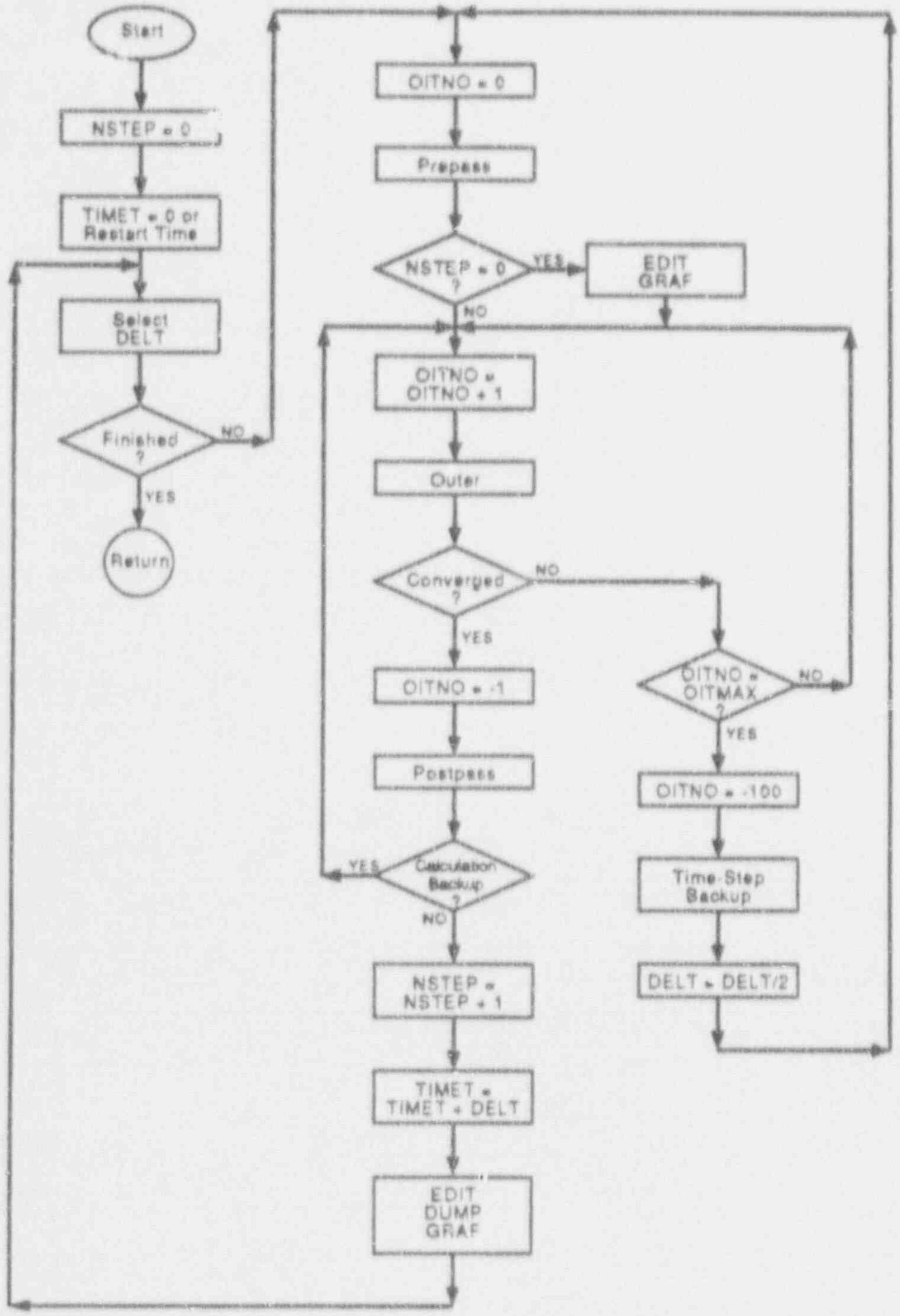


Fig. 2.
Transient calculation flow diagram.

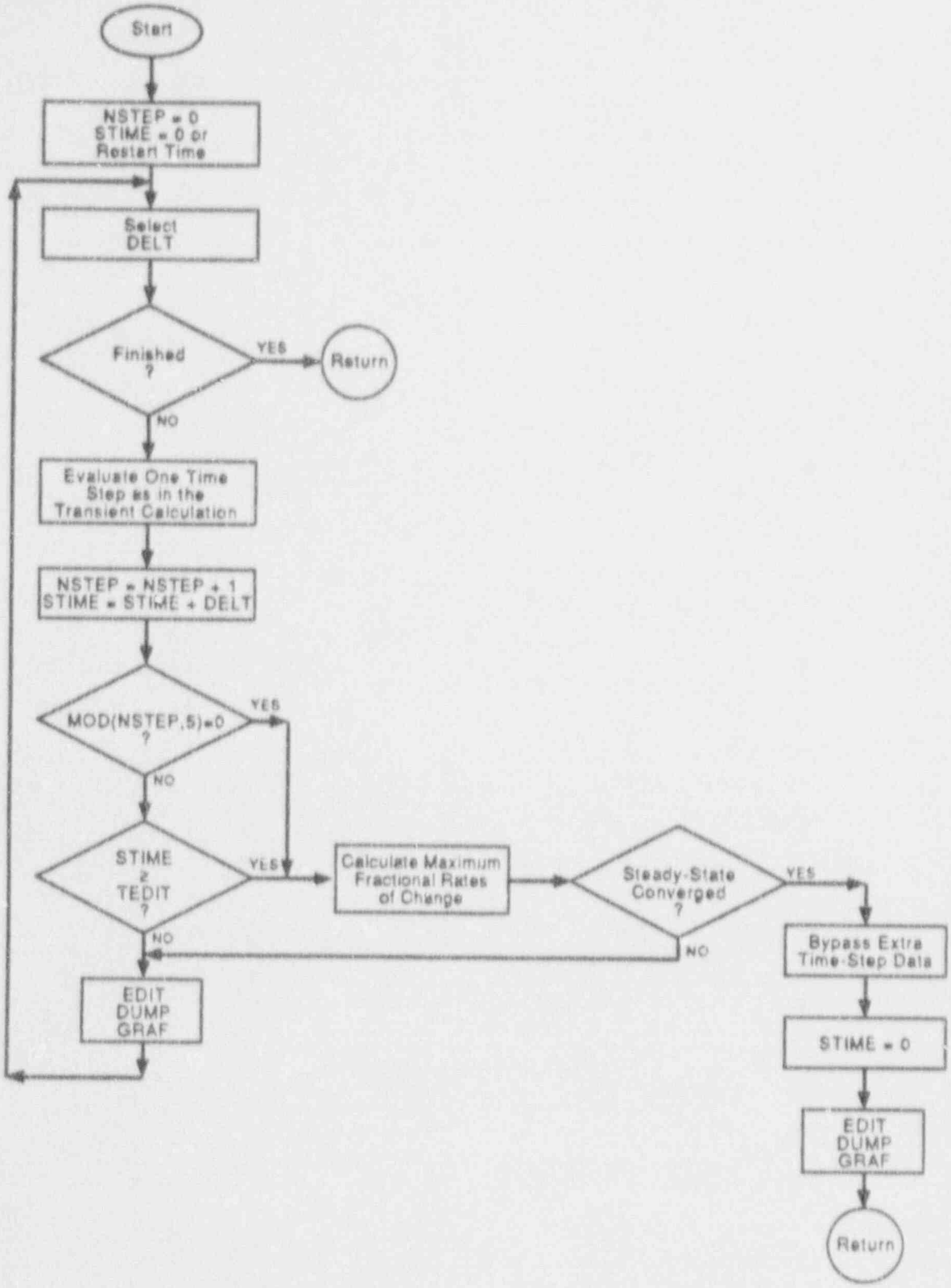


Fig. 3.
Steady-state calculation flow diagram.

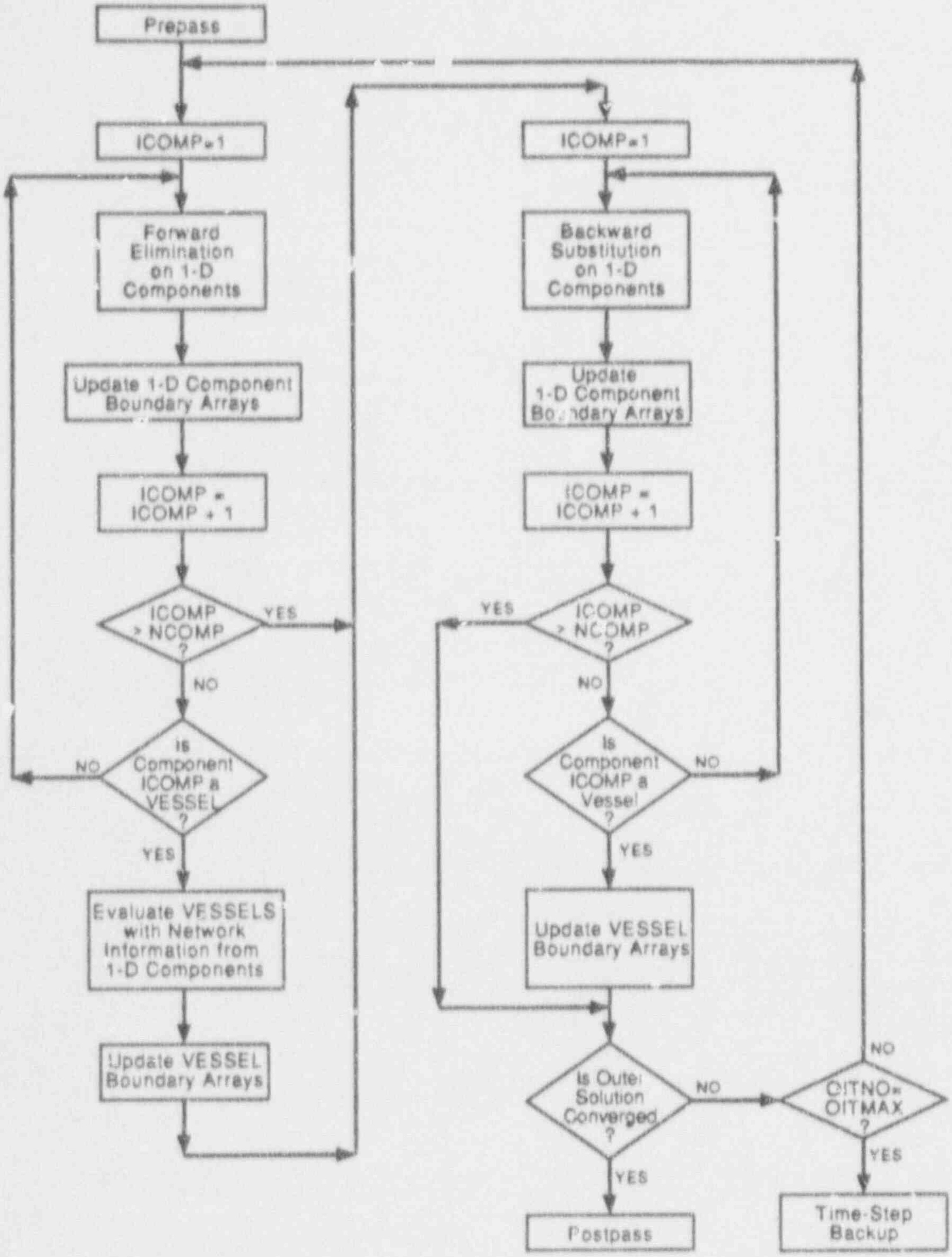


Fig. 4.
Outer calculation flow diagram.

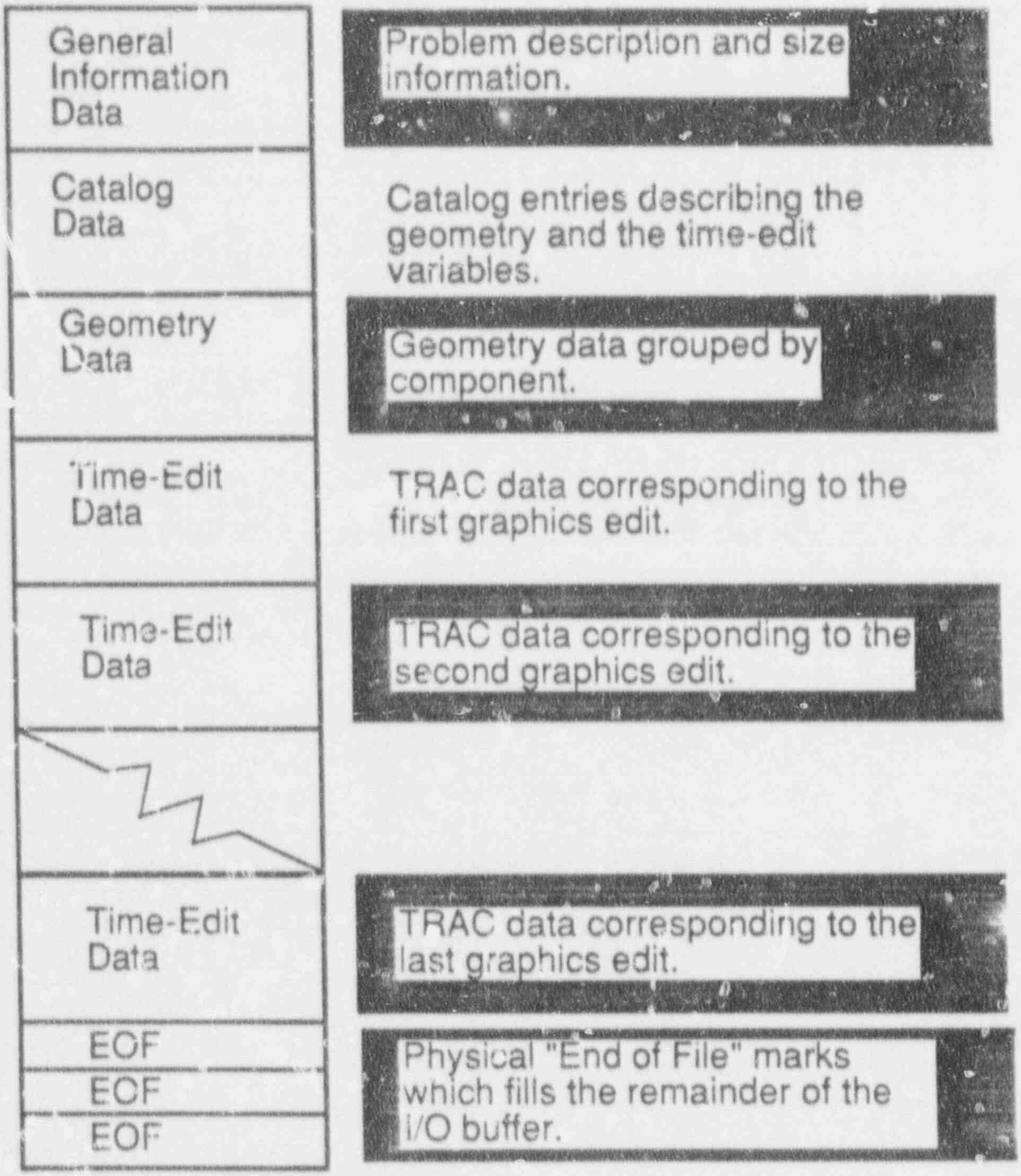
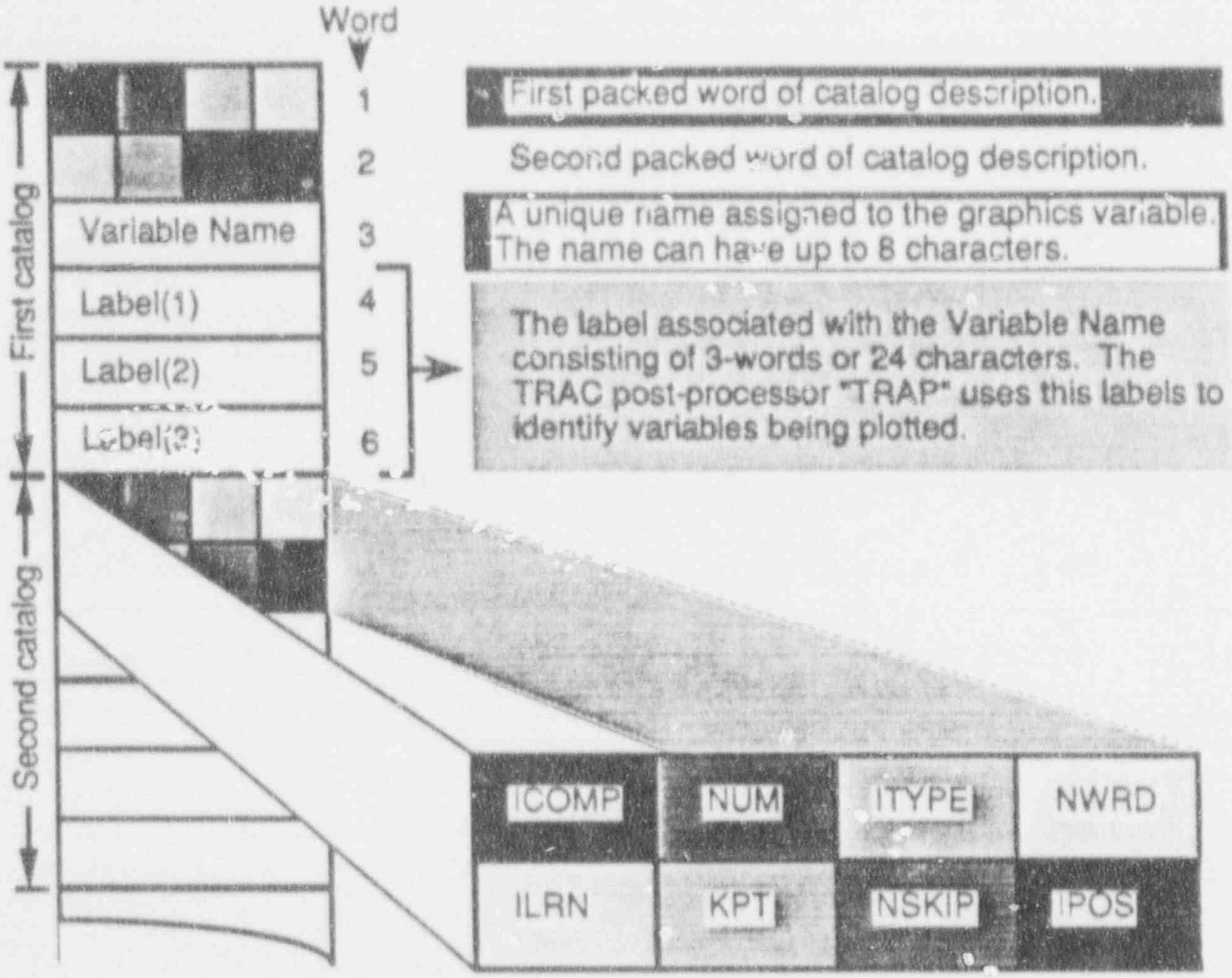


Fig. 5.
Structure of the TRCGRF graphics file.

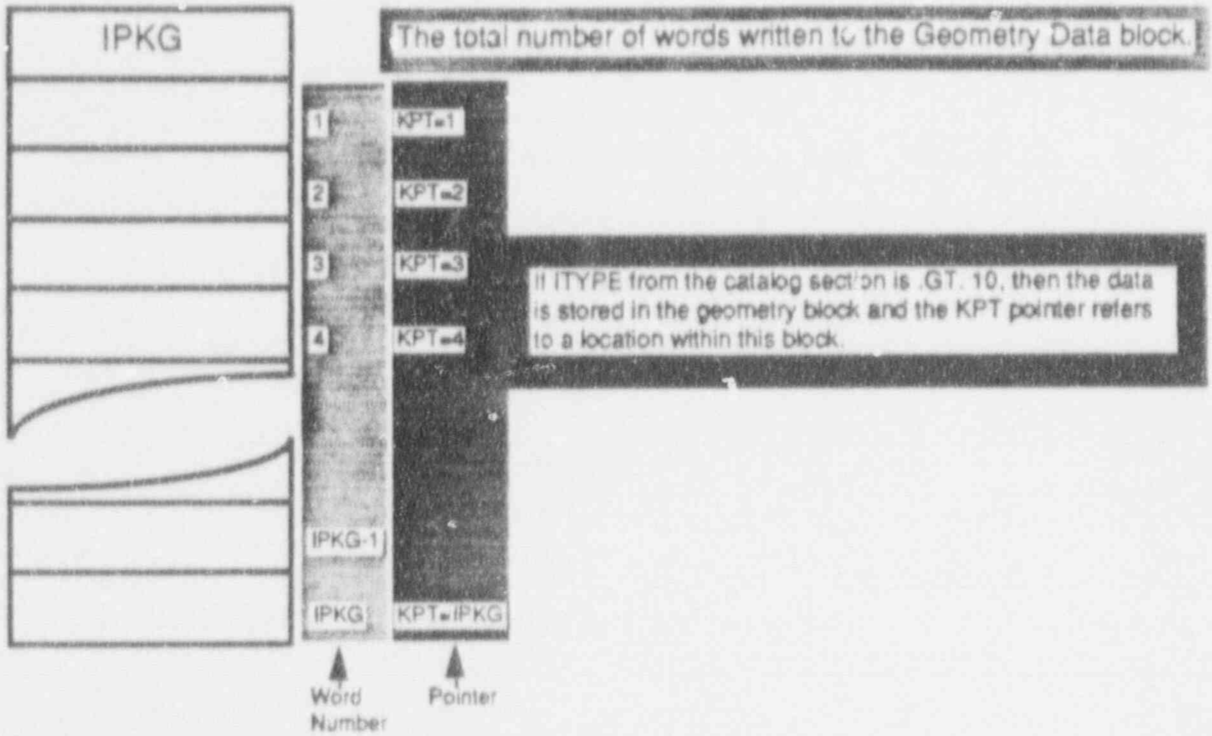
NWTX	Length of each Time-Edit Data Section.
NUMTCR	Number of title cards. Each card can have a maximum of 80 charactors (20A4) with 20 storage elements.
TITLE (1) . . TITLE (NUMCTR)	Problem identification title , 20*NUMTCR storage elements.
NCOMP	Total number of components. Current version uses 0 (zero) to remain compatable with older code versions.
COMP(1) . . . COMP(NCOMP)	Component types with NCOMP entries. (PIPE, PUMP, VESSEL, ROD, SLAB, etc.)
NCTX	The total number of catalog entries. Every time a call to GRFPUT is made in TRAC, a catalog entry is created for that GRFPUT variable call.

Fig. 6.
Structure of the "General Information Data"
for the TRCGRF graphics file.



ICOMP = TRAC assigned component number.
NUM = User assigned component number.
ITYPE = Variable data type. For definitions of data types, see TRAC subroutine GRFPUT.
NWRD = The number of values written to the graphics file for the variable.
ILRN = The axial level or the rod number of the variable.
KPT = The relative pointer to the starting location in the TIME-EDIT or GEOMETRY Block for the variable.
NSKIP = Flag for the data skip frequency that is used by TRAP.
IPOS = The value of the location of the variable relative to the start of the array containing the variable

Fig. 7
Structure of the "Catalog Data" for the TRCGRF graphics file.



DATA WRITTEN TO THE GEOMETRY BLOCK:

If (ITYPE.GT.10) -The data is written to the Geometry Block.
If (ITYPE.GT.10.AND.ITYPE.LT.20) - The data is type real and it is packed.
If (ITYPE.GT. 20) - The data is not packed and it can be type real, integer, or character.
If (ITYPE.EQ.31.AND.Variable Name.EQ.'type') - The data is type character
If (ITYPE.EQ.33.AND.Variable Name.EQ.'stype') - The data is type character and is dimensioned NWRD.
If (ITYPE.EQ.33.AND.Variable Name.NE.'stype') - The data is type integer.
If (ITYPE.GT.20.AND.ITYPE.LT.26) - The data is type integer and the data is dimensioned NWRD.

For all other cases the data is type real and the data is dimensioned NWRD. The data is also packed and written to the graphics file as (NWRD+7)/4 packed words.

NOTE: The variables ITYPE, NWRD and KPT are written to the catalog section of the graphics file. Please refer to subroutine PACKIT for packing information.

Fig. 8.
Structure of the "Geometry Data" for the TRCGRF graphics file.

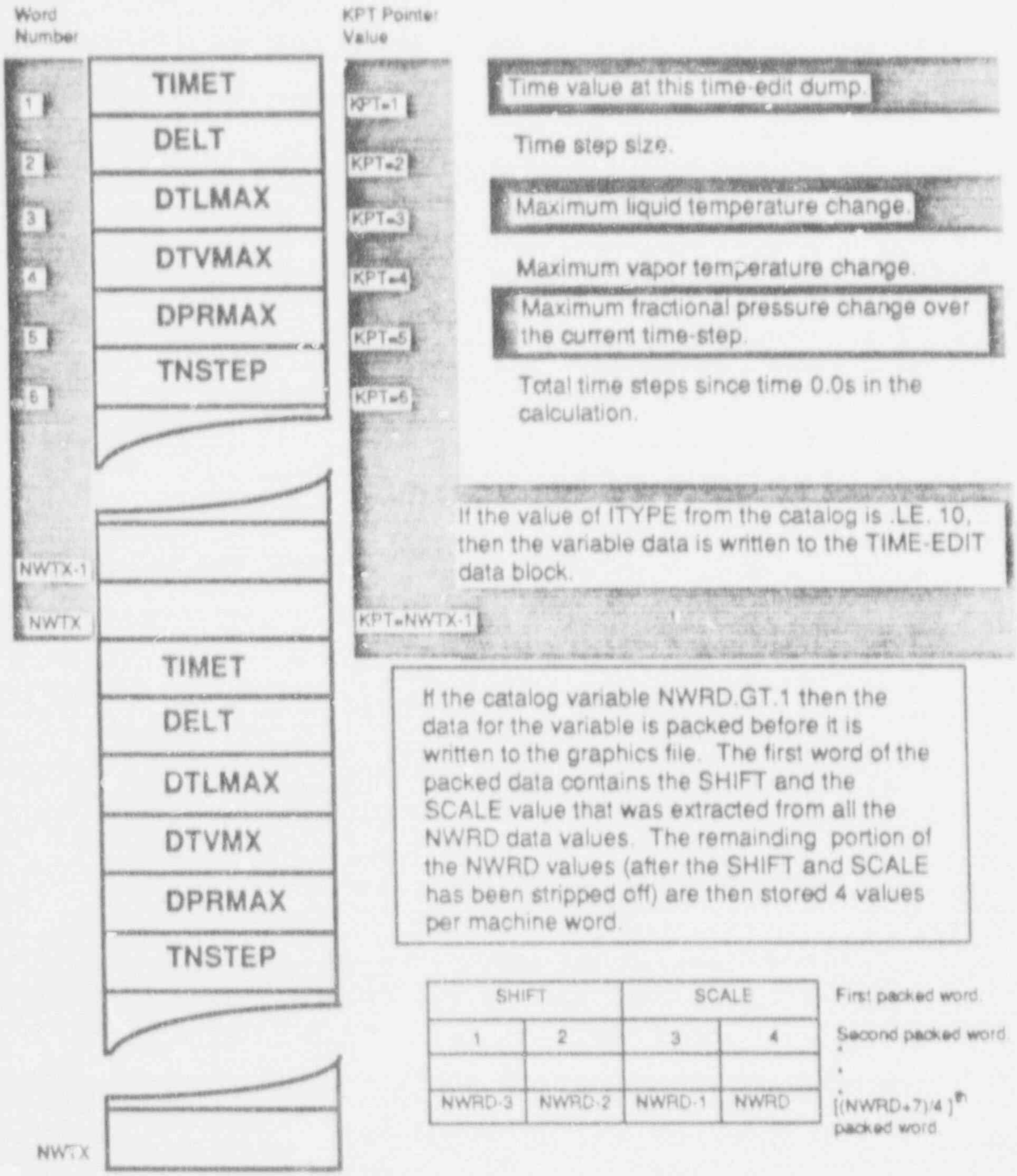


Fig. 9.
Structure of the "Time-Edit Data" for the TRCGRF graphics file.

DATE	Date of file creation.
TIME	Time of file creation.
NCOMP	Number of hydro and heat-structure components.
LENTBL	Length of "Fixed Length Table."
LENTTL	Number of TITLE elements in the "Problem Identification" Title.
TITLE (LENTTL)	"Problem Identification" Title.
-*BFIO*-	Pattern indicating logical "end of file."
First Time-Edit Data:	Data written to the dump file for the first-time edit requested.
-*BFIO*-	
Second Time-Edit Data:	Data written to the dump file for the second-time edit requested.
-*BFIO*-	
N^{th} Time-Edit Data:	Data written to the dump file for the N^{th}-time edit requested.
EOF	Physical "end of file" mark. Repeated till I/O buffer is filled.

Fig. 10.
Structure of the TRCDMP dump file.

ETIME	Current problem time.
NSTEP	Time-step number of the present calculation.
DELT	Time-step size.
DELPMX	Maximum time-step size for a 10% change in neutronic power.
DELXMX	Maximum time-step size for the maximum value adjustment.
OITNO	Outer-iteration number.
NSTEPS	Time-step number accummulated over all previous calculations.
CPUTOT	Total CPU (Central processing units) time.
VMAXT	Reciprocal time-step size for the Courant limit in 1D components at t (n+1).
VMAXO	Reciprocal time-step size for the Courant limit in 1D components at t (n).
VMNEW	VESSEL water mass (liquid and vapor) at t (n+1).
VMOLD	VESSEL water mass (liquid and vapor) at t (n).
VMCON	Net water mass convected into the VESSEL during time interval t (n+1) - t (n).
DAMX	Error caused by relative change in void fraction.
DAL	Maximum increase in void fraction.
DAU	Maximum decrease in void fraction.
OAL	Maximum increase in void fraction after a decrease.
OAU	Maximum decrease in void fraction after an increase.
VARERM	Maximum pressure-matrix solution error.
ISOLUT	Flag for the optional solute field.
IELV	Flag for GRAV or ELEV input.
IKFAC	Flag for FRIC or K-factor input.
NOAIR	Flag for evaluating noncondensable (air) partial pressure.
IGAS	Flag for the type of noncondensable gas.
NFRC1	Flag for inputing forward and reverse loss coefficients for 1D components.
NFRC3	Flag for inputing forward and reverse loss coefficients for VESSEL components.
NDIA1	Flag for inputing heat-transfer diameters for 1D components.
ITHD	Flag for inputing heat-transfer diameters for heat-structure components.
DTEND	Temporary variable for the time-step data-set ending time TEND.
HDUMP	Temporary variable for the time-step data-set next dump time TDUMP.
HEDIT	Temporary variable for the time-step data-set next long-edit time TEDIT.
HGRAF	Temporary variable for the time-step data-set next graphics-edit time TGRAF.
HSEDIT	Temporary variable for the time-step data-set next short-edit time TSEDIT.
NDID	Flag for when trip-controlled time-step data overrides regular time-step data.
NSTAB	Flag for the SETS3D calculation.
NEWRFD	Flag that activates the reflood model for heat-structure components coupled to VESSELs.
VMAXT3	Reciprocal time-step size for the Courant limit in VESSEL components at t(n+1).
VMAXT3O	Reciprocal time-step size for the Courant limit in VESSEL components at t(n).
Continued on the next page.	

Fig. 11.
Structure of the "Time-Edit Data" for the TRCDMP dump file.

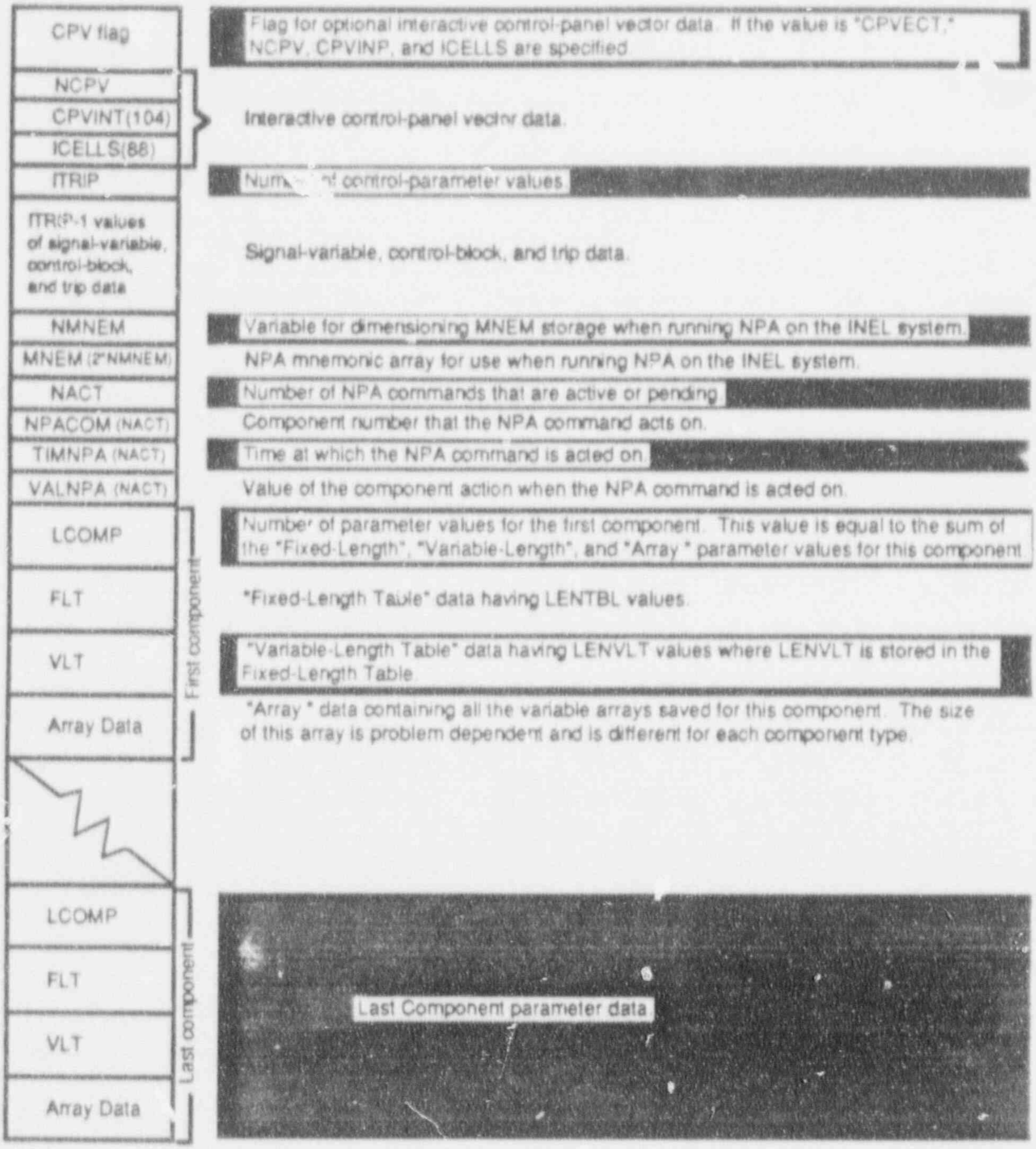


Fig. 11. (cont.)
Structure of the "Time-Edit Data" for the TRCDMP dump file.

APPENDIX A
TRAC SUBPROGRAMS

Name	Function
ACCM1X	Evaluates ACCUM (accumulator) water level.
ACCMBD	Sets boundary array for the ACCUM (accumulator) component.
ACCUM1	Controls ACCUM (accumulator) prepass.
ACCUM2	Controls ACCUM (accumulator) outer iteration.
ACCUM3	Controls ACCUM (accumulator) postpass.
ALLBLK	Tests for all blanks in specified substring of string.
ASIGN	Assigns the component pointers according to the internal order (IORDER) array.
ASTPLN	Calculates mass and energy fluxes at the PLENUM junctions during postpass.
ATERM	Sends message to the nuclear plant analyzer (NPA) if TRAC terminates prematurely.
AUXPLN	Calculates mass and energy fluxes at the PLENUM junctions during the outer iteration.
BACIT	Initiates backward substitution after direct vessel matrix inversion.
BAKUP	Overwrites end-of-time-step variables with start-of-time-step values for one vessel level.
BALANC	Support subroutine for SGEEV.
BALBAK	Support subroutine for SGEEV.
BANSOL	Solves linear matrix equation.
BDPLEN	Fills the PLENUM boundary array.
BEENAL	Assigns axis labels to grapics variables for plotting.
BFALOC	Allocates files and buffers for buffe ed I/O.
BFCLOS	Empties buffers and closes file.
BFIN	Initiates binary input subroutine.
BFOUT	Initiates binary output subroutine.
BGLSDC	Factors the banded matrix A into A = LU.
BGLSSL	Solves the general banded linear system of equations A * X = B.
BITS	Manages bit address flags.

Name	Function
BKMOM	Initiates backward substitution for stabilizing momentum equations.
BKSMOM	Performs backward substitution for stabilizing momentum equations.
BKSPLN	Initiates backward substitution for stabilizing mass and energy equations for the plenum component.
BKSSTB	Initiates backward substitution for stabilizing mass and energy equations.
BKSTB3	Initiates backward substitution for stabilizing mass and energy equations for the VESSEL component.
BLKDAT	Initializes common variables in a block data statement.
BREAK1	Controls BREAK prepass.
BREAK2	Controls BREAK outer iteration.
BREAK3	Controls BREAK postpass.
BREAKX	Evaluates BREAK pressure, temperature, and void fraction.
BSPDOC	Factors a symmetric positive definite banded system of linear equations.
BSPDSL	Solves a symmetric positive definite banded system of linear equations.
CBEDIT	Edits the first 10 control-block parameter values along with their variable-name labels and a control-block schematic diagram.
CDTHEX	Calculates the diametral thermal expansion of Zircaloy as a function of temperature.
CELLA3	Calculates cell-averaged quantities that are required for the interphasic heat-transfer calculation for the VESSEL component.
CELLAV	Calculates cell-averaged quantities that are required for the interphasic heat-transfer calculation for one-dimensional components.
CHBD	Checks boundary data.
CHBSAV	Transfers selected BD-array data into the A array required for the accumulator phase-separation model.
CHBSET	Stores data in the BD array temporarily to check for consistency in the junction data.
CHEN	Uses Chen correlation to evaluate the forced convection nucleate boiling heat-transfer coefficient.
CHF	Evaluates the CHF based on a local-conditions formulation.
CHF1	Applies Biasi CHF correlation.
CHKBD	Checks for the consistency in the boundary-array data during initialization.

Name	Function
CHKSR	Checks VESSEL component source locations.
CHOKE	Establishes the choked phasic velocities and the derivatives.
CIF3	Calculates interfacial shear for VESSEL component.
CIHTST	Sets up arrays for heat-structure component.
CIVSSL	Transfers vessel data from LCM to SCM so that the remaining data can be initialized.
CLEAN	Closes TRAC output files.
CLEAR	Sets an array to a constant value.
CLRINT	Support subroutine for IBM.
COMPI	Performs various A-array loading tasks common to most one-dimensional components.
CONBLK	Computes all 61 types of control-block outputs that do not require table storage (that is, except for "DLAY" and "FNG1").
CONCF	Returns maximum solubility (kg solute/kg water) for species ISPEC at pressure P and water temperature TL.
CONSTB	Drives subroutine STBMF.
CONVRT	Takes absolute areas and converts them into fractional areas.
COPYA	Copies value of variable SRCVAL into variable SNKVAL.
CORE1	Evaluates rod heat-transfer coefficients and tracks quench fronts.
CORE3	Evaluates rod temperature distributions.
CPLL	Calculates specific heat of liquid water as a function of enthalpy and pressure.
CPVEC3	Evaluates the control-panel vector parameters.
CPVPRT	Prints the control-panel status, which is called from PSETQ.
CPVV1	Calculates specific heat of water vapor as a function of temperature and pressure.
CCVMGT	Logical magnitude function.
CTAIN1	Controls containment prepass.
CTAIN2	Controls containment outer iteration.
CTAIN3	Controls containment postpass.
CWVSSL	Transfers VESSEL data from LCM to SCM so that they can be printed.
CYLHT	Calculates temperature fields in a cylinder.

Name	Function
DATER	Date routine.
DATEU	Date routine.
DBRK	Generates BREAK data dump.
DCHNID	Defines id for each variable in a frame of graphics data.
DCODF	Calculates a numeric code based on data types.
DCOMP	Dumps one-dimensional component data.
DDACUM	Gets the address of variables for the ACCUM component.
DDBRAK	Gets the address of variables for the BREAK component.
DDFILL	Gets the address of variables for the FILL component.
DDGCMP	Gets the address of variables that are common to more than one component.
DDGVAR	Gets the address of variables which are not component-related.
DDHSTR	Gets the address of variables for the HTSTR component.
DDPIPE	Gets the address of variables for the PIPE component.
DDPLEN	Gets the address of variables for the PLENUM component.
DDPRZR	Gets the address of variables for the PRIZR component.
DDPUMP	Gets the address of variables for the PUMP component.
DDSTGN	Gets the address of variables for the STGEN component.
DDTEE	Gets the address of variables for the TEE component.
DDTURB	Gets the address of variables for the TURB component.
DDVLVE	Gets the address of variables for the VALVE component.
DECAYS	Initializes the decay-heat constants to be consistent with the ANS5.1 1979 standard.
DELAY	Provides a time-delay function for the input variable (XIN). The output (XOUT) is played back with the value that the input had TAU seconds previously. Linear interpolation is used for playback when (TIMET minus TAU) falls between two stored time values. The user specifies the number of table storage pairs (NINT) to be saved. Both the time and the value of the input are stored in the table array as pairs of points.
DELTAR	Calculates transient fuel-cladding gap spacing (only if NFCI = 1).
DFILL	Generates FILL data dump.
DGBFA	Factors a double precision band matrix by elimination.

Name	Function
DGBS1	Solves double precision band system A * X = B or TRANS(A) * X = B using factors computed by subroutine DGBFA.
DHTSTR	Determines the size of the data dump and writes the restart input data for a heat-structure component to the dump file.
DLEVEL	Generates VESSEL level data dump.
DMPIT	Main module for generating a dump.
DPIPE	Generates PIPE data dump.
DPLEN	Generates PLENUM data dump.
DPUMP	Generates PUMP data dump.
DROD1	Writes the restart input data arrays for a subset of the heat-structure component data to the TRCDMP file.
DSTGEN	Generates STGEN (steam-generator) data dump.
DTEE	Generates TEE data dump.
DTURB	Generates TURB (turbine) data dump.
DVLVE	Generates VALVE data dump.
DVPSCL	Initializes scale factors on derivative of velocities with respect to pressure for one VESSEL level.
DVSSL	Generates VESSEL data dump.
ECOMP	Writes hydrodynamic and heat-transfer information for one-dimensional components to output file.
EDIT	Entry routine for edit module.
ELGR	Converts cell elevations to the slope between cells and converts K-factors to additive friction-loss coefficients.
ENABIN	Enables and processes (CTRL-E)I interrupts.
ENDDMP	Empties dump buffers and closes dump file.
ENDGRF	Empties graphics buffers and closes graphics file.
EOVLY	Closes overlay bookkeeping.
ERRGET	Sets error trap indicators.
ERROR	Processes different kinds of error conditions.
ERRTRP	Processes trapped errors.
ESTGEN	Evaluates STGEN (steam-generator) parameters on explicit pass.
ETEE	Evaluates TEE parameters on explicit pass.

Name	Function
EVALDF	Evaluates the absolute difference between XOLD and XNEW.
EVFXXX	Evaluates the XXX component-action function.
EVLTAB	Interpolates the function value F from the tabular data based on the value of the table's independent variable: a signal variable (NVAR.GT.0), a control block (NVAR.LT.0), or a trip-signal difference DELSV (NVAR.EQ 0).
EXPAND	Adds rows of conduction nodes within the vessel rods during reflood.
FAXPOS	Evaluates the flow-area fraction, FA, or valve-stem fractional position, XPOS, for the VALVE.
FBRCSS	Identifies break components that are coupled through a fluid-flow path to the secondary side of a steam generator.
FEMOM	Sets up stabilizing momentum equations.
FEMOMX	Performs forward elimination on radial motion equation.
FEMOMY	Performs forward elimination on azimuthal motion equation.
FEMOMZ	Performs forward elimination on axial motion equation.
FEXIST	Mimics CTSS subroutine FEXIST for UNICOS.
FF3D	Makes final pass update for all variables in three-dimensional VESSEL.
FILL1	Controls FILL prepass.
FILL2	Controls FILL outer iteration.
FILL3	Controls FILL postpass.
FILLX	Evaluates postpass FILL velocity.
FLTOM	Controls transfer of data between hydro and heat-structure databases.
FLUX	Calculates mass flow at the boundary of a one-dimensional component for use in mass inventory.
FLUXES	Defines explicit portion of mass and energy flux terms.
FNMESH	Initializes the supplemental user-specified rows of conduction nodes within the vessel rods at the start of reflood.
FPROP	Calculates values for fluid enthalpy, transport properties, and surface tension.
FROD	Calculates temperature profiles in nuclear or electrically heated fuel rods.
FTHEX	Calculates the fuel linear thermal-expansion coefficient for uranium-dioxide and mixed-oxide fuels.
FWALL	Computes a two-phase friction factor.
FWKF	Evaluates form-loss K-factors for an abrupt contraction or expansion.

Name	Function
GAPHT	Calculates fuel-cladding gap heat-transfer coefficient.
GETBIT	Returns value of bit N of word B.
GETCRV	Gets appropriate pump curves from database.
GETJTL	Performs dummy return for UNICOS.
GLEVEL	Transfers data for axial level IZ from inverted form to stacked form and calls subroutine PACKIT.
GRAF	Edits graphics data during transient.
GRFGET	Returns entries in graphics catalog block.
GRFPUT	Places entries in graphics catalog block.
GVSSL1	Calculates integrated vessel parameters for graphics purposes.
GVSSL2	Calculates average values for vessel graphics (integrated values calculated in subroutine GVSSL1).
HEV	Calculates the heat of evaporation of liquid corresponding to a given temperature for low pressures.
HLFILM	Calculates wall to liquid heat-transfer coefficient in transition and film boiling.
HLFLMR	Calculates wall to liquid heat-transfer coefficient in reflood transition and film boiling.
HOUT	Controls the outer-iteration logic for a complete time step.
HQR	Support subroutine for SGEEV.
HQR2	Support subroutine for SGEEV.
HTCOR	Computes heat-transfer coefficients.
HTIF	Calculates the interphasic heat-transfer for the zero-dimensional and one-dimensional components.
HTPIPE	Averages velocities and generates heat-transfer coefficients for one-dimensional components.
HTSTR1	Controls heat-structure prepass.
HTSTR3	Controls heat-structure postpass.
HTSTRV	Initializes to zero some VESSEL-component hydro-cell arrays used to store heat-structure information.
HTVSSL	Averages velocities and generates heat-transfer coefficients for the vessel.
HUNTS	Searches character string for specified search string.

Name	Function
HVFILM	Calculates the vapor heat-transfer coefficient that is the maximum of the Bromley, natural-convection, and the Dougall-Rohsenow coefficients.
HVNB	Calculates vapor heat-transfer coefficient for nucleate boiling.
HVWEBB	Calculates vapor heat-transfer coefficient for dispersed vapor flow.
IACCUM	Initializes the ACCUM (accumulator) data arrays that are not input.
IBRK	Initializes the BREAK data arrays that are not input.
ICHL	Returns character at given position in string (left-justified, blank-filled).
ICMP	Main module to control the initialization of component data.
ICMPR	Logically compares a real variable with an integer variable.
ICOMP	Controls the routines that initialize component data.
IDEL	Searches specified substring of string for any one character in a set of specified characters.
IDIFF	Difference function.
IFILL	Initializes the FILL data arrays that are not input from cards.
IFSET	Initializes three-dimensional interfacial shear at start of each VESSEL prepass.
IGACUM	Supplies ACCUM (accumulator) data for graphics.
IGBRAK	Supplies BREAK data for graphics.
IGCOMP	Supplies graphic output information for most one-dimensional components to the graphics COMMON block.
IGFILL	Supplies FILL data for graphics.
IGHSTR	Supplies heat-structure data for graphics.
IGPIPE	Supplies PIPE data for graphics.
IGPLEN	Supplies PLENUM data for graphics.
IGPRZR	Supplies PRIZER (pressurizer) data for graphics.
IGPUMP	Supplies PUMP data for graphics.
IGRAF	Initializes graphics variables and writes a header to the graphics file.
IGRF	Controls the creation of the graphics dictionary.
IGSTGN	Supplies STGEN (steam-generator) data for graphics.
IGSVCB	Obtains the signal-variable values.
IGTEE	Supplies TEE data for graphics.
IGTURB	Supplies TURB (turbine) stage data for graphics.

Name	Function
IGVLVE	Supplies VALVE data for graphics.
IGVSSL	Supplies VESSEL data for graphics.
ILEVEL	Writes integer VESSEL level array to output file TRCOUT.
INDEL	Searches specified substring of string for first nonoccurrence of any one character in a set of specified characters.
INIT	Entry routine for subroutine INIT.
INITBC	Initializes VESSEL component phantom cells and sets some boundary conditions.
INNER	Performs an inner iteration for a one-dimensional component.
INPUT	Entry routine for subroutine INPUT.
IOVLY	Initializes overlay bookkeeping.
IPIPE	Initializes the PIPE data arrays that are not input.
IPLEN	Loads the PLENUM arrays that are needed, but not input, to start a problem.
IPRIZR	Initializes the PRIZER (pressurizer) data arrays that are not input.
IPROP	Calls subroutines THERMO, FPROP, and MIXPRP for most one-dimensional components.
IPUMP	Initializes the PUMP data arrays that are not input.
IROD	Initializes rod component parameters that are not user-input.
IRODL	Initializes heat-structure arrays that provide information on the location of hydro data.
ISAMAX	Finds the smallest index of an element of maximum magnitude of a vector.
ISORT	Sorts a list of integers in ascending order.
ISTGEN	Initializes the STGEN (steam-generator) data arrays that are not input.
ITEE	Initializes the TEE data arrays that are not input from cards.
ITOHX	Used to create data address for the output file.
ITOLA	Used to convert addresses for the data dictionary file.
ITURB	Loads the arrays that are not input but that are needed to start a problem.
IVLVE	Initializes the VALVE data arrays that are not input.
IVSSL	Initializes the VESSEL data arrays that are not input.
IWALL3	Divides input friction factor by hydraulic diameter.

Name	Function
J1D	Fills boundary array at component junctions.
J3D	Fills boundary array at vessel source junctions.
JFIND	Locates junctions in junction sequence array.
JUNSOL	Determines junction parameters for connecting and sequencing components.
JVALUE	Converts one character of a string to a binary number: 0-9 returned as binary mode; blank, as binary 0; all others, as less than 0.
LABELH	Edits the H2O properties comments.
LCHPIP	Defines the pointer to the hydro array data for a one-dimensional component
LCHVSS	Defines the pointer to the hydro array data for a VESSEL component.
LCMOVE	Copies data from one part of LCM to another.
LCMTRN	Transfers data to LCM.
LDCHAR	Copies contents of R1 into R2.
LENTAB	Computes lengths of various pointer tables.
LEVEL	Uses a curve fit to obtain the water level in a cylindrical pipe as a function of the void fraction.
LEVELI	Transfers data for axial level IZ from inverted form to stacked form.
LEVELR	Transfers data for axial level IZ from stacked form to inverted form.
LININT	Performs linear interpolation on arrays.
LINT4D	Linearly interpolates a function table with zero to four independent variables.
LOAD	Reads in specially formatted input data.
LOCF	Locates the variable address.
LOCPMP	Calculates the required relative variable location in a common block for the PUMP.
LOCTEE	Calculates the required relative variable location in a common block for the TEE.
LOCTRB	Calculates the required relative variable location in a common block for the TURB.
LOCVLV	Calculates the required relative variable location in a common block for the VALVE.
MACCUM	Controls modification of an ACCUM (accumulator) component.

Name	Function
MANAGE	Performs all level and rod-data management operations for the VESSEL and heat-structure components.
MAPIN	Converts data types (for the NPA only).
MATSOL	Solves the vessel-matrix equation A * X = C using the capacitance method.
MBN	Calculates values for electrically heated nuclear fuel-rod insulator properties.
MBREAK	Controls modification of a BREAK component.
MCTAIN	Controls modification to a CTAIN component.
MDINIT	Creates the master dictionary table.
MFILL	Controls modification to a FILL component.
MFROD	Orders fuel-rod property selection and evaluates an average temperature for property evaluation.
MFUEL	Calculates uranium-dioxide and uranium-plutonium dioxide properties.
MGAP	Calculates values for the thermal conductivity of the gap-gas mixture.
MHTR	Calculates values for electrically heated fuel-rod heater coil properties.
MIX3D	Initializes stabilizer quantities at start of problem and equivalences stabilizer quantities to basic values when two-step method is not being used.
MIXPRP	Calculates mixture properties from those of separate phases.
MOVLEV	Copies N elements from array A into array B.
MPIPE	Controls modification to a PIPE component.
MPLEN	Controls modification to a PLENUM component.
MPRIZR	Controls modification of a PRIZER (pressurizer) component.
MPROP	Orders structure property selection and evaluates an average temperature for property evaluation.
MPUMP	Controls modification of a PUMP component.
MSTGEN	Controls modification of a STGEN (steam-generator) component.
MSTRCT	Calculates properties for certain types of steel.
MTEE	Controls modification of a TEE component.
MTURB	Controls modification of a TURB (turbine) component.
MVALVE	Controls modification of a VALVE component.
MVSSL	Controls modification of a VESSEL component.

Name	Function
MWRX	Calculates the Zircaloy steam reaction in the cladding at high temperatures.
MZIRC	Calculates properties for Zircaloy-4.
NAMLST	Performs input-data check on all namelist variables.
NEWDLT	Evaluates prospective new-time increment.
NPACTL	Gets NPA user interactive input.
NXTCMP	Finds the beginning of data for the next component.
OFFTKE	Calculates exit void fraction for TEE component offtake model.
ORDER	Rearranges the signal-variable, control-block, and trip ID numbers in ascending order based on their absolute value and searches for the do-loop index values for each control-parameter evaluation pass through the signal variables, control blocks, and trips.
ORTHES	Support subroutine for SGEEV.
ORTRAN	Support subroutine for SGEEV.
OUT1D	Controls outer calculation for one-dimensional components.
OUT3D	Controls outer calculation for a VESSEL.
OUTER	Controls outer calculation for one time step.
PACKIT	Packs data from one array into another.
PIPE1	Controls PIPE prepass.
PIPE1X	Calculates liquid volume discharged (q_{out}), collapsed liquid level (z), and volumetric flow rate (v_{flow}); assumes vertical component with low-numbered cell at top.
PIPE2	Controls PIPE outer iteration.
PIPE3	Controls PIPE postpass.
PIPROD	Moves hydro data for a one-dimensional component to and from the heat-structure database.
PLEN1	Performs the prep stage calculation for the PLENUM time-step initialization.
PLEN2	Controls PLENUM outer iteration.
PLEN3	Controls PLENUM postpass
PNTROD	Initializes rod pointers.
PNTVSS	Initializes general vessel pointers.
POST	Controls postpass calculation for one time step.

Name	Function
POST3D	Controls postpass calculation for the VESSEL.
POSTER	Performs postpass calculation for one-dimensional components.
PRCINT	Processes interrupts.
PRCNPA	Processes NPA commands that affect TRAC execution during an NPA simulation.
PREFWD	Prepares for evaluation of the three-dimensional wall shear coefficients.
PREINP	Converts free-format TRACIN deck to format used by TRAC input subroutine.
PREP	Controls prepass calculation for one time step.
PREP1D	Controls the prepass calculation for one-dimensional components.
PREP3D	Controls prepass calculation for three-dimensional components.
PREPER	Performs prepass calculation for one-dimensional components.
PRIZR1	Controls PRIZER (pressurizer) prepass.
PRIZR2	Controls PRIZER (pressurizer) outer iteration.
PRIZR3	Controls PRIZER (pressurizer) postpass.
PRZR1X	Evaluates pressurizer mass change during steady-state calculation.
PSTEPQ	Controls printing, dumping, and graphing of data at the completion of a time step.
PTRSA	Initializes general vessel pointers for use by signal variables and graphics.
PTRSPL	Initializes general plenum pointers for use by signal variables and graphics.
PUMP1	Controls PUMP prepass.
PUMP2	Controls PUMP outer iteration.
PUMP3	Controls PUMP postpass.
PUMPD	Calculates head and torque from PUMP curves.
PUMPI	Supplies built-in PUMP characteristics.
PUMPSR	Evaluates PUMP momentum and energy source.
PUMPX	Calculates PUMP head and torque.
QADJUST	Dummy routine for UNICOS.
QTIME	Mimics CTSS subroutine QTIME for UNICOS.
R1MACH	Support subroutine for SGEEV.
RACCUM	Reads ACCUM (accumulator) data input file and creates pointer table for these data.

Name	Function
RBREAK	Reads BREAK data from input file and creates a pointer table for these data.
RCNTL	Reads in signal-variable, trip, and controller input data.
RCOMP	Reads data common to most one-dimensional components from input files and writes these data to output file.
RCPVEC	Processes the control-panel vector input cards.
RDCOM3	Controls reading of three-dimensional VESSEL data from input file.
RDCOMP	Controls reading of component data from input file.
RDCRDS	Reads time-step cards until DTMIN < 0 is encountered.
RDCRVS	Reads PUMP curves from input file.
RDDIM	Reads number of points on PUMP curves from input file.
RDLCM	Moves data from LCM to SCM.
RDREST	Controls reading of component data from a restart dump file.
RDZMOM	Defines momentum cell reciprocal lengths and weighting factors.
REACCM	Reads ACCUM (accumulator) data from a restart dump and creates a pointer table for these data.
READI	Reads integer data in I14 format.
READR	Reads real data in E14.6 format.
REBRK	Reads BREAK data from a restart dump and creates a pointer table for these data.
RECNTL	Reads the signal-variable, trip, and controller data from the restart file.
RECOMP	Reads data from a restart dump common to most one-dimensional components.
RECPV	Adds the restart file control panel vector data that was not specified on input and prints it out.
REFILL	Reads FILL data from a restart dump and creates a pointer table for these data.
REHTST	Reads heat-structure scalar input data from a restart dump and creates a pointer table for these data.
REPIPE	Reads PIPE data from a restart dump and creates a pointer table for these data.
REPLEN	Reads PLENUM data from a restart dump and creates a pointer table for these data.

Name	Function
REPRZR	Reads PRIZER (pressurizer) data from a restart dump and creates a pointer table for these data.
REPUMP	Reads PUMP data from a restart dump and creates a pointer table for these data.
REROD1	Reads heat-structure input-data arrays from a restart dump.
RESTGN	Reads STGEN (steam-generator) data from a restart dump and creates a pointer table for these data.
RETEE	Reads TEE data from a restart dump and creates a pointer table for these data.
RETURB	Reads TURB (turbine) stage data from a restart dump and creates a pointer table for these data.
REVLVE	Reads VALVE data from a restart dump and creates a pointer table for these data.
REVSSL	Reads VESSEL data from a restart dump and creates a pointer table for these data.
RFDBK	Evaluates the reactor core reactivity feedback caused by changes in the fuel temperature, coolant temperature, and coolant void from the beginning of the previous time step.
RFILL	Reads FILL data from input file and creates a pointer table for these data.
RHOLIQ	Calculates values of liquid density and its derivatives.
RHTSTR	Reads ROD or SLAB heat-structure data from the input file and creates a pointer table for these data.
RINGO	Initializes certain variables for the vessel inner ring radial boundary.
RKIN	Integrates the neutron point-kinetics equations.
RLEVEL	Writes real VESSEL level array to output file TRCOUT.
RODHT	Calculates the fuel-rod temperature field.
RPIPE	Reads PIPE data from the input file and creates a pointer table for these data.
RPLEN	Reads PLENUM data from the input file and creates a pointer table for these data.
RPRIZR	Reads PRIZER (pressurizer) data from input file and creates a pointer table for these data.
RPUMP	Reads PUMP data from input file and creates a pointer table for these data.

Name	Function
RRDLCM	Reads rod data from LCM.
RROD1	Reads basic ROD input parameters.
RROD2	Reads and checks array data for powered heat structures.
RSPERR	Support subroutine for IBM.
RSTGEN	Reads STGEN (steam-generator) data from input file and creates pointer tables for these data.
RTEE	Reads TEE data from input file and creates a pointer table for these data.
RTURB	Reads TURB (turbine) stage data from input file and creates a pointer table for these data.
RVLVE	Reads VALVE data from input file and creates a pointer table for these data.
RVSLCM	Reads VESSEL data from LCM.
RVSSL	Reads VESSEL data from input file and creates a pointer table for these data.
S1DPTR	Sets pointers for one-dimensional components.
SATDER	Calculates the derivative of saturation temperature of vapor with respect to pressure.
SATPRS	Calculates saturation pressure of vapor corresponding to a given temperature.
SATTMP	Calculates saturation temperature of vapor corresponding to a given pressure.
SAVBD	Moves boundary information into component arrays.
SAXPY	Performs single precision computation of Y = A * X + Y.
SCLMOM	Sets up geometric scale factors for velocities to improve momentum conservation.
SCLTBL	Scales input table according to scale factor passed by input routine.
SCMLCM	Checks for overflow. Transfers fixed-length, variable-length, and pointer tables to LCM. Adjusts pointers.
SCOPY	Support subroutine for SGEEV.
SCOPYM	Support subroutine for SGEEV.
SDOT	Computes single precision inner product of single precision vectors.
SEDIT	Writes short edit to TRCOUT file.
SEPDI	Computes separator side-arm void fraction and mixture velocity.

Name	Function
SEPDX	Computes mechanistic separator carryover and carryunder quantities.
SETBD	Stores component information in boundary arrays.
SETBDT	Sets values for boundary to first theta cell equal to values for last theta cell and sets values for boundary to last theta cell equal to values for first theta cell.
SETBRK	Sets special pointers for a BREAK component.
SETCMP	Determines the component type and sets the LCM pointer for control-panel vector parameter IPARAM for component ICOMP.
SETCPV	Sets up the control-panel vector pointers. All errors encountered by subordinate routines are treated as warning errors. If an error would inhibit further processing, IERRFL is set to 1. At the end of this routine a fatal error is issued if IERRFL is not 0. This allows checking of all parameters in a single pass.
SETEOS	Sets the equation-of-state constants.
SETERR	Support subroutine for IBM.
SETFIL	Sets special pointers for a FILL.
SETIC	Currently not used.
SETLCM	Monitors use of LCM dynamic area.
SETNET	Provides the information needed to set up the network solution matrices.
SETPMP	Sets the volume flow pointer for a PUMP.
SETPRZ	Sets special pointers for a PRIZER (pressurizer).
SETVA	Sets value of variable VAR to VAL for one level of VESSEL data.
SETVSL	Sets special pointers for a VESSEL.
SFA44	Hardwired version of subroutine SGEFA for 4 × 4 matrices.
SFA55	Handwired version of subroutine SGEFA for 5 × 5 matrices.
SGBFA	Factors a real band matrix for elimination.
SGBSL	Solves the real band system A * X = B or TRANS(A) * X = B using factors computed by subroutine SGBFA.
SGEDI	Computes the determinant of a matrix using the factors computed by SGEFA.
SGEEV	Computes the eigenvalues and eigenvectors of a general real matrix.
SGEFA	Factors a real matrix by Gaussian elimination.
SGEFAV	Factors a real matrix by Gaussian elimination.

Name	Function
SGEMM	Performs matrix multiplication.
SGESL	Solves the real system A * X = B or TRANS(A) * X = B using the factors computed by or SGEFA.
SGESLM	Solves a system of linear equations with many right hand sides.
SGESLV	Solves the real system A * X = D or TRANS(A) * X = B.
SHIFT	Support subroutine for IBM.
SHIFTB	Translates the table's abscissa-coordinate values so that the function value F in the table corresponds to an abscissa-coordinate value of 0.0.
SHIFTR	Shifts an argument to the right by a specified number of bits and fills remaining space with zeros.
SHRINK	Removes rows of conduction nodes within the heat-structure rods or slabs during reflood.
SIGMA	Returns surface tension of water as a function of pressure.
SMOVE	Moves a character from one string to another.
SMOVEN	Moves a specified number of characters from one string to another.
SOUND	Performs homogeneous equilibrium sound speed calculation.
SPLIT	Reads appropriate data from PUMP curves.
SRCHCL	Searches the component list for component number ICOMP. It returns the component LCM pointer in IBASE. If the component is not found, it sets IERR to 1 and returns −1 in IBASE.
SRCHMDT	Searches master dictionary tabel for a specified entry.
SRCHTB	Searches variable name table for a specified entry.
SRCHVT	Searches a set of master dictionary variable name table entries for a specified variable name.
SRTLP	Sorts components into loops and reorders them for the network solution.
SSCAL	Performs single precision vector scale X = A * X.
SSEPOR	Performs detailed calculation of a steam-water separator.
SSL44	Hardwired version of subroutine SGESL for 4 × 4 matrices.
SSL55	Hardwired version of subroutine SGESL for 5 × 5 matrices.
SSWTCH	Mimics CTSS subroutine SSWTCH for UNICOS.
STBME	Sets up the stabilizing mass and energy equations.
STBME3	Sets up stabilizer mass and energy equations for VESSEL component.
STBMPL	Sets up the stabilizing mass and energy equations for the PLENUM.

Name	Function
STDIR	Sets up direct inversion of the VESSEL matrix.
STEADY	Generates a steady-state solution.
STGABD	Finds the void fractions in adjacent cells within a steam generator to use in heat-transfer averaging.
STGEN1	Controls STGEN (steam-generator) prepass.
STGEN2	Controls STGEN (steam-generator) outer iteration.
STGEN3	Controls STGEN (steam-generator) postpass.
STGN1X	Evaluates heat-transfer coefficients for STGEN (steam-generator) secondary side.
STGN3X	Performs STGEN (steam-generator) heat-transfer calculation.
STGNTX	Computes needed quantities on prepass for STGEN (steam generator).
STGPTH	Initializes TRAC communication to the NPA controller.
STINIT	Creates the problem specific Data Dictionary File used by the NPA Protocol Handler.
STPCLS	Closes disk file used for NPA controller communication.
STPMSG	Checks for message from the NPA controller.
STPRD	Reads message from the NPA controller.
STPWRT	Writes message to the NPA controller.
STRLER	Provides error message for NPA controller communication failure (reserved for future use).
SVSET	Evaluates location-independent ($0 = ISUN < 17$) signal variables.
SVSET1	Evaluates signal variables with locations defined in the one-dimensional components.
SVSET3	Evaluates signal variables with locations defined in the three-dimensional VESSEL.
SVSETH	Evaluates signal variables defined in heat structures.
SWITCH	Moves one level of VESSEL data starting at IADD1 to IADD2 and vice versa. (Not currently maintained.)
TEE1	Controls TEE prepass.
TEE1X	Calculates source for TEE side-leg hydrodynamics.
TEE2	Controls TEE outer iteration.
TEE3	Controls TEE postpass.
TF1D	Drives one-dimensional hydrodynamics routines.

Name	Function
TF1DS	Solves the hydrodynamic equations for the one-dimensional two-fluid pipe model.
TF1DS1	Sets up initial velocity approximations and their pressure derivatives for the one-dimensional two-fluid pipe model.
TF1DS3	Performs the backward-substitution for the one-dimensional two-fluid pipe model.
TF3DS	Sets up basic mass and energy equations for three-dimensional VESSEL component.
TF3DS1	Estimates new-time velocities from motion equation and calculates variation of velocities with respect to pressure for three-dimensional VESSEL component.
TF3DS3	Performs back-substitution for three-dimensional VESSEL component.
TFPLBK	Performs the backward-substitution for the basic difference equations for the PLENUM (similar to TF1DS3 for the other one-dimensional components).
TFPLN	Solves the basic hydrodynamic equations for the PLENUM (similar to TF1DS for the other one-dimensional components).
THCL	Returns thermal conductivity of water as a function of pressure and enthalpy.
THCV	Returns thermal conductivity of steam as a function of pressure and enthalpy.
THERM2	Computes THERMO flag for use with MELPROG.
THERMO	Calculates thermodynamic properties of water.
TIMCHK	Checks elapsed time to see whether certain functions should be performed.
TIME	Mimics CTSS subroutine TIME for UNICOS.
TIMER	Timekeeping routine.
TIMING	Mimics CTSS subroutine TIMING for UNICOS.
TIMSTP	Sets up time-step and time-edit interval times.
TIMUPD	Updates start-of-time-step values with end-of-time-step values for one VESSEL level.
TMPPTR	Sets up temporary pointers for subroutines PREIFD and PREFWD.
TMSFB	Calculates the minimum stable film-boiling temperature (T_{min}).
TRAC	Supplies MAIN program.

Name	Function
TRANS	Controls overall calculation for each time step.
TRANSF	Transfers data from the STGEN (steam-generator) internal network matrix to the loop network matrix.
TRBPOW	Calculates the efficiency and power output of a turbine stage.
TRBPRE	Calculates the data pertaining to the entire turbine-generator set (common/sum all stages) during the prep stage.
TRBPST	Calculates the data pertaining to the entire turbine-generator set (common/sum all stages) during the post stage.
TRIP	Returns status of a trip.
TRIPS	Evaluates the control parameters for the beginning of the time-step system state.
TRISLV	Solves linear system of the form A * X = B where A is tridiagonal.
TRPSET	Sets up trip status flags.
TURB1	Performs the prep stage calculation for the turbine stage component time-step initialization.
TURB2	Controls turbine stage outer iteration.
TURB3	Controls turbine stage postpass.
UNPKIT	Unpacks data packed by subroutine PACKIT.
VALUE	Converts an ASCII string to its binary value.
VDPCSS	Defines necessary signal variables, control blocks, and controllers for constrained steady-state calculation.
VELBC	Sets velocities at internal FILL boundaries for a vessel.
VFWALL3	Evaluates three-dimensional wall shear coefficients.
VISCL	Evaluates viscosity of water as a function of pressure and enthalpy.
VISCV	Evaluates viscosity of steam as a function of pressure and enthalpy.
VLEVEL	Indicates the beginning of a certain level in a VESSEL.
VLVE1	Controls VALVE prepass.
VLVE2	Controls VALVE outer iteration.
VLVE3	Controls VALVE postpass.
VLVEX	Evaluates the value of the flow-area change action for a VALVE.
VMCELL	Converts a VESSEL cell number to a VESSEL-matrix cell number.
VOLFA	Calculates cell volume flow areas.

Name	Function
VOLV	Calculates cell-averaged phase velocities for one-dimensional components.
VRBD	Defines VESSEL velocities in the upstream radial direction for the inner ring. (Not currently used.)
VSLGEO	Writes the geometry cards for the VESSEL on the restart input file.
VSLLEV	Writes the level data cards for the VESSEL on the restart input file.
VSLROD	Writes the rod-data cards for the VESSEL to the restart input file.
VSSL1	Performs prepass calculations for VESSEL dynamics.
VSSL2	Performs inner iterations for VESSEL dynamics.
VSSL3	Performs postpass calculations for VESSEL dynamics.
VSSROD	Transfers data between hydro and heat-structure databases.
VSSSSR	Performs steady-state change ratio calculations for vessel.
WACCUM	Writes selected ACCUM (accumulator) data to output file TRCOUT.
WARRAY	Writes a real array to output file TRCOUT.
WBREAK	Writes selected BREAK data to output file TRCOUT.
WCOMP	Controls the writing of selected component data to output file TRCOUT.
WDRAG	Calculates coefficient of friction for liquid and vapor at the wall.
WFILL	Writes selected FILL data to output file TRCOUT.
WHTSTR	Writes selected heat-structure data to output file TRCOUT.
WIARR	Writes an integer array to output file TRCOUT.
WLABI	Edits labeled integer-valued input data that is to be read by the LOAD subroutine.
WLABR	Edits labeled real-valued input data that is to be read by the LOAD subroutine.
WLEVEL	Writes real VESSEL level array to output file TRCOUT.
WPIPE	Writes selected PIPE data to output file TRCOUT.
WPLEN	Writes selected PLENUM quantities to the output file TRCOUT.
WPRIZR	Writes selected PRIZER (pressurizer) data to output file TRCOUT.
WPUMP	Writes selected PUMP data to output file TRCOUT.
WRCOMP	Writes data common to one-dimensional components to output files.
WRITEE	This subroutine does not combine numbers as does subroutine R. It merely puts an E at the end of the data for a variable to make it compatible with the LOAD subroutine of the TRAC code.

Name	Function
WRITEI	Takes integers and puts them into format compatible with the LOAD subroutine of TRAC.
WRITER	Takes real numbers and puts them into format compatible with the LOAD subroutine of TRAC.
WRLCM	Transfers a given number of words from SCM to LCM.
WSTGEN	Writes selected STGEN (steam generator) data to output file TRCOUT.
WTEE	Writes selected TEE data to output file TRCOUT
WTURB	Writes selected quantities to the printer for a TURB (turbine) stage component.
WVLVE	Writes selected VALVE data to output file TRCOUT.
WVSSL	Writes selected VESSEL data to output file TRCOUT.
XOR	Support subroutine for IBM.
ZCORE	Calculates axial locations for CHF and transition boiling within the core and computes associated void fractions.
ZEROV	Zeroes velocities at zero flow areas.
ZPWHCI	Evaluates axial power shape based on user input.

APPENDIX B

TRAC SUBROUTINE CALLING SEQUENCE

TRAC
    CALLS
        PRODCTN , ERROR , GETUFL , LENTAB , BLKDAT ,SAMPLE , SAMPON , GETJTL , SETLCM , LOADTIM ,LABELP , INPUT , INIT , DMPIT , STEADY ,TRANS , QTIME , CLEAN , SAMPTRM , EXIT.
ACCM1X
    CALLED BY
        ACCUM1.
ACCMBD
    CALLS
        J1D.
    CALLED BY
        ACCUM1 , ACCUM2 , ACCUM3 , IACCUM.
ACCUM1
    CALLS
        SAVBD , J1D , PREPER , ACCM1X , ACCMBD ,BKMOM.
    CALLED BY
        PREP1D.
ACCUM2
    CALLS
        INNER , ACCMBD.
    CALLED BY
        OUT1D.
ACCUM3
    CALLS
        POSTER , SAVBD , EVALDF , CONSTB , ACCMBD.
    CALLED BY
        POST.
ALLBLK
    CALLS
        INDEL.
    CALLED BY
        PREINP.
ASIGN
    CALLED BY
        INPUT.
ASTPLN
    CALLED BY
        PLEN3.
AUXPLN
    CALLS
        GETBIT.
    CALLED BY
        PLEN2.
BACIT
    CALLED BY
        VSSL2.
BAKUP
    CALLED BY
        VSSL2 , VSSL3.
BANSOL
    CALLED BY
        RODHT.
BDPLEN

```
        CALLED BY
                INPUT   , PLEN1   , PLEN2   , PLEN3.
BFALOC
        CALLS
                LDCHAR.
        CALLED BY
                DMPIT   , IGRAF   , RDREST.
BFCLOS
        CALLED BY
                ENDDMP  , ENDGRF.
BFIN
        CALLS
                ERROR   , RDLCM.
        CALLED BY
                RDREST  , REACCM  , REBRK   , RECOMP  , REFILL  ,REHTST  , REPIPE  , REPLEN  ,
                REPRZR  , REPUMP  ,REROD1   RESTGN  , RETEE   , RETURB  , REVLVE  ,REVSSL.
BFOUT
        CALLS
                ERROR   , WRLCM.
        CALLED BY
                DBRK    , DCOMP   , DFILL   , DHTSTR  , DLEVEL  ,DMPIT   , DPIPE   , DPLEN   , DPUMP   ,
                DROD1   ,DSTGEN   , DTEE    , DTURB   , DVLVE   , DVSSL   ,GRAF    , IGRAF.
BITS
        CALLS
                SETBIT  , OFFBIT  , CHGBIT  , OF1123  , ON1123  ,ERROR.
SETBIT
        CALLED BY
                BITS    , CHBSET  , FF3D    , HTIF    , J3D     ,PLEN3   , POSTER  , PREPER  , RCOMP   ,
                TF1DS   ,TF1DS1   , TF1DS3  , TFPLBK  , TFPLN.
OFFBIT
        CALLED BY
                BITS    , CHBSET  , HTIF    , TF1DS   , TF1DS3  ,TFPLN.
CHGBIT
        CALLED BY
                BITS.
OF1123
        CALLED BY
                BITS    , J3D     , POSTER.
ON1123
        CALLED BY
                BITS    , INNER.
BKMOM
        CALLS
                BKSMOM.
        CALLED BY
                ACCUM1  , PIPE1   , PRIZR1  , PUMP1   , STGEN1  ,TEE1    , TURB1   , VLVE1.
BKSMOM
        CALLED BY
                BKMOM.
BKSPLN
        CALLS
                SFA55   , SSL55   , CONCF.
        CALLED BY
                PLEN3.
BKSSTB
        CALLS
                SFA55   , SSL55   , CONCF.
```

CALLED BY
POSTER.
BKSTB3
CALLS
SFA55 , SSL55 , CONCF.
CALLED BY
VSSL3.
BLKDAT
CALLED BY
TRAC.
BREAK1
CALLS
BREAKX , J1D , SHIFTB , GETBIT.
CALLED BY
PREP1D.
BREAK2
CALLS
J1D.
CALLED BY
OUT1D.
BREAK3
CALLS
THERMO , FPROP , J1D.
CALLED BY
POST.
BREAKX
CALLS
TRIP , SHIFTB , EVLTAB , LININT , ERROR ,THERMO , FPROP , MIXPRP ,
SATTMP.
CALLED BY
BREAK1.
BSPDDC
BSPDSL
CBEDIT
CALLED BY
RCNTL , RECNTL.
CBSET
CALLS
ERROR , CONBLK , DELAY , LININT , LINT4D.
CALLED BY
TRIPS.
CDTHEX
CALLS
LININT.
CALLED BY
DELTAR.
CELLA3
CALLED BY
VSSL2.
CELLAV
CALLED BY
TF1D.
CHBD
CALLS
ERROR.
CALLED BY
CHKBD.

CHBSAV
CALLED BY
IACCUM , INPUT , ISTGEN , ITEE , ITURB ,IVLVE.
CHBSET
CALLS
OFFBIT , SETBIT.
CALLED BY
IACCUM , INPUT , ISTGEN , ITEE , ITURB ,IVLVE.
CHEN
CALLS
SATPRS.
CALLED BY
HTCOR , HTVSSL.
CHF
CALLS
CHF1 , ERROR , SATPRS.
CALLED BY
HTCOR , HTVSSL.
CHF1
CALLED BY
CHF , HTCOR , HTVSSL.
CHKBD
CALLS
CHBD , ICMPR , GETBIT.
CALLED BY
IACCUM , INPUT , ISTGEN , ITEE , ITURB ,IVLVE.
CHKSR
CALLS
ERROR.
CALLED BY
RVSSL.
CHOKE
CALLS
SOUND , THERMO , ERROR , SGEFA , SGEDI ,SGESL , SGEEV , SATPRS
CALLED BY
TF1DS1.
CIF3
CALLS
GETBIT.
CALLED BY
VSSL1.
CIHTST
CALLS
RDLCM , RRDLCM , IRODL , IROD , WRLCM.
CALLED BY
ICOMP.
CIVSSL
CALLS
RVSLCM , IVSSL , ERROR , LDCHAR , WRLCM ,PTRSA , JFIND.
CALLED BY
ICOMP.
CLEAN
CALLS
IOVLY , ENDGRF , ENDDMP , COMPACT , EOVLY.
CALLED BY
TRAC , ERROR , ERRTRP , STEADY.
CLEAR

CALLED BY
CORE1 , HOUT , ICOMP , INPUT , LCMTRN ,LOAD , OUT1D , OUT3D , OUTER , PLEN1 ,PLEN2 , PLEN3 , PNTROD , PNTVSS , POS ,POST3D , PREP1D , PREP3D , PREPER , RACCUM ,RBREAK , RCNTL , RCOMP , RDDIM , REROD1 ,REVSSL , RFILL , RHTSTR , RPIPE , RPLEN ,RPRIZR , RPUMP , RROD2 , RSTGEN , RTEE ,RTURB , RVLVE , RVSSL , S1DPTR , SCMLCM ,SEDIT , SRTLP , STGEN1 , STGEN2 , STGEN3 ,WVSSL.

COMPI
CALLED BY
INPUT , ISTGEN , ITEE , ITURB , IVLVE.

CONBLK
CALLS
ERROR.
CALLED BY
CBSET.

CONCF
CALLED BY
BKSPLN , BKSSTB , BKSTB3 , FF3D.

CONSTB
CALLS
STBME , J1D , ICMPR.
CALLED BY
ACCUM3 , PIPE3 , PRIZR3 , PUMP3 , STGEN3 ,TEE3 , TURB3 , VLVE3.

COPYA
CALLED BY
MIX3D.

CORE1
CALLS
TRIP , MANAGE , CLEAR , ERROR , MFROD ,FNMESH , SHRINK , EXPAND , ZCORE , HTVSSL ,HTCOR , EVFXXX , ZPWHCI , RFDBK , RKIN.
CALLED BY
HTSTR1.

CORE3
CALLS
MANAGE , ERROR , FROD , EVALDF.
CALLED BY
HTSTR3.

CPLL
CALLED BY
FPROP.

CPVV1
CALLED BY
FPROP , HTCOR , HTVSSL , HTWEBB.

CTAIN1
CALLS
ERROR.
CALLED BY
PREP1D.

CTAIN2
CALLS
ERROR.
CALLED BY
OUT1D.

CTAIN3
CALLS
ERROR.
CALLED BY

POST.
CWVSSL.
CALLS
RVSLCM , WVSSL.
CALLED BY
WCOMP.
CYLHT
CALLED BY
POSTER , STGN3X.
DATEU
CALLS
DATE.
CALLED BY
INPUT.
DBRK
CALLS
BFOUT , RDLCM.
CALLED BY
DMPIT.
DCODF
CALLED BY
LOAD.
DCOMP
CALLS
RDLCM , BFOUT.
CALLED BY
DMPIT , DPIPE , DPUMP , DSTGEN , DTEE , DTURB , DVLVE.
DECAYS
CALLED BY
RROD2.
DELAY
CALLS
LININT , ERROR.
CALLED BY
CBSET.
DELTAR
CALLS
CDTHEX , FTHEX.
CALLED BY
GAPHT.
DFILL
CALLS
RDLCM , BFOUT.
CALLED BY
DMPIT.
DGBFA
CALLS
DSCAL , DAXPY.
DGBSL
CALLS
DAXPY.
DHTSTR
CALLS
RDLCM , RRDLCM , BFOUT , DROD1.
CALLED BY
DMPIT.
DLEVEL

CALLS
LEVELI , BFOUT.
CALLED BY
DVSSL.
DMPIT
CALLS
IOVLY , BFALOC , ERROR , BFOUT , QTIME ,RDLCM , DPIPE , DTEE , DPUMP ,
DVLVE ,DBRK , DFILL , DCOMP , DSTGEN , DTURB ,DPLEN , DVSSL , DHTSTR
, EOVLY
CALLED BY
TRAC , ERROR , ERRTRP , PSTEPQ , TIMCHK ,TRANS
DPIPE
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DPLEN
CALLS
RDLCM , BFOUT.
CALLED BY
DMPIT.
DPUMP
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DROD1
CALLS
BFOUT , MANAGE.
CALLED BY
DHTSTR.
DSTGEN
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DTEE
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DTURB
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DVLVE
CALLS
DCOMP , BFOUT.
CALLED BY
DMPIT.
DVPSCL
CALLS
SETVA.
CALLED BY
IVSSL , VSSL1.
DVSSL

CALLS
RVSLCM , BFOUT , MANAGE , DLEVEL.
CALLED BY
DMPIT.
ECOMP
CALLS
WARRAY , GETBIT.
CALLED BY
WACCUM , WBREAK , WFILL , WPIPE , WPRIZR ,WPUMP , WSTGEN , WTEE ,
WTURB , WVLVE.
EDIT
CALLS
IOVLY , SEDIT , WCOMP , EOVLY.
CALLED BY
ERROR , ERRTRP , HOUT , PSTEPQ , STEADY ,TIMCHK , TRANS.
ELGR
CALLS
ERROR , WARRAY.
CALLED BY
IACCUM , INPUT , ISTGEN , ITEE , ITURB ,IVLVE.
ENDDMP
CALLS
BFCLOS , ERROR , COMPACT.
CALLED BY
CLEAN.
ENDGRF
CALLS
BFCLOS , ERROR , COMPACT.
CALLED BY
CLEAN.
EOVLY
CALLS
ERROR.
CALLED BY
CLEAN , DMPIT , EDIT , ERROR , GRAF ,INIT , INPUT , OUT1D , OUT3D ,
OUTER ,POST , PREP , PREP1D , PREP3D , RDCOM3 ,RDCOMP , RDREST ,
TRIPS.
ERRGET
CALLS
QXIT.
ERROR
CALLS
DMPIT , EDIT , QTIME , QADJUST , EOVLY ,CLEAN.
CALLED BY
TRAC , BFIN , BFOUT , BITS , BREAKX ,CBSET , CHBD , CHF , CHKSR ,
CHOKE ,CIVSSL , CONBLK , CORE1 , CORE3 , CTAIN1 ,CTAIN2 , CTAIN3 , DELAY
, DMPIT , ELGR ,ENDDMP , ENDGRF , EOVLY , EVALDF , EVFXXX ,EVLTAB ,
FBRCSS , FILLX , GETBIT , GETCRV ,GRAF , GRFPUT , HOUT , HTSTR3 ,
HVWEBB ,ICOMP , IGRAF , INIT , INPUT , ISTGEN ,ITEE , IVLVE , JFIND , LOAD
, LOCPMP ,LOCTEE , LOCTRB , LOCVLV , MANAGE , MATSOL ,MFROD , MSTRCT
, NAMLST , NXTCMP , OFFTKE ,OUT1D , OUT3D , OUTER , POST , POST3D
,POSTER , PREFWD , PREINP , PREP1D , PREP3D ,PTRSPL , PUMPD , PUMPSR ,
RACCUM , RBREAK ,RCNTL , RCOMP , RDCOMP , RDCRDS , RDDIM , RDREST ,
REACCM , READI , READR , REBRK ,RECNTL , REFILL , REHTST , REPIPE ,
REPLEN ,REPRZR , REPUMP , RETEE , RETURB , REVLVE ,REVSSL , RFDBK ,
RFILL , RHTSTR , RKIN ,RODHT , RPIPE , RPLEN , RPRIZR , RPUMP ,RROD1 ,
RROD2 , RSTGEN , RTEE , RTURB ,RVLVE , RVSSL , SCLMOM , SETLCM ,

SOUND ,SRTLP ,STEADY ,STGN3X ,SVSET ,SVSET1 ,SVSET3 ,SVSETH ,
TEE1 ,THERMO ,TIMCHK ,TIMSTP ,TRANS ,TRIP ,TRPSET ,VLVEX ,VSSL1 ,
VSSL2.

ERRTRP
CALLS
QXIT ,POST ,DMPIT ,EDIT ,CLEAN ,EXIT.

ESTGEN
CALLED BY
ISTGEN ,STGEN1 ,STGEN3.

ETEE
CALLED BY
ITEE ,TEE1 ,TEE3.

EVALDF
CALLS
ERROR.
CALLED BY
ACCUM3 ,CORE3 ,PIPE3 ,PRIZR3 ,PUMP3 ,STGEN3 ,TEE3 ,TURB3 ,VLVE3
,VSSL3.

EVFXXX
CALLS
ERROR ,TRIP ,LININT ,EVLTAB.
CALLED BY
CORE1 ,PIPE1 ,PIPE3 ,PUMP3 ,RKIN ,TEE1X ,TEE3 ,TURB1 ,VLVE3.

EVLTAB
CALLS
ERROR ,LININT.
CALLED BY
BREAKX ,EVFXXX ,FILLX ,PUMPSR ,TRBPRE ,VLVEX.

EXPAND
CALLED BY
CORE1.

FAXPOS
CALLED BY
RVLVE ,VLVEX.

FBRCSS
CALLS
ERROR.
CALLED BY
INPUT.

FEMOM
CALLS
LEVEL ,GETBIT.
CALLED BY
PREPER.

FEMOMX
CALLS
SATTMP.
CALLED BY
VSSL1.

FEMOMY
CALLS
SATTMP.
CALLED BY
VSSL1.

FEMOMZ
CALLS
SATTMP.

CALLED BY
VSSL1.
FF3D
CALLS
GVSSL1 , SETBIT , CONCF.
CALLED BY
VSSL3.
FILL1
CALLS
FILLX , J1D , GETBIT.
CALLED BY
PREP1D.
FILL2
CALLS
J1D.
CALLED BY
OUT1D.
FILL3
CALLS
J1D.
CALLED BY
POST.
FILLX
CALLS
TRIP , SHIFTB , EVLTAB , LININT , ERROR ,THERMO , FPROP , MIXPRP.
CALLED BY
FILL1.
FLTOM
CALLS
LDCHAP , VSSROD , PIPROD.
CALLED BY
HTSTR1.
FLUX
CALLS
GETBIT , ICMPR.
CALLED BY
PREPER.
FLUXES
CALLED BY
VSSL2.
FNMESH
CALLED BY
CORE1.
FPROP
CALLS
CPLL , CPVV1 , VISCL , VISCV , THCL ,THCV , SIGMA.
CALLED BY
BREAK3 , BREAKX , FILLX , IBRK , IFILL ,INPUT , IVSSL , PLEN3 , POSTER ,
VSSL3.
FROD
CALLS
MWRX , GAPHT , RODHT.
CALLED BY
CORE3.
FTHEX
CALLED BY
DELTAR.

```
FWALL
        CALLS
                FWKF.
        CALLED BY
                PREPER.
FWKF
        CALLED BY
                FWALL   , IWALL3.
GAPHT
        CALLS
                DELTAR  , MGAP.
        CALLED BY
                FROD.
GETBIT
        CALLS
                ERROR.
        CALLED BY
                AUXPLN  , BREAK1  , CHKBD   , CIF3    , ECOMP   ,FEMOM   , FILL1   , FLUX    , GRAF    ,
                HTIF    ,PLEN3    , POSTER  , PREPER  , STBME   , TEE3    ,TF1DS   , TF1DS1  , TF1DS3  ,
                TF3DS   , TF3DS1  ,TFPLBK   , TFPLN.
GETCRV
        CALLS
                ERROR   , SPLIT.
        CALLED BY
                PUMPD.
GLEVEL
        CALLS
                LEVELI  , PACKIT.
        CALLED BY
                GRAF    , IGRAF.
GRAF
        CALLS
                IOVLY   , RDLCM   , GRFGET  , BFOUT   , QTIME   ,RVSLCM  , RRDLCM  , RHVGET  ,
                SETLCM  , PACKIT  ,ERROR    , MANAGE  , GLEVEL  , EOVLY   , LOCTRB  ,GETBIT.
        CALLED BY
                PSTEPQ  , STEADY  , TRANS.
GRFGET
        CALLED BY
                GRAF    , IGRAF.
GRFPUT
        CALLS
                SETLCM  , ERROR.
        CALLED BY
                IGACUM  , IGBRAK  , IGCOMP  , IGFILL  , IGHSTR  ,IGPIPE  , IGPLEN  , IGPRZR  , IGPUMP
                , IGRAF   ,IGSTGN  , IGSVCB  , IGTEE   , IGTURB  , IGVLVE  ,IGVSSL.
GVSSL1
        CALLED BY
                FF3D.
GVSSL2
        CALLS
                SATTMP.
        CALLED BY
                VSSL3.
HEV
        CALLED BY
                SATDER  , SATTMP  , SETEOS   THERMO.
HLFILM
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CALLED BY
HTCOR.
HLFLMR
CALLED BY
HTVSSL.
HOUT
CALLS
CLEAR , OUTER , EDIT , POST , ERROR ,QTIME.
CALLED BY
STEADY , TRANS.
HTCOR
CALLS
CHEN , CHF1 , CHF , HVNB , TMSFB ,HVFILM , HLFILM , VISCV , CPVV1 ,
THCV.
CALLED BY
CORE1 , HTPIPE , STGN1X.
HTIF
CALLS
OFFBIT , SETBIT , SATPRS , GETBIT.
CALLED BY
PLEN2 , TF1D , VSSL2.
HTPIPE
CALLS
HTCOR.
CALLED BY
PREPER.
HTSTR1
CALLS
HTSTRV , RDLCM , RRDLCM , MANAGE , FLTOM ,CORE1 , WRLCM.
CALLED BY
PREP.
HTSTR3
CALLS
RDLCM , RRDLCM , MANAGE , ERROR , CORE3 ,WRLCM.
CALLED BY
POST.
HTSTRV
CALLS
RDLCM , RVSLCM , MANAGE , SETVA.
CALLED BY
HTSTR1.
HTVSSL
CALLS
CHEN , CHF1 , CHF , HVNB , HLFLMR ,HVWEBB , VISCV , CPVV1 , THCV.
CALLED BY
CORE1.
HVWEBB
CALLS
ERROR , CPVV1 , THCV , VISCV.
CALLED BY
HTVSSL.
HUNTS
CALLS
IDEL.
CALLED BY
PREINP.
HVFILM

CALLED BY
HTCOR.
HVNB
CALLED BY
HTCOR , HTVSSL.
IACCUM
CALLS
JUNSOL , VOLFA , IPROP , CHBSAV , ACCMBD ,CHBSET , WRLCM , CHKBD ,
ELGR , JFIND.
CALLED BY
ICOMP.
IBRK
CALLS
THERMO , FPROP , MIXPRP , WRLCM , J1D ,JFIND.
CALLED BY
ICOMP.
ICHL
CALLED BY
INPUT.
ICMPR
CALLED BY
CHKBD , CONSTB , FLUX , INNER , PREPER ,SAVBD , SETBD.
ICOMP
CALLS
ERROR , RDLCM , WRLCM , CLEAR , CIHTST ,SETLCM , IPIPE , ITEE , IPUMP ,
IFILL ,IBRK , IPRIZR , ISTGEN , IACCUM , ITURB ,IVLVE , IPLEN , SETNET ,
CIVSSL , LOCTRB ,LOCVLV.
CALLED BY
INIT.
IDEL
CALLED BY
HUNTS , INPUT , PREINP.
IDIFF
CALLED BY
JVALUE.
IFILL
CALLS
THERMO , FPROP , MIXPRP , WRLCM , J1D ,JFIND.
CALLED BY
ICOMP.
IFSET
CALLS
SETVA.
CALLED BY
VSSL1.
IGACUM
CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGBRAK
CALLS
GRFPUT.
CALLED BY
IGRAF.
IGCOMP
CALLS

GRFPUT.
CALLED BY
IGACUM , IGPIPE , IGPRZR , IGPUMP , IGSTGN ,IGTEE , IGTURB , IGVLVE.
IGFILL
CALLS
GRFPUT.
CALLED BY
IGRAF.
IGHSTR
CALLS
GRFPUT.
CALLED BY
IGRAF.
IGPIPE
CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGPLEN
CALLS
GRFPUT.
CALLED BY
IGRAF.
IGPRZR
CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGPUMP
CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGRAF
CALLS
BFALOC , ERROR , SETLCM , GRFPUT , IGSVCB ,RDLCM , IGPIPE , IGTEE ,
IGPUMP , IGFILL ,IGBRAK , IGPRZR , IGSTGN , IGVSSL , IGACUM ,IGTURB , IGPLEN
, IGHSTR , IGVLVE , BFOUT ,GRFGET , RVSLCM , RVVGET , PACKIT , MANAGE
,GLEVEL , LOCTRB.
CALLED BY
INIT.
IGSTGN
CALLS
GRFPUT , IGCOMP.
CALLED BY
IGRAF.
IGSVCB
CALLS
GRFPUT.
CALLED BY
IGRAF.
IGTEE
CALLS
GRFPUT , IGCOMP.
CALLED BY
IGRAF.
IGTURB

CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGVLVE
CALLS
IGCOMP , GRFPUT.
CALLED BY
IGRAF.
IGVSSL
CALLS
GRFPUT.
CALLED BY
IGRAF.
ILEVEL
CALLS
WIARR , LEVELR.
CALLED BY
RVSSL.
INDEL
CALLED BY
ALLBLK , PREINP.
INIT
CALLS
IOVLY , ICOMP , IGRAF , ERROR , EOVLY.
CALLED BY
TRAC.
INITBC
CALLS
SETVA.
CALLED BY
IVSSL.
INNER
CALLS
ON1123 , TF1D , J1D , ICMPR.
CALLED BY
ACCUM2 , PIPE2 , PRIZR2 , PUMP2 , STGEN2 ,TEE2 , TURB2 , VLVE2.
INPUT
CALLS
FEXIST , ERROR , CLEAR , IOVLY , DATEU ,TIME , PREINP , READI , SETLCM ,
SETEOS ,NAMLST , ASSIGN , READR , LOAD , ISORT ,WLABI , WARRAY ,
RCNTL , NXTCMP , RDCOMP ,RDCOM3 , RDREST , ORDER , FBRCSS , SRTLP
,VMCELL , ASIGN , EOVLY , JUNSOL , VOLFA ,COMPI , IPROP , CHBSAV ,
SETBD , CHBSET ,WRLCM , CHKBD , ELGR , THERMO , FPROP ,MIXPRP ,
BDPLEN , MANAGE , LININT , ZPWHCI ,LCHVSS , LDCHAR , LCHPIP , TRSLBL ,
IDEL ,ICHL , JFIND.
CALLED BY
TRAC.
IOVLY
CALLED BY
CLEAN , DMPIT , EDIT , GRAF , INIT ,INPUT , OUT1D , OUT3D , OUTER , POST
,PREP , PREP1D , PREP3D , RDCOM3 , RDCOMP ,RDREST , TRIPS.
IPIPE
CALLED BY
ICOMP.
IPLEN
CALLED BY

ICOMP.

IPRIZR

CALLED BY

ICOMP.

IPROP

CALLED BY

IACCUM , INPUT , ISTGEN , ITEE , ITURB , IVLVE.

IPUMP

CALLED BY

ICOMP.

IROD

CALLED BY

CIHTST.

IRODL

CALLED BY

CIHTST.

ISORT

CALLED BY

INPUT.

ISTGEN

CALLS

JUNSOL , VOLFA , COMPI , IPROP , CHBSAV ,J1D , CHBSET , SETBD , ERROR , ESTGEN ,WRLCM , CHKBD , ELGR , JFIND.

CALLED BY

ICOMP.

ITEE

CALLS

COMPI , IPROP , JUNSOL , VOLFA , CHBSAV ,SETBD , CHBSET , ETEE , WRLCM , CHKBD ,ELGR , ERROR , JFIND.

CALLED BY

ICOMP.

ITURB

CALLS

TRBPOW , JUNSOL , VOLFA , COMPI , IPROP ,CHBSAV , SETBD , CHBSET , WRLCM , CHKBD ,ELGR , JFIND.

CALLED BY

ICOMP.

IVLVE

CALLS

JUNSOL , VOLFA , COMPI , IPROP , CHBSAV ,SETBD , CHBSET , ERROR , WRLCM , CHKBD ,ELGR , JFIND

CALLED BY

ICOMP.

IVSSL

CALLS

SETVA , MANAGE , WLEVEL , THERMO , FPROP ,INITBC , RDZMOM , IWALL3 , MIX3D , SCLMOM ,DVPSCL , SETBDT , J3D

CALLED BY

CIVSSL.

IWALL3

CALLS

SETVA , FWKF.

CALLED BY

IVSSL.

J1D

CALLED BY

ACCMBD , ACCUM1 , BREAK1 , BREAK2 , BREAK3 ,CONSTB , FILL1 , FILL2 ,

FILL3 , IBRK , IFILL , INNER , ISTGEN , SETBD , STGEN1 , STGEN2 , STGEN3 ,
STGNTX , TEE1X.

J3D

CALLS

MANAGE , OF1123 , SETBIT.

CALLED BY

IVSSL , POST3D , VSSL1 , VSSL2 , VSSL3.

JFIND

CALLS

ERROR.

CALLED BY

CIVSSL , IACCUM , IBRK , IFILL , INPUT , ISTGEN , ITEE , ITURB , IVLVE.

JUNSOL

CALLS

LDCHAR.

CALLED BY

IACCUM , INPUT , ISTGEN , ITEE , ITURB , IVLVE.

JVALUE

CALLS

IDIFF.

CALLED BY

PREINP , VALUE.

LABELP

CALLED BY

TRAC.

LCHPIP

CALLED BY

INPUT.

LCHVSS

CALLED BY

INPUT.

LCMTRN

CALLS

SETLCM , WRLCM , CLEAR.

CALLED BY

REHTST , REVSSL , RHTSTR , RVSSL.

LDCHAR

CALLED BY

BFALOC , CIVSSL , FLTOM , INPUT , JUNSOL , RACCUM , RBREAK , REACCM ,
REBRK , REFILL , REPIPE , REPLEN , REPRZR , REPUMP , RESTGN , RETEE ,
RETURB , REVLVE , REVSSL , RFILL , RPIPE , RPLEN , RPRIZR , RPUMP ,
RSTGEN , RTEE , RTURB , RVLVE , RVSSL , SRTLP.

LENTAB

CALLED BY

TRAC.

LEVEL

CALLED BY

FEMOM , OFFTKE.

LEVELI

CALLED BY

DLEVEL , GLEVEL , WLEVEL , WVSSL.

LEVELR

CALLED BY

ILEVEL , REVSSL , RLEVEL , RVSSL.

LININT

CALLED BY

BREAKX , CBSET , CDTHEX , DELAY , EVFXXX , EVLTAB , FILLX , INPUT , MZIRC

, PUMPD , PUMPX , RFILL , RPIPE , RPUMP , RROD2 , RTEE , RTURB , RVLVE , VSSL1.

LINT4D
CALLED BY
CBSET , RFDBK.

LOAD
CALLS
CLEAR , DCODF , ERROR.
CALLED BY
INPUT , RBREAK , RCNTL , RCOMP , RDCRVS , RFILL , RHTSTR , RPIPE , RPLEN , RPUMP , RROD2 , RSTGEN , RTEE , RTURB , RVLVE , RVSSL.

LOCPMP
CALLS
ERROR.
CALLED BY
SVSET1.

LOCTEE
CALLS
ERROR.
CALLED BY
SVSET.

LOCTRB
CALLS
ERROR.
CALLED BY
GRAF , ICOMP , IGRAF.

LOCVLV
CALLS
ERROR.
CALLED BY
ICOMP , SVSET1.

MANAGE
CALLS
ERROR.
CALLED BY
CORE1 , CORE3 , DROD1 , DVSSL , GRAF , HTSTR1 , HTSTR3 , HTSTRV , IGRAF , INPUT , IVSSL , J3D , POST3D , RFDBK , SVSET3 , SVSETH , VSSL1 , VSSL2 , VSSL3 , WHTSTR , WVSSL.

MATSOL
CALLS
BGLSDC , ERROR , BGLSSL , SGEFAV , SGESLV.
CALLED BY
OUT3D , POST3D , PREP3D , VSSL2.

MBN
CALLED BY
MFROD.

MFROD
CALLS
ERROR , MFUEL , MZIRC , MBN , MHTR , MSTRCT.
CALLED BY
CORE1.

MFUEL
CALLED BY
MFROD.

MGAP
CALLED BY
GAPHT.

- MHTR
  - CALLED BY
    - MFROD.
- MIX3D
  - CALLS
    - COPYA.
  - CALLED BY
    - IVSSL , VSSL3.
- MIXPRP
  - CALLED BY
    - BREAKX , FILLX , IBRK , IFILL , INPUT.
- MODIFY
- MPROP
  - CALLS
    - MSTRCT.
  - CALLED BY
    - PREPER , STGN1X.
- MSTRCT
  - CALLS
    - ERROR.
  - CALLED BY
    - MFROD , MPROP.
- MWRX
  - CALLED BY
    - FROD.
- MZIRC
  - CALLS
    - LININT.
  - CALLED BY
    - MFROD.
- NAMLST
  - CALLS
    - ERROR.
  - CALLED BY
    - INPUT.
- NEWDLT
  - CALLS
    - SEDIT.
  - CALLED BY
    - TIMSTP.
- STDIR
  - CALLED BY
    - VSSL2.
- NXTCMP
  - CALLS
    - ERROR.
  - CALLED BY
    - INPUT.
- OFFTKE
  - CALLS
    - LEVEL , ERROR.
  - CALLED BY
    - TEE3.
- ORDER
  - CALLED BY
    - INPUT.
- OUT1D

CALLS
IOVLY , RDLCM , SETLCM , CLEAR , PIPE2 ,PUMP2 , TEE2 , VLVE2 , BREAK2 , FILL2 ,PRIZR2 , CTAIN2 , STGEN2 , ACCUM2 , TURB2 ,PLEN2 , ERROR , WRLCM , EOVLY.
CALLED BY
OUTER.

OUT3D
CALLS
IOVLY , CLEAR , RDLCM , ERROR , RVSLCM ,VSSL2 , WRLCM , MATSOL , EOVLY.
CALLED BY
OUTER.

OUTER
CALLS
IOVLY , CLEAR , OUT1D , SGEFAV , SGESLV ,ERROR , OUT3D , EOVLY.
CALLED BY
HOUT.

PACKIT
CALLED BY
GLEVEL , GRAF , IGRAF.

PIPE1
CALLS
SAVBD , PREPER , PIPE1X , SETBD , EVFXXX ,BKMOM.
CALLED BY
PREP1D.

PIPE1X
CALLED BY
PIPE1.

PIPE2
CALLS
INNER.
CALLED BY
OUT1D.

PIPE3
CALLS
POSTER , SETBD , SAVBD , EVFXXX , EVALDF ,CONSTB.
CALLED BY
POST.

PIPROD
CALLS
RDLCM.
CALLED BY
FLTOM.

PLEN1
CALLS
CLEAR , BDPLEN.
CALLED BY
PREP1D.

PLEN2
CALLS
CLEAR , THERMO , HTIF , AUXPLN , TFPLN ,BDPLEN , TFPLBK.
CALLED BY
OUT1D.

PLEN3
CALLS
ASTPLN , STBMPL , BKSPLN , SETBIT , CLEAR ,THERMO , FPROP , BDPLEN , GETBIT.

CALLED BY
POST.

PNTROD
CALLS
CLEAR.
CALLED BY
REHTST , RHTSTR.

PNTVSS
CALLS
CLEAR.
CALLED BY
REVSSL , RVSSL.

POST
CALLS
IOVLY , TRBPST , CLEAR , RDLCM , SETLCM ,PIPE3 , PUMP3 , TEE3 , VLVE3 , BREAK3 ,FILL3 , PRIZR3 , CTAIN3 , STGEN3 , ACCUM3 ,TURB3 , PLEN3 , ERROR , WRLCM , SGEFAV ,SGESLV , POST3D , HTSTR3 , EOVLY.
CALLED BY
ERRTRP , HOUT , STEADY , TRANS.

POST3D
CALLS
CLEAR , RDLCM , RVSLCM , VSSL3 , ERROR ,WRLCM , MATSOL , MANAGE , J3D.
CALLED BY
POST.

POSTER
CALLS
OF1123 , THERMO , BKSSTB , ERROR , CYLHT ,SETBIT , FPROP , GETBIT.
CALLED BY
ACCUM3 , PIPE3 , PRIZR3 , PUMP3 , STGEN3 ,TEE3 , TURB3 , VLVE3.

PREFWD
CALLS
SETLCM , ERROR , TMPPTR , VFWALL3.
CALLED BY
VSSL1.

PREINP
CALLS
ERROR , VALUE , HUNTS , IDEL , ALLBLK ,INDEL , JVALUE.
CALLED BY
INPUT.

PREP
CALLS
IOVLY , TRIPS , PREP1D , HTSTR1 , PREP3D ,EOVLY.
CALLED BY
STEADY , TRANS.

PREP1D
CALLS
IOVLY , TRBPRE , CLEAR , RDLCM , SETLCM ,PIPE1 , PUMP1 , TEE1 VLVE1 , BREAK1 ,FILL1 , PRIZR1 , CTAIN1 , STGEN1 , ACCUM1 , TURB1 , PLEN1 , ERROR , WRLCM , SGEFAV ,SGESLV , EOVLY.
CALLED BY
PREP.

PREP3D
CALLS
IOVLY , CLEAR , RDLCM , RVSLCM , VSSL1 ,ERROR , WRLCM , MATSOL , EOVLY.
CALLED BY

PREP.
PREPER
CALLS
CLEAR , SETBIT , VOLV , FWALL , MPROP ,HTPIPE , FLUX , PUMPSR , FEMOM , GETBIT ,ICMPR.
CALLED BY
ACCUM1 , PIPE1 , PRIZR1 , PUMP1 , STGEN1 ,TEE1 , TURB1 , VLVE1.
PRIZR1
CALLS
SAVBD , PREPER , PRZR1X , SETBD , BKMOM.
CALLED BY
PREP1D.
PRIZR2
CALLS
INNER.
CALLED BY
OUT1D.
PRIZR3
CALLS
POSTER , SETBD , SAVBD , EVALDF , CONSTB.
CALLED BY
POST.
PRZR1X
CALLED BY
PRIZR1.
PSTEPQ
CALLS
EDIT , SEDIT , GRAF , DMPIT.
CALLED BY
STEADY , TRANS.
PTRSA
CALLED BY
CIVSSL.
PTRSPL
CALLS
SETLCM , ERROR.
CALLED BY
REPLEN , RPLEN.
PUMP1
CALLS
SAVBD , PREPER , SETBD , BKMOM.
CALLED BY
PREP1D.
PUMP2
CALLS
INNER.
CALLED BY
OUT1D.
PUMP3
CALLS
POSTER , SETBD , SAVBD , EVFXXX , EVALDF ,CONSTB.
CALLED BY
POST.
PUMPD
CALLS
GETCRV , ERROR , LININT.
CALLED BY

PUMPX.
PUMPI
CALLED BY
RDCRVS.
PUMPSR
CALLS
TRIP , EVLTAB , ERROR , PUMPX , SHIFTB.
CALLED BY
PREPER.
PUMPX
CALLS
LININT , WARRAY , PUMPD.
CALLED BY
PUMPSR.
RACCUM
CALLS
ERROR , CLEAR , READI , LDCHAR , S1DPTR ,SCMLCM , RCOMP.
CALLED BY
RDCOMP.
RBREAK
CALLS
ERROR , CLEAR , READI , READR , LDCHAR ,S1DPTR , SETLCM , LOAD ,
WARRAY , SCLTBL ,WRLCM , SATTMP.
CALLED BY
RDCOMP.
RCNTL
CALLS
CLEAR , LOAD , READI , READR , CBEDIT ,WLABR , ERROR , SETLCM.
CALLED BY
INPUT.
RCOMP
CALLS
LOAD , WARRAY , ERROR , WIARR , SETBIT ,CLEAR.
CALLED BY
RACCUM , RPIPE , RPRIZR , RPUMP , RSTGEN ,RTEE , RTURB , RVLVE.
RDCOM3
CALLS
IOVLY , RVSSL , EOVLY.
CALLED BY
INPUT.
RDCOMP
CALLS
IOVLY , RPIPE , RPUMP , RTEE , RVLVE ,RBREAK , RFILL , RPRIZR , RSTGEN ,
RACCUM ,RTURB , RPLEN , RHTSTR , ERROR , WRLCM ,EOVLY.
CALLED BY
INPUT.
RDCRDS
CALLS
ERROR.
CALLED BY
STEADY.
RDCRVS
CALLS
LOAD , WARRAY , PUMPI.
CALLED BY
RPUMP.
RDDIM

```
        CALLS
              CLEAR  , READI  , WIARR  , ERROR.
        CALLED BY
              RPUMP.
RDLCM
        CALLED BY
              BFIN   , CIHTST , DBRK   , DCOMP  , DFILL  ,DHTSTR , DMPIT  , DPLEN  , GRAF   ,
              HTSTR1 ,HTSTR3 , HTSTRV , ICOMP  , IGRAF  , OUT1D  ,OUT3D  , PIPROD , POST
              , POST3D , PREP1D ,PREP3D , RRDLCM , RVSLCM , SVSET  , SVSETH ,TRBPRE ,
              TRBPST , VLVEX  , WCOMP  , WHTSTR.
RDREST
        CALLS
              IOVLY  , SETLCM , FEXIST , ERROR  , BFALOC ,BFIN   , RECNTL , EOVLY  , REPIPE
              , REPUMP ,RETEE  , REVLVE , REBRK  , REFILL , REPRZR ,RESTGN , REACCM ,
              RETURB , REPLEN , REHTST ,REVSSL.
        CALLED BY
              INPUT.
RDZMOM
        CALLS
              SETVA.
        CALLED BY
              IVSSL.
REACCM
        CALLS
              BFIN   , LDCHAR , S1DPTR , ERROR  , SCMLCM ,RECOMP , WRCOMP.
        CALLED BY
              RDREST.
READI
        CALLS
              ERROR.
        CALLED BY
              INPUT  , RACCUM , RBREAK , RCNTL  , RDDIM  ,RFILL  , RHTSTR , RPIPE  , RPLEN
              , RPRIZR ,RPUMP  , RROD1  , RSTGEN , RTEE   , RTURB  ,RVLVE  , RVSSL.
READR
        CALLS
              ERROR.
        CALLED BY
              INPUT  , RBREAK , RCNTL  , RFILL  , RHTSTR ,RPIPE  , RPRIZR , RPUMP  , RROD1
              , RSTGEN ,RTEE   , RTURB  , RVLVE  , RVSSL  , TIMSTP.
REBRK
        CALLS
              BFIN   , LDCHAR , S1DPTR , SETLCM , ERROR  ,WARRAY , WRLCM.
        CALLED BY
              RDREST.
RECNTL
        CALLS
              ERROR  , CBEDIT.
        CALLED BY
              RDREST.
RECOMP
        CALLS
              BFIN.
        CALLED BY
              REACCM , REPIPE , REPRZR , REPUMP , RESTGN ,RETEE  , RETURB , REVLVE.
REFILL
        CALLS
              BFIN   , LDCHAR , S1DPTR , SETLCM , ERROR  ,WARRAY , WRLCM.
```

CALLED BY
RDREST.
REHTST
CALLS
BFIN , PNTROD , ERROR , LCMTRN , REROD1.
CALLED BY
RDREST.
REPIPE
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WRCOMP , WARRAY.
CALLED BY
RDREST.
REPLEN
CALLS
BFIN , PTRSPL , ERROR , SCMLCM , WARRAY ,LDCHAR.
CALLED BY
RDREST.
REPRZR
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WRCOMP.
CALLED BY
RDREST.
REPUMP
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WARRAY , WRCOMP.
CALLED BY
RDREST.
REROD1
CALLS
BFIN , WIARR , WARRAY , CLEAR.
CALLED BY
REHTST.
RESTGN
CALLS
BFIN , LDCHAR , S1DPTR , SCMLCM , RECOMP ,WIARR , WARRAY , WRCOMP.
CALLED BY
RDREST.
RETEE
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WRCOMP , WARRAY.
CALLED BY
RDREST.
RETURB
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WIARR , WARRAY ,
WRCOMP , WRLCM.
CALLED BY
RDREST.
REVLVE
CALLS
BFIN , LDCHAR , S1DPTR , ERROR , SCMLCM ,RECOMP , WRCOMP , WARRAY.
CALLED BY
RDREST.
REVSSL
CALLS
BFIN , ERROR , PNTVSS , LCMTRN , WARRAY ,WIARR , LDCHAR , WRLCM ,
CLEAR , LEVELR.

```
        CALLED BY
              RDREST.
RFDBK
        CALLS
              MANAGE , ERROR  , LINT4D.
        CALLED BY
              CORE1.
RFILL
        CALLS
              ERROR  , CLEAR  , READI  , READR  , LDCHAR ,S1DPTR , SETLCM , LOAD   ,
              WARRAY , SCLTBL ,LININT  , WRLCM.
        CALLED BY
              RDCOMP.
RHOLIQ
        CALLED BY
              THERMO.
RHTSTR
        CALLS
              ERROR  , CLEAR  , READI  , READR  , RROD1  ,PNTROD , LCMTRN , LOAD   ,
              WIARR  , WARRAY ,WLABR   , RROD2  , WRLCM.
        CALLED BY
              RDCOMP.
RING0
RKIN
        CALLS
              EVFXXX , TRIP   , ERROR.
        CALLED BY
              CORE1.
RLEVEL
        CALLS
              WARRAY , LEVELR.
        CALLED BY
              RVSSL.
RODHT
        CALLS
              TRISLV , BANSOL , ERROR.
        CALLED BY
              FROD.
RPIPE
        CALLS
              ERROR  , CLEAR  , READI  , READR  , LDCHAR ,S1DPTR , SCMLCM , RCOMP  ,
              LOAD   , WARRAY ,SCLTBL  , LININT , WRLCM.
        CALLED BY
              RDCOMP.
RPLEN
        CALLS
              ERROR  , CLEAR  , READI  , PTRSPL , SCMLCM ,LOAD   , WLABI  , WARRAY ,
              LDCHAR.
        CALLED BY
              RDCOMP.
RPRIZR
        CALLS
              ERROR  , CLEAR  , READI  , READR  , LDCHAR ,S1DPTR , SCMLCM , RCOMP.
        CALLED BY
              RDCOMP.
RPUMP
        CALLS
```

ERROR , CLEAR , READI , READR , LDCHAR ,RDDIM , S1DPTR , SCMLCM ,
RDCRVS , RCOMP ,LOAD , WARRAY , SCLTBL , LININT , THERMO.
CALLED BY
RDCOMP.
RRDLCM
CALLS
RHVGET , RDLCM.
CALLED BY
CIHTST , DHTSTR , GRAF , HTSTR1 , HTSTR3 ,SVSETH , WHTSTR.
RHVGET
CALLED BY
GRAF , RRDLCM.
RROD1
CALLS
READI , READR , ERROR.
CALLED BY
RHTSTR.
RROD2
CALLS
LOAD , WARRAY , CLEAR , WLABR , ERROR ,SCLTBL , LININT , DECAYS.
CALLED BY
RHTSTR.
RSTGEN
CALLS
ERROR , CLEAR , READI , READR , LDCHAR ,S1DPTR , SCMLCM , RCOMP ,
WRLCM , LOAD ,WLABI , WIARR , WARRAY.
CALLED BY
RDCOMP.
RTEE
CALLS
ERROR , CLEAR , READI , READR , LDCHAR ,S1DPTR , SCMLCM , RCOMP ,
LOAD , WARRAY ,SCLTBL , LININT , WRLCM.
CALLED BY
RDCOMP.
RTURB
CALLS
ERROR , CLEAR , READI , READR , LDCHAR ,S1DPTR , SCMLCM . LOAD ,
WIARR , WARRAY ,SCLTBL , LININT , WRLCM , RCOMP.
CALLED BY
RDCOMP.
RVLVE
CALLS
ERROR , CLEAR , READI , READR , FAXPOS ,LDCHAR , S1DPTR , SCMLCM ,
RCOMP , LOAD ,WARRAY , LININT , SCLTBL , THERMO.
CALLED BY
RDCOMP.
RVSLCM
CALLS
RVVGET , RDLCM.
CALLED BY
CIVSSL , CWVSSL , DVSSL , GRAF , HTSTRV ,IGRAF , OUT3D , POST3D ,
PREP3D , SVSET3.
RVVGET
CALLED BY
IGRAF , RVSLCM.
RVSSL
CALLS

ERROR , CLEAR , READI , READR , PNTVSS ,LCMTRN , LOAD , WARRAY ,
WIARR , LDCHAR ,CHKSR , WRLCM , RLEVEL , ILEVEL , LEVELR ,VDPCSS.

CALLED BY

RDCOM3.

S1DPTR

CALLS

CLEAR.

CALLED BY

RACCUM , RBREAK , REACCM , REBRK , REFILL ,REPIPE , REPRZR , REPUMP ,
RESTGN , RETEE ,RETURB , REVLVE , RFILL , RPIPE , RPRIZR ,RPUMP ,
RSTGEN , RTEE , RTURB , RVLVE.

SATDER

CALLS

HEV.

CALLED BY

TF1DS , TF3DS , TFPLN , THERMO.

SATPRS

CALLED BY

CHEN , CHF , CHOKE , HTIF , SATTMP ,SOUND , TF1DS , TF1DS3 , TF3DS ,
TF3DS3 ,TFPLBK , TFPLN , THERMO.

SATTMP

CALLS

HEV , SATPRS.

CALLED BY

BREAKX , FEMOMX , FEMOMY , FEMOMZ , GVSSL2 ,RBREAK , SOUND , TF1DS3 ,
TF3DS1 , TF3DS3 ,TFPLBK , THERMO , TRBPOW.

SAVBD

CALLS

ICMPR.

CALLED BY

ACCUM1 , ACCUM3 , PIPE1 , PIPE3 , PRIZR1 ,PRIZR3 , PUMP1 , PUMP3 ,
STGEN1 , STGEN3 ,T[illegible] , TEE3 , TURB1 , TURB3 , VLVE1 ,VLVE3.

SCLMOM

CALLS

ERROR.

CALLED BY

IVSSL.

SCLTBL

CALLS

WARRAY.

CALLED BY

RBREAK , RFILL , RPIPE , RPUMP , RROD2 ,RTEE , RTURB , RVLVE.

SCMLCM

CALLS

SETLCM , WRLCM , CLEAR.

CALLED BY

[illegible]ACCUM , [illegible]EACCM , REPIPE , REPLEN , REPRZR ,REPUMP , RESTGN , RETEE ,
[illegible]TURB , REVLVE ,RPIPE , RPLEN , RPRIZR , RPUMP , RSTGEN ,RTEE ,
[illegible]URB , RVLVE.

SED[illegible]

[illegible]

CLEAR , QTIME.

CALLED BY

EDIT , NEWDLT , PSTEPQ.

SEPDI

CALLED BY

TEE[illegible]

SEPDX
CALLS
SSEPOR.
CALLED BY
TEE1.
SETBD
CALLS
J1D , ICMPR
CALLED BY
INPUT , ISTGEN , ITEE , ITURB , IVLVE , PIPE1 , PIPE3 , PRIZR1 , PRIZR3 , PUMP1 , PUMP3 , STGEN1 , STGEN3 , TEE1 , TEE3 , TURB1 , TURB3 , VLVE1 , VLVE3.
SETBDT
CALLED BY
IVSSL , VSSL1 , VSSL2.
SETEOS
CALLS
HEV.
CALLED BY
INPUT.
SETIC
SETLCM
CALLS
MEMADJ , ERROR.
CALLED BY
TRAC , GRAF , GRFPUT , ICOMP , IGRAF , INPUT , LCMTRN , OUT1D , POST , PREFWD , PREP1D , PTRSPL , RBREAK , RCNTL , RDREST , REBRK , REFILL , RFILL , SCMLCM.
SETNET
CALLED BY
ICOMP.
SETVA
CALLED BY
DVPSCL , HTSTRV , IFSET , INITBC , IVSSL , IWALL3 , RDZMOM , VSSL1.
SFA44
CALLED BY
TF1DS , TFPLN.
SFA55
CALLED BY
BKSPLN , BKSSTB , BKSTB3 , TF1DS , TF3DS , TFPLN.
SGBFA
CALLS
SSCAL , SAXPY.
SGBSL
CALLS
SAXPY.
SGEFA
CALLED BY
CHOKE.
SGESL
CALLED BY
CHOKE.
SHIFTB
CALLED BY
BREAK1 , BREAKX , FILLX , PUMPSR , VLVEX.
SHRINK
CALLED BY

SEPDX
CALLS
SSEPOR.
CALLED BY
TEE.
SETBD
CALLS
J1D , ICMPR
CALLED BY
INPUT , ISTGEN , ITEE , ITURB , IVLVE , PIPE1 , PIPE3 , PRIZR1 , PRIZR3 , PUMP1 , PUMP3 , STGEN1 , STGEN3 , TEE1 , TEE3 , TURB1 , TURB3 , VLVE1 , VLVE3.
SETBDT
CALLED BY
IVSSL , VSSL1 , VSSL2.
SETEOS
CALLS
HEV.
CALLED BY
INPUT.
SETIC
SETLCM
CALLS
MEMADJ , ERROR.
CALLED BY
TRAC , GRAF , GRFPUT , ICOMP , IGRAF , INPUT , LCMTRN , OUT1D , POST , PREFWD , PREP1D , PTRSPL , RBREAK , RCNTL , RDREST , REBRK , REFILL , RFILL , SCMLCM.
SETNET
CALLED BY
ICOMP.
SETVA
CALLED BY
DVPSCL , HTSTRV , IFSET , INITBC , IVSSL , IWALL3 , RDZMOM , VSSL1.
SFA44
CALLED BY
TF1DS , TFPLN.
SFA55
CALLED BY
BKSPLN , BKSSTB , BKSTB3 , TF1DS , TF3DS , TFPLN.
SGBFA
CALLS
SSCAL , SAXPY.
SGBSL
CALLS
SAXPY.
SGEFA
CALLED BY
CHOKE.
SGESL
CALLED BY
CHOKE.
SHIFTB
CALLED BY
BREAK1 , BREAKX , FILLX , PUMPSR , VLVEX.
SHRINK
CALLED BY

```
                CORE1.
SIGMA
        CALLED BY
                FPROP.
SMOVE
        CALLED BY
                SMOVEN.
SMOVEN
        CALLS
                SMOVE.
SOUND
        CALLS
                THERMO  , ERROR   , SATPRS  , SATTMP.
        CALLED BY
                CHOKE.
SPLIT
        CALLED BY
                GETCRV.
SRTLP
        CALLS
                CLEAR   , LDCHAR  , ERROR   , EXIT.
        CALLED BY
                INPUT.
SSEPOR
        CALLED BY
                SEPDX.
SSL44
        CALLED BY
                TF1DS   , TFPLN.
SSL55
        CALLED BY
                BKSPLN  , BKSSTB  , BKSTB3  , TF1DS   , TF3DS   ,TFPLN.
STBME
        CALLS
                GETBIT.
        CALLED BY
                CONSTB.
STBME3
        CALLED BY
                VSSL3.
STBMPL
        CALLED BY
                PLEN3.
STEADY
        CALLS
                TIMCHK  , TIMSTP  , PREP    , ERROR   , EDIT    ,GRAF    , HOUT    , POST    , PSTEPQ  ,
                RDCRDS  ,CLEAN    , EXIT.
        CALLED BY
                TRAC.
STGABD
        CALLED BY
                STGN1X.
STGEN1
        CALLS
                CLEAR   , SAVBD   , STGNTX  , PREPER  , J1D     ,SGEFAV  , SGESLV  , TRANSF  ,
                STGN1X  , SETBD   ,BKMOM    , ESTGEN.
        CALLED BY
```

PREP1D.
STGEN2
CALLS
TRANSF , CLEAR , STGNTX , INNER , J1D , SGEFAV , SGESLV.
CALLED BY
OUT1D.
STGEN3
CALLS
POSTER , SETBD , TRANSF , SAVBD , ESTGEN , STGN3X , J1D , EVALDF ,
CLEAR , CONSTB , SGEFAV , SGESLV.
CALLED BY
POST.
STGN1X
CALLS
MPROP , STGABD , HTC(.
CALLED BY
STGEN1.
STGN3X
CALLS
ERROR , CYLHT.
CALLED BY
STGEN3.
STGNTX
CALLS
J1D.
CALLED BY
STGEN1 , STGEN2.
SVSET
CALLS
RDLCM , SVSET1 , SVSET3 , SVSETH , ERROR , LOCTEE.
CALLED BY
TRIPS.
SVSET1
CALLS
ERROR , LOCPMP , LOCVLV.
CALLED BY
SVSET.
SVSET3
CALLS
RVSLCM , ERROR , MANAGE.
CALLED BY
SVSET.
SVSETH
CALLS
RDLCM , RRDLCM , ERROR , MANAGE.
CALLED BY
SVSET.
SWITCH
CALLS
MOVLEV.
TEE1
CALLS
SAVBD , TEE1X , PREPER , SEPDX , ERROR , SETBD , BKMOM , ETEE.
CALLED BY
PREP1D.
TEE1X
CALLS

J1D , EVFXXX.
CALLED BY
TEE1 , TEE2.
TEE2
CALLS
TEE1X , SEPLI , INNER.
CALLED BY
OUT1D.
TEE3
CALLS
POSTER , SETBD , SAVBD , EVFXXX , OFFTKE ,EVALDF , ETEE , CONSTB ,
GETBIT.
CALLED BY
POST.
TF1D
CALLS
THERMO , CELLAV , HTIF , TF1DS1 , TF1DS ,TF1DS3.
CALLED BY
INNER.
TF1DS
CALLS
SETBIT , OFFBIT , SFA44 , SFA55 , SSL44 ,SSL55 , GETBIT , SATPRS , SATDER.
CALLED BY
TF1D.
TF1DS1
CALLS
SETBIT , CHOKE , GETBIT.
CALLED BY
TF1D.
TF1DS3
CALLS
SETBIT , OFFBIT , THERMO , GETBIT , SATPRS ,SATTMP.
CALLED BY
TF1D.
TF3DS
CALLS
THERMO , SFA55 , SSL55 , GETBIT , SATPRS ,SATDER.
CALLED BY
VSSL2.
TF3DS1
CALLS
VELBC , ZEROV , GETBIT , SATTMP.
CALLED BY
VSSL2.
TF3DS3
CALLS
THERMO , SATPRS , SATTMP.
CALLED BY
VSSL2.
TFPLBK
CALLS
SETBIT , THERMO , GETBIT . SATPRS , SATTMP.
CALLED BY
PLEN2.
TFPLN
CALLS
SETBIT , OFFBIT , SFA44 , SSL44 SFA55 ,SSL55 , GETBIT , SATPRS , SATDER.

CALLED BY
PLEN2.
THCL
CALLED BY
FPROP.
THCV
CALLED BY
FPROP , HTCOR , HTVSSL , HVWE[illegible]3.
THERMO
CALLS
ERROR , RHOLIQ , SATTMP , SATDER , SATPRS ,HEV.
CALLED BY
BREAK3 , BREAKX , CHOKE , FILLX , IBRK ,IFILL , INPUT , IVSSL , PLEN2 ,
PLEN3 ,POSTER , RPUMP , RVLVE , SOUND , TF1D ,TF1DS3 , TF3DS , TF3DS3
, TFPLBK , VSSL2 ,VSSL3.
TIMCHK
CALLS
SSWTCH , SYCALL , ERROR , QTIME , EDIT ,
DMPIT.
CALLED BY
STEADY , TRANS.
TIMSTP
CALLS
ERROR , READR , TRIP , NEWDLT.
CALLED BY
STEADY , TRANS.
TIMUPD
CALLED BY
VSSL1.
TMPPTR
CALLED BY
PREFWD.
TMSFB
CALLED BY
HTCOR.
TRANS
CALLS
TIMCHK , TIMSTP , PREP , ERROR , EDIT ,GRAF , HOUT , POST , PSTEPQ ,
DMPIT.
CALLED BY
TRAC.
TRANSF
CALLED BY
STGEN1 , STGEN2 , STGEN3.
TRBPOW
CALLS
SATTMP.
CALLED BY
ITURB , TURB1.
TRBPRE
CALLS
RDLCM , TRIP , EVLTAB.
CALLED BY
PREP1D.
TRBPST
CALLS
RDLCM.

CALLED BY
POST.

TRIP
CALLS
ERROR.
CALLED BY
BREAKX , CORE1 , EVFXXX , FILLX , PUMPSR ,RKIN , TIMSTP , TRBPRE , VLVEX , WPUMP.

TRIPS
CALLS
IOVLY , SVSET , CBSET , TRPSET , EOVLY.
CALLED BY
PREP.

TRISLV
CALLED BY
RODHT.

TRPSET
CALLS
ERROR.
CALLED BY
TRIPS.

TURB1
CALLS
SAVBD , PREPER , SETBD , TRBPOW , EVFXXX ,BKMOM.
CALLED BY
PREP1D.

TURB2
CALLS
INNER.
CALLED BY
OUT1D.

TURB3
CALLS
POSTER , SETBD , SAVBD , EVALDF , CONSTB.
CALLED BY
POST.

UNPKIT

VALUE
CALLS
JVALUE.
CALLED BY
PREINP.

VDPCSS
CALLED BY
RVSSL.

VELBC
CALLED BY
TF3DS1.

[illegible]3
[illegible]LLS
WDRAG.
CALLED BY
PREFWD.

VISCL
CALLED BY
FPROP.

[illegible]

CALLED BY
FPROP , HTCOR , HTVSSL , HVWEBB.
VLVE1
CALLS
VLVEX , SAVBD , PREPER , SETBD , BKMOM.
CALLED BY
PREP1D.
VLVE2
CALLS
INNER.
CALLED BY
OUT1D.
VLVE3
CALLS
POSTER , SETBD , SAVBD , EVFXXX , EVALDF ,CONSTB.
CALLED BY
POST.
VLVEX
CALLS
TRIP , FAXPOS , SHIFTB , EVLTAB , RDLCM ,ERROR.
CALLED BY
VLVE1.
VMCELL
CALLED BY
INPUT.
VOLFA
CALLED BY
IACCUM , INPUT , ISTGEN , ITEE , ITURB ,IVLVE.
VOLV
CALLED BY
PREPER.
VRBD
CALLED BY
VSSL1.
VSSL1
CALLS
MANAGE , TIMUPD , DVPSCL , VRBD , IFSET ,SETVA , LININT , ERROR ,
SETBDT , CIF3 ,PREFWD , FEMOMX , FEMOMY , FEMOMZ , J3D.
CALLED BY
PREP3D.
VSSL2
CALLS
MANAGE , BAKUP , THERMO , TF3DS1 , CELLA3 ,HTIF , SETBDT , FLUXES ,
TF3DS , STDIR ,ERROR , MATSOL , BACIT , TF3DS3 , VSSSSR ,J3D.
CALLED BY
OUT3D.
VSSL3
CALLS
MANAGE , BAKUP , THERMO , FPROP , STBME3 ,BKSTB3 , MIX3D , FF3D ,
EVALDF , GVSSL2 ,J3D.
CALLED BY
POST3.
VSSROD
CALLED BY
FLTOM.
VSSSSR
CALLED BY

VSSL2.
WACCUM
CALLS
ECOMP.
CALLED BY
WCOMP.
WARRAY
CALLS
WLABR.
CALLED BY
ECOMP , ELGR , INPUT , PUMPX , RBREAK ,RCOMP , RDCRVS , REBRK ,
REFILL , REPIPE ,REPLEN , REPUMP , REROD1 , RESTGN , RETEE ,RETURB ,
REVLVE , REVSSL , RFILL , RHTSTR ,RLEVEL , RPIPE , RPLEN , RPUMP ,
RROD2 ,RSTGEN , RTEE , RTURB , RVLVE , RVSSL ,SCLTBL , WLEVEL ,
WRCOMP , WVSSL.
WBREAK
CALLS
ECOMP.
CALLED BY
WCOMP.
WCOMP
CALLS
RDLCM , WRLCM , WPIPE , WTEE , WPUMP ,WFILL , WPRIZR , WSTGEN ,
CWVSSL , WACCUM ,WTURB , WVLVE , WBREAK , WPLEN , WHTSTR.
CALLED BY
EDIT.
WDRAG
CALLED BY
VFWALL3.
WFILL
CALLS
ECOMP.
CALLED BY
WCOMP.
WHTSTR
CALLS
RDLCM , RRDLCM , WRLCM , MANAGE.
CALLED BY
WCOMP.
WIARR
CALLS
WLABI.
CALLED BY
ILEVEL , RCOMP , RDDIM , REROD1 , RESTGN ,RETURB , REVSSL , RHTSTR ,
RSTGEN , RTURB ,RVSSL , WRCOMP.
WLABI
CALLED BY
INPUT , RPLEN , RSTGEN , WIARR.
WLABR
CALLED BY
RCNTL , RHTSTR , RROD2 , WARRAY.
WLEVEL
CALLS
LEVELI , WARRAY.
CALLED BY
IVSSL , WVSSL.
WPIPE

```
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WPLEN
        CALLED BY
                WCOMP.
WPRIZR
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WPUMP
        CALLS
                TRIP   , ECOMP.
        CALLED BY
                WCOMP.
WRCOMP
        CALLS
                WARRAY , WIARR.
        CALLED BY
                REACCM , REPIPE , REPRZR , REPUMP , RESTGN ,RETEE  , RETURB , REVLVE.
WRLCM
        CALLED BY
                BFOUT  , CIHTST , CIVSSL , HTSTR1 , HTSTR3 ,IACCUM , IBRK   , ICOMP  , IFILL  ,
                INPUT  ,ISTGEN , ITEE   , ITURB  , IVLVE  , LCMTRN ,OUT1D  , OUT3D  , POST   ,
                POST3D , PREP1D ,PREP3D , RBREAK , RDCOMP , REBRK  , REFILL ,RETURB ,
                REVSSL  RFILL  , RHTSTR , RPIPE  ,RSTGEN , RTEE   , RTURB  , RVSSL  ,
                SCMLCM ,WCOMP  , WHTSTR.
WSTGEN
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WTEE
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WTURB
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WVLVE
        CALLS
                ECOMP.
        CALLED BY
                WCOMP.
WVSSL
        CALLS
                MANAGE , WLEVEL , LEVELI , CLEAR  , WARRAY.
        CALLED BY
                CWVSSL.
ZCORE
        CALLED BY
                CORE1.
```

ZEROV
CALLED BY
TF3DS1.
ZPWHCI
CALLED BY
CORE1 , INPUT.

LIBRARY SUBROUTINES

PRODCTN
CALLED BY
TRAC.
GETUFL
CALLED BY
TRAC.
SAMPLE
CALLED BY
TRAC.
SAMPON
CALLED BY
TRAC.
GETJTL
CALLED BY
TRAC.
LOADTIM
CALLED BY
TRAC.
QTIME
CALLED BY
TRAC , DMPIT , ERROR , GRAF , HOUT ,SEDIT , TIMCHK.
SAMPTRM
CALLED BY
TRAC.
EXIT
CALLED BY
TRAC , ERRTRP , SRTLP , STEADY.
SGEDI
CALLED BY
CHOKE.
SGEEV
CALLED BY
CHOKE.
COMPACT
CALLED BY
CLEAN , ENDDMP , ENDGRF.
DATE
CALLED BY
DATEU.
DSCAL
CALLED BY
DGBFA.
DAXPY
CALLED BY
DGBFA , DGBSL.
QXIT
CALLED BY
ERRGET , ERRTRP.

QADJUST
        CALLED BY
                ERROR.
FEXIST
        CALLED BY
                INPUT , RDREST.
TIME
        CALLED BY
                INPUT.
ASSIGN
        CALLED BY
                INPUT.
TRSLBL
        CALLED BY
                INPUT.
BGLSDC
        CALLED BY
                MATSOL.
BGLSSL
        CALLED BY
                MATSOL.
SGEFAV
        CALLED BY
                MATSOL , OUTER , POST , PREP1D , STGEN1 ,STGEN2 , STGEN3.
SGESLV
        CALLED BY
                MATSOL , OUTER , POST , PREP1D , STGEN1 ,STGEN2 , STGEN3.
MEMADJ
        CALLED BY
                SETLCM.
SSCAL
        CALLED BY
                SGBFA.
SAXPY
        CALLED BY
                SGBFA , SGBSL.
MOVLEV
        CALLED BY
                SWITCH.
SSWTCH
        CALLED BY
                TIMCHK.
SYCALL
        CALLED BY
                TIMCHK.

APPENDIX C

COMPONENT DATA TABLES

C.1. POINTER TABLES

The pointer tables for one-dimensional components (described below) use four general sets of pointers: DUALPT, HYDROPT, INTPT, and HEATPT.

C.1.1. DUALPT

These pointers refer to variables whose values are stored for both old- and new-time values.

Name	Array	Dimension	Description
LALP	ALP	NCELLS	Old vapor fraction.
LALPD	ALPD	0	Variable not currently implemented.
LALPDN	ALPDN	0	Variable not currently implemented.
LALPN	ALPN	NCELLS	New vapor fraction.
LALV	ALV	NCELLS	Old value of flashing interfacial HTC times interfacial area.
LALVE	ALVE	NCELLS	Old value of liquid-side interfacial HTC times interfacial area.
LALVEN	ALVEN	NCELLS	New value of liquid-side interfacial HTC times interfacial area.
LALVN	ALVN	NCELLS	New value of flashing interfacial HTC times interfacial area.
LARA	ARA	NCELLS	Old stabilizer value for $\alpha\rho_a$.
LARAN	ARAN	NCELLS	New stabilizer value for $\alpha\rho_a$.
LAREL	AREL	NCELLS	Old stabilizer value for $(1-\alpha)\rho_\ell e_\ell$.
LARELN	ARELN	NCELLS	New stabilizer value for $(1-\alpha)\rho_\ell e_\ell$.
LAREV	AREV	NCELLS	Old stabilizer value for $\alpha\rho_v e_v$.
LAREVN	AREVN	NCELLS	New stabilizer value for $\alpha\rho_v e_v$.
LARL	ARL	NCELLS	Old stabilizer value for $(1-\alpha)\rho_\ell$.
LARLN	ARLN	NCELLS	New stabilizer value for $(1 - \alpha)\rho_\ell$.
LARV	ARV	NCELLS	Old stabilizer value for $\alpha\rho_v$.
LARVN	ARVN	NCELLS	New stabilizer value for $\alpha\rho_v$.
LBIT	BIT	NCELLS+1	Bit flags from previous time step.
LBITN	BITN	NCELLS+1	Bit flags for current time step.

LCHTI	CHTI	NCELLS	Old value of vapor-side interfacial HTC times interfacial area.
LCHTIA	CHTIA	NCELLS	Old value of air interfacial HTC times interfacial area.
LCHTAN	CHTAN	NCELLS	New value of air interfacial HTC times interfacial area.
LCHTIN	CHTIN	NCELLS	New value of vapor-side interfacial HTC times interfacial area.
LCIF	CIF	NCELLS+1	Old interfacial drag coefficients.
LCIFN	CIFN	NCELLS+1	New interfacial drag coefficients.
LCONC	CONC	NCELLS* ISOLUT	Old solute mass to coolant mass ratio. ISOLUT = 0 or 1.
LCONCN	CONC	NCELLS* ISOLUT	New solute mass to coolant mass ratio. ISOLUT = 0 or 1.
LD(3)	D	NCELLS	Variable not currently implemented.
LDN(3)	DN	NCELLS	Variable not currently implemented.
LEA	EA	NCELLS	Old air internal energy.
LEAN	EAN	NCELLS	New air internal energy.
LEL	EL	NCELLS	Old liquid internal energy.
LELN	ELN	NCELLS	New liquid internal energy.
LEV	EV	NCELLS	Old vapor internal energy.
LEVN	EVN	NCELLS	New vapor internal energy.
LGAM	GAM	NCELLS	Old vapor generation rate per unit volume.
LGAMN	GAMN	NCELLS	New vapor generation rate per unit volume.
LHIG	HIG	NCELLS	New HTC between inside wall and air.
LHIGO	HIGO	NCELLS	Old HTC between inside wall and air.
LHIL	HIL	NCELLS	New HTC between inside wall and liquid.
LHILO	HILO	NCELLS	Old HTC between inside wall and liquid.
LHIV	HIV	NCELLS	New HTC between inside wall and vapor.
LHIVO	HIVO	NCELLS	Old HTC between inside wall and vapor.
LP	P	NCELLS	Old pressure.
LPA	PA	NCELLS	Old air partial pressure.

LPAN	PAN	NCELLS	New air partial pressure.
LPN	PN	NCELLS	New pressure.
LQPPC	QPPC	NCELLS	New critical heat flux (CHF).
LQPPCO	QPPCO	NCELLS	Old CHF.
LROA	ROA	NCELLS	Old air density.
LROAN	ROAN	NCELLS	New air density.
LROL	ROL	NCELLS	Old liquid density.
LROLN	ROLN	NCELLS	New liquid density.
LROV	ROV	NCELLS	Old vapor density.
LROVN	ROVN	NCELLS	New vapor density.
LS	S	NCELLS* ISOLUT	Old solute mass plated on structure surface. ISOLUT = 0 or 1.
LSN	SN	NCELLS* ISOLUT	New solute mass plated on structure surface. ISOLUT = 0 or 1.
LTD	TD	0	Variable not currently implemented.
LTDN	TDN	0	Variable not currently implemented.
LTL	TL	NCELLS	Old liquid temperature.
LTLN	TLN	NCELLS	New liquid temperature.
LTV	TV	NCELLS	Old vapor temperature.
LTVN	TVN	NCELLS	New vapor temperature.
LTW	TW	NCELLS* NODES	Old wall temperatures.
LTWN	TWN	NCELLS* NODES	New wall temperatures.
LVL	VL	NCELLS+1	Old liquid velocity.
LVLN	VLN	NCELLS+1	New liquid velocity.
LVLT	VLT	NCELLS+1	New stabilizer liquid velocity ($\tilde{V}_\ell^{n+1}$).
LVLTO	VLTO	NCELLS+1	Old stabilizer liquid velocity ($\tilde{V}_\ell^{n}$).
LVM	VM	NCELLS+1	Old mixture velocity.
LVMN	VMN	NCELLS+1	New mixture velocity.
LVV	VV	NCELLS+1	Old vapor velocity.
LVVN	VVN	NCELLS+1	New vapor velocity.

LVVT	VVT	NCELLS+1	New stabilizer vapor velocity ($\tilde{V}_g^{n+1}$).
LVVTO	VVTO	NCELLS+1	Old stabilizer vapor velocity ($\tilde{V}_g^{n}$).

C.1.2. HYDROPT

These pointers refer to variables associated with the hydrodynamic calculations.

Name	Array	Dimension	Description
LALPMN	ALPMN	NCELLS	Minimum value of void fraction among a cell and all its neighbors.
LALPMX	ALPMX	NCELLS	Maximum value of void fraction among a cell and all its neighbors.
LALPO	ALPO	NCELLS	Void fraction at the start of the previous step (α^{n-1}).
LAM	AM	NCELLS	Air mass.
LARC	ARC	NCELLS* ISOLUT	Density of solute in cell, $c(1-\alpha)\rho_\ell$. ISOLUT = 0 or 1.
LCFZ	CFZ	0	Variable not currently implemented.
LCL	CL	NCELLS	Liquid conductivity.
LCPL	CPL	NCELLS	Liquid specific heat at constant pressure.
LCPV	CPV	NCELLS	Vapor specific heat at constant pressure.
LCV	CV	NCELLS	Vapor conductivity.
LDALVA	DALVA	NCELLS	Variable not currently implemented.
LDFLDP	DFLDP	NCELLS+1	Derivative of liquid velocity with respect to pressure.
LDFVDP	DFVDP	NCELLS+1	Derivative of vapor velocity with respect to pressure.
LDRIV	DR	19*(NCELLS+1)	Storage array for thermodynamic derivatives and enthalpies.
LDX	DX	NCELLS	Cell length in flow direction.
LELEV	ELEV	NCELLS*IELV	Cell-centered elevations. It is used only if IELV is set to 1 in the NAMELIST input.
LFA	FA	NCELLS+1	Cell-edge flow area.
LFAVOL	FAVOL	NCELLS	Cell flow area used in choked-flow model.
LFINAN	FINAN	NCELLS	Inverted annular regime factor.
LFRIC	FRIC	(NCELLS+1)	Additive friction factors.

		*NFRC1	
LFSMLT	FSMLT	NCELLS	Interphasic area multiplier during condensation.
LGRAV	GRAV	NCELLS+1	Gravitation terms (cosine theta).
LGRVOL	GRAVOL	NCELLS	Cell-averaged GRAV.
LH(1)	WFHF	NCELLS+1	Weighting factor for stratified-flow regime.
LH(2)	SI*DX	NCELLS+1	Stratified interfacial area.
LH(3)	DHLDZ	NCELLS+1	Gravitational head force caused by void gradient.
LHD	HD	(NCELLS+1) *(NDIA1-1)	Hydraulic diameters.
LHDHT	HDHT	(NCELLS+1)	Heat-transfer hydraulic diameters.
LHFG	HFG	NCELLS	Latent heat of vaporization.
LHGAM	HGAM	NCELLS	Contribution to phase change from subcooled boiling.
LHLA	HLA	NCELLS	Sum of all products of liquid HTC with heat-transfer area.
LHLATW	HLATW	NCELLS	Similar to HLA except that the product includes wall temperature.
LHVA	HVA	NCELLS	Sum of all products of vapor HTC with heat-transfer area.
LHVATW	HVATW	NCELLS	Similar to HVA except that the product includes wall temperature.
LQP3F	QP3F	NCELLS	QPPP factor applied to the wall heat source.
LQPPP	QPPP	NODES* NCELLS	Wall heat source.
LRARL	RARL	0	Variable not currently implemented.
LRARV	RARV	0	Variable not currently implemented.
LREGNM	REGNM	NCELLS+1	Flow-regime number.
LRHS	RHS	NCELLS	Implicit vs explicit weighting factor, g'.
LRMEM	RMEM	0	Variable not currently implemented.
LRMVM	RMVM	NCELLS+1	Mixture density times mixture velocity.
LROM	ROM	NCELLS	Mixture density.

LRVMF	RVMF	NCELLS+1	Vapor mass flow.
LSIG	SIG	NCELLS	Surface tension.
LTRID	TRID	6*(NCELLS+1)	Storage for stabilizer linear system.
LTSAT	TSAT	NCELLS	Saturation temperature.
LTSSN	TSSN	NCELLS	Saturation temperature for steam pressure.
LVISL	VISL	NCELLS	Liquid viscosity.
LVISV	VISV	NCELLS	Vapor viscosity.
LVLALP	VLALP	NCELLS	Liquid mass flux that enters the cell from the cell edges located above the cell.
LVLVC	VLVC	NCELLS	Liquid velocity at a neighboring cell edge where the donor-celled liquid fraction is maximum.
LVLVOL	VLVOL	NCELLS	Choked-flow model cell liquid velocity.
LVLX	VLX	0	Variable not currently implemented.
LVOL	VOL	NCELLS	Cell volumes.
LVR	VR	NCELLS+1	Relative velocity.
LVRV	VRV	NCELLS	Cell-averaged relative velocity.
LVVVOL	VVVOL	NCELLS	Choked-flow model cell vapor velocity.
LVVX	VVX	0	Variable not currently implemented.
LWA	WA	NCELLS	Wall areas.
LWAT	WAT	NCELLS	Total heat-transfer area.
LWFL	WFL	NCELLS+1	Wall friction factor for liquid.
LWFV	WFV	NCELLS+1	Wall friction factor for vapor.

C.1.3 INTPT

These pointers refer to variables with integer values.

Name	Array	Dimension	Description
LIDR	IDR	NCELLS	Heat-transfer regime.
LLCCFL	LCCFL	NCELLS+1	CCFL flag.
LMATID	MATID	NODES-1	Structural material identifications.
LNFF	NFF	NCELLS+1	Friction-correlation options.

C.1.4. HEATPT

These pointers refer to variables associated with the wall heat-transfer calculations for embedded heat structures.

Name	Array	Dimension	Description
LCPW	CPW	(NODES-1) *NCELLS	Specific heat of wall.
LCW	CW	(NODES-1) *NCELLS	Wall conductivity.
LDR	DR	NODES-1	Radial mesh size.
LEMIS	EMIS	NCELLS	Wall emissivity.
LHOL	HOL	NCELLS	HTC between outside wall and liquid.
LHOV	HOV	NCELLS	HTC between outside wall and vapor.
LRN	RN	NODES	Radii at nodes.
LRN2	RN2	NODES-1	Radii at node centers.
LROW	ROW	(NODES-1) *NCELLS	Wall density.
LTCHF	TCHF	NCELLS	CHF temperature.
LTOL	TOL	NCELLS	Liquid temperature outside wall.
LTOV	TOV	NCELLS	Vapor temperature outside wall.

C.2. ACCUMULATOR COMPONENT

C.2.1. ACCUMVLT–ACCUM Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
BSMASS	Time-integrated mass flow from component.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FLOW	Volume flow rate at discharge.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
QINT	Initial water volume in accumulator.
QOUT	Volume of liquid that has been discharged from the accumulator.
Z	Water height above discharge.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	Description
IA1111	Dummy variable that provides a known start to the COMMON block.
ICJ	Iteration index of adjacent component.
ICONC	Indicator for presence of solute in the coolant.
ISTOP	Indicator that accumulator has emptied.
IUV1	Indicator for velocity update at JUN1 (equal to zero).
IUV2	Indicator for velocity update at JUN2.
JS2	Junction sequence number at cell NCELLS of the accumulator.
JUN2	Junction number of the junction at cell NCELLS.
NCELLS	Number of fluid cells.
TYPE2	Type of adjacent component at JUN2.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.2.2. ACCUMPT–ACCUM Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
LBD1	BD1	LENBD	Dummy BD1 array.
LQPPL	QFPL	NCELLT	Heat flux from wall to liquid.

C.2.3. ACCDATA–ACCUM Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; ACCUMVLT, defined in Sec. C.2.1; and ACCUMPT, defined in Sec. C.2.2.

C.3. BREAK COMPONENT

C.3.1. BREAKVLT–BREAK Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
ALPOFF	Coolant void fraction when the trip is OFF after it was ON.
BSA	Total air from break.

BSMASS	Time-integrated mass flow from break.
BXA	Air mass flow from break.
BXMASS	Current mass flow from break.
CONOFF	Ratio of solute mass to coolant mass when the trip is OFF after it was ON.
PAOFF	Air partial pressure when the trip is OFF after it was ON.
POFF	Coolant pressure when the trip is OFF after it was ON.
RBMX	Maximum rate of change of pressure at the break.
TIN	Fluid temperature at the break.
TLOFF	Liquid temperature when the trip is OFF after it was ON.
TVOFF	Vapor temperature when the trip is OFF after it was ON.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
IBF	Last interpolated interval in the rate-factor table.
IBP	Last interpolated interval in the break composition parameter tables.
IBSV	Break-table abscissa-coordinate variable ID number.
IBTR	Trip ID number that controls evaluation of the break tables.
IBTY	Break-table input option.
ICJ	Iteration index of adjacent component.
INEXTI	Variable no longer used.
IOFF	Fluid-state option when the trip is OFF after it was ON.
IONOFF	Number of time steps the trip is ON.
ISAT	Break-table use option.
JS1	Junction sequence number.
JUN1	Junction number where break is located.
NBRF	Number of pairs in the rate-factor table.
NBSV	Rate-factor table's abscissa-coordinate variable ID number.
NBTB	Number of pairs for each break table.
TYPE1	Variable no longer used.

ZI1111	Dummy variable that provides a known end to the COMMON block.

C.3.2. BREAKPT–BREAK Pointer Table (For BREAKS, NCELLS = 1)

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
LALPTB	ALPTB	|NBTB|*2	Void fraction table.
LCONTB	CONTB	|NBTB|*2	Ratio of solute mass to coolant mass table.
LPATB	PTAB	|NBTB|*2	Air partial pressure table.
LPTB	PTB	|NBTB|*2	Pressure table.
LRFTB	RFTB	|NBRF|*2	Rate-factor table.
LTLTB	TLTB	|NBTB|*2	Liquid temperature table.
LTVTB	TVTB	|NBTB|*2	Vapor temperature table.

C.3.3. BRKDATA–BREAK Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; BREAKVLT, defined in Sec. C.3.1.; and BREAKPT, defined in Sec. C.3.2.

C.4. FILL COMPONENT

C.4.1. FILLVLT–FILL Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
ALPOFF	Coolant void fraction when the trip is OFF after it was ON.
CONOFF	Ratio of solute mass to coolant mass when the trip is OFF after it was ON.
FLOWIN	Initial mass flow into or from adjacent component.
FLWOFF	Coolant mass flow when the trip is OFF after it was ON.
FSMASS	Time-integrated mass-flow out of fill.
FXMASS	Current mass-flow rate out of fill.
PAOFF	Air partial pressure when the trip is OFF after it was ON.
POFF	Coolant pressure when the trip is OFF after it was ON.
RFMX	Maximum rate of change of fill velocity or mass flow.

TLOFF	Liquid temperature when the trip is OFF after it was ON.
TVOFF	Vapor temperature when the trip is OFF after it was ON.
TWTOLD	The fraction of a previous fill fluid dynamic-state parameter that is averaged with the fill table's defined parameter and that defines the fill parameter value for this time step ($0.0 \leq$ TWTOLD < 1.0).
VLOFF	Liquid velocity when the trip is OFF after it was ON.
VVOFF	Vapor velocity when the trip is OFF after it was ON.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICJ	Iteration index of adjacent component.
IFASV	ID number of the signal variable of control block defining the void fraction for the IFTY = 10 option.
IFCNSV	ID number of the signal variable or control block defining the ratio of solute mass to liquid-coolant mass for the IFTY = 10 option.
IFF	Last interpolated interval in the rate-factor table.
IFMLSV	ID number of the signal variable or control block defining liquid mass flow for the IFTY = 10 option.
IFMVSV	ID number of the signal variable or control block defining vapor mass flow for the IFTY = 10 option.
IFP	Last interpolated interval in the fill table.
IFPASV	ID number of the signal variable or control block defining the partial air pressure for the IFTY = 10 option.
IFPSV	ID number of the signal variable or control block defining the pressure for the IFTY = 10 option.
IFSV	The signal-variable ID number, which defines the fill table's independent variable.
IFTLSV	ID number of the signal variable or control block defining the liquid temperature for the IFTY = 10 option.
IFTR	Fill trip number.
IFTVSV	ID number of the signal variable or control block defining the vapor temperature for the IFTY = 10 option.
IFTY	Fill type.

INEXTI	Variable no longer used.
IOFF	Fill fluid-state option when the trip is OFF after it was ON.
IONOFF	The number of time steps the trip has been ON.
JS1	Junction sequence number at JUN1.
JUN1	Junction number where fill is located.
NFRF	Number of rate-factor table pairs whose rate factor is applied to the fill table's independent variable.
NFSV	Rate-factor table's abscissa-coordinate variable ID number.
NFTB	Number of pairs in the fill table.
TYPE1	Variable no longer used.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.4.2. FILLPT–FILL Pointer Table (For FILLS, NCELLS = 1)

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
LALPTB	ALPTB	|NFTB|*2	Void fraction table.
LCONTB	CONTB	|NFTB|*2	Ratio of solute mass to coolant mass.
LPATB	PATB	|NFTB|*2	Air partial pressure table.
LPTB	PTB	|NFTB|*2	Pressure table.
LRFTB	RFTB	|NFRF|*2	Fill rate-factor table.
LTLTB	TLTB	|NFTB|*2	Liquid temperature table.
LTVTB	TVTB	|NFTB|*2	Vapor temperature table.
LVMTB	VMTB	|NFTB|*2	Liquid velocity table.
LVVTB	VVTB	|NFTB|*2	Vapor velocity table.

C.4.3 FILLDATA–FILL Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; FILLVLT, defined in Sec. C.4.1; and FILLPT, defined in Sec. C.4.2.

C.5. HEAT-STRUCTURE COMPONENT

C.5.1. RODVLT–Heat-Structure Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
AMH2	Hydrogen mass generated from metal-water reaction.
BCR0	Zero-order coefficient of the first-order polynomial that defines the effective core-averaged concentration of control-rod pin boron.
BCR1	First-order coefficient of the first-order polynomial that defines the effective core-averaged concentration of control-rod pin boron.
BEFF	Total delayed neutron fraction.
BPP0	Zero-order coefficient of the first-order polynomial that defines the effective core-averaged concentration of burnable-poison pin boron.
BPP1	First-order coefficient of the first-order polynomial that defines the effective core-averaged concentration of burnable-poison pin boron.
DRFB	Reactivity-feedback change in K over last time step.
DRI	Estimated change in reactivity over the previous time step.
DRIO	Old value of DRI equals the old value of the power or reactivity-estimate correction.
DTNHT(2)	Delta temperature minimums used in reflood calculation.
DTPK	Kaganove-method integration time step for solving the point-kinetics equations.
DTXHT(2)	Delta temperature maximums used in reflood calculation.
DZNHT	Delta Z_{min}.
ENEFF	Total decay heat fraction.
EXTSOU	Thermal power (W) produced by external source neutrons in the reactor core.
FUCRAC	Fraction of uncracked fuel.
HDRI	Thermal diameter (m) for the inside surface of the heat-structure rod or slab element. Used only when NAMELIST variable ITHD = 1.
HDRO	Thermal diameter (m) for the outside surface of the heat-structure rod or slab element. Used only when NAMELIST variable ITHD = 1.
HGAPO	Rod gap-conductance coefficient (MATRD = 3).

HLI	Constant liquid heat-transfer coefficient ($W \cdot m^{-2} \cdot K^{-1}$) at the inner surface. Used when inner surface boundary condition flag is set such that IDBCI = 1, indicating constant HTCs and external temperatures.
HLO	Constant liquid heat-transfer coefficient ($W \cdot m^{-2} \cdot K^{-1}$) at the outer surface. Used when outer surface boundary condition flag is set such that IDBCO = 1, indicating constant HTCs and external temperatures.
HVI	Constant vapor heat-transfer coefficient ($W \cdot m^{-2} \cdot K^{-1}$) at the inner surface. Used when inner surface boundary condition flag is set such that IDBCI = 1, indicating constant HTCs and external temperatures.
HVO	Constant vapor heat-transfer coefficient ($W \cdot m^{-2} \cdot K^{-1}$) at the outer surface. Used when outer surface boundary condition flag is set such that IDBCO = 1, indicating constant HTCs and external temperatures.
PDRAT	Rod pitch-to-diameter ratio.
PLDR	Pellet dish radius. 0.0 = no pellet dish calculation; 1.0 = pellet dish calculation.
POWEXP	Exponent value to which the power distribution is raised to define the weighting function for averaging the reactivity-feedback parameters over the core volume.
QRDTOT	Total rod heat flux.
REAC	Reactivity feedback at the beginning of the previous time step.
REACN	Reactivity-feedback estimate at the end of the present time step.
REACT	Total reactivity at the beginning of the present time step.
RMCK	Reactor multiplication constant at the beginning of the present time step
RMCKN	Reactor multiplication constant estimate at the end of the present time step.
RPOWPF	Prompt fission power.
RPOWR	Beginning-of-time-step reactor power.
RPOWRI	Initial reactor power.
RPOWRN	End-of-time-step reactor power.
RPOWRO	End-of-time-step reactor power of the previous time step.
RPOWTO	Beginning-of-time-step reactor power of the previous time step.
RPWOFF	Programmed reactivity or reactor power when the controlling trip is OFF after it was ON.

RPWSCL	Reactivity-power table's scale factor for programmed reactivity or reactor power.
RRPWMX	Maximum rate of change of programmed reactivity or reactor power.
RZPWMX	Maximum rate of change of the axial power shape.
SDT	Time interval (s) since the last reactivity change printout.
STIMET	Problem time (s) at which the last reactivity change was summed to variable storage for later printout.
TLI	Constant liquid temperature (K) at the inner surface. Used when inner surface boundary condition flag is set such that IDBCI = 1, indicating constant HTCs and external temperatures.
TLO	Constant liquid temperature (K) at the outer surface. Used when outer surface boundary condition flag is set such that IDBCO = 1, indicating constant HTCs and external temperatures.
TNEUT	Neutron generation time.
TPOWI	Total power across the inner surface of the heat-structure component.
TPOWO	Total power across the outer surface of the heat-structure component.
TRAMAX	Average-rod peak-cladding temperature.
TRHMAX	Maximum supplemental rod temperature.
TVI	Constant vapor temperature (K) at the inner surface. Used when inner surface boundary condition flag is set such that IDBCI = 1, indicating constant HTCs and external temperatures.
TVO	Constant vapor temperature (K) at the outer surface. Used when outer surface boundary condition flag is set such that IDBCO = 1, indicating constant HTCs and external temperatures.
WATLEV	Not used.
WIDTH	Width (m) of slab surface (used to compute surface area).
ZPWIN	Axial power-shape table's abscissa-coordinate variable value corresponding to the initial axial power shape.
ZPWOFF	Axial power-shape table's abscissa-coordinate variable value that corresponds to the axial power shape that is used when the controlling trip is OFF after it was ON.
ZLPBOT	Axial location (m) of the bottom of the lower hot patch.
ZLPTOP	Axial location (m) of the top of the lower hot patch.
ZUPBOT	Axial location (m) of the bottom of the upper hot patch.

ZUPTOP	Axial location (m) of the top of the upper hot patch.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	Description
IA1111	Dummy variable that provides a known start to the COMMON block.
IAXCND	Axial conduction indicator. 0 = no axial heat-transfer conduction calculated; 1 = axial heat-transfer conduction calculated in the heat-structure rod or slab element.
IBU(4)	Boron-unit flag for the Jth reactivity coefficient.
IDBCI	Boundary condition option for the inner surface of the heat-structure rod or slab element. 0 = adiabatic boundary condition; 1 = constant HTCs and external temperatures; 2 = coupled to specified cells in one or more hydro components.
IDBCO	Boundary condition option for the outer surface of the heat-structure rod or slab element. 0 = adiabatic boundary condition; 1 = constant HTCs and external temperatures; 2 = coupled to specified cells in one or more hydro components.
IEXT	Specifies if this heat structure input was generated by the post processor EXTRACT. 0 = no; 1 = yes.
IONOFF	Number of time steps the reactivity-power table's controlling trip has been ON.
IPATCH	Hot patch modelling indicator. 0 = no modelling; 1 = modelling of hot patches.
IRC(4)	Number of values that defines the argument number reactivity-coefficient table.
IRCJFM(4)	Form number of reactivity coefficient for the argument number reactivity-feedback parameter.
IRCJTB(4,4)	Number of first argument reactivity-feedback parameter value entries for the second argument reactivity-coefficient table.
IRF	Last interpolated interval number in rate-factor table for the reactivity-power table.

IRFTR	Trip ID number that controls evaluation with the reflood axial fine mesh in the fuel rod.
IRP	Last interpolated interval number in the reactivity-power table.
IRPWSV	Reactivity-power table's abscissa-coordinate variable ID number.
IRPWTR	Trip ID number that controls evaluation of the reactivity-power table.
IRPWTY	Reactor-kinetics option indicator.
ISNOTB	A flag variable that is defined if the solute is boron for the reactivity-feedback calculation. 0 = solute is boron; 1 = solute is not boron.
IZF	Last interpolated interval number in the rate-factor table for the axial power-shape table.
IZP	Last interpolated interval number in the axial power-shape table.
IZPWSV	Axial power-shape table's abscissa-coordinate variable ID number.
IZPWTR	Trip ID number that controls evaluation of the axial power-shape table.
LENRD	Length of rod data.
LFVNR	Relative position of new fundamental variables of rod data.
LFVNR1	Relative position of new heat-transfer data.
LFVR	Relative position of old fundamental variables of rod data.
LFVR1	Relative position of old heat-transfer data.
LIQLEV	Specification of liquid level. 0 = no liquid level calculated on rod or slab surface; 1 = liquid level tracked on rod or slab surface (this smooths the heat-transfer solution).
LNDRD	Offset for double-sided heat structures. If the heat structure is connected to hydro components on one side, then LNDRD = 0. If the heat structure is connected to a hydro component on both the inside and outside surfaces, then LNDRD = the offset for the inside surface heat-transfer parameters.
LNFVR	Length of fundamental variables of rod data.
LNFVR1	Length of heat-transfer data.
LNPTRR	Number of pointers of rod data.
LOCROD	Pointer for beginning of rod data.
NCRX	Number of copies of structure that affect fluid dynamics.

NCRZ	Number of (course) axial intervals between temperature nodes.
NDG	Input-specified number of delated-neutron groups.
NDGX	Number of delayed-neutron groups.
NDH	Input specified number of decay-heat groups.
NDHX	Number of decay-heat groups.
NFBPWT	Flag that defines the spatial distribution used to weight the averaging of the reactivity-feedback parameters over the reactor-vessel volume.
NFCI	FCI flag. 0 = no calculation; 1 = calculation.
NFCIL	Limit on FCI calculations per time step.
NFUEL	Number of nodes in fuel pellet.
NHIST	Number of value pairs in the power-history table.
NINT	Maximum possible number of interfaces between dissimilar materials in rods.
NMWRX	Metal-water reaction flag. 0 = no calculation; 1 = calculation.
NONOFF	Number of time steps the trip-controlling evaluation of the axial power-shape table has been ON.
NOPOWR	Specification of whether a power source is present in the heat-structure rod or slab element. 0 = power source present in the rod or slab; 1 = no power source present in the rod or slab.
NRAMAX	Location of average-rod peak-cladding temperature used in reflood calculation.
NRFD	Reflood flag. 0 = takes no action; 1 = turns on fine-mesh flag if it is off.
NRHMAX	Location of supplemental rod peak-cladding temperature.
NRIDR	Specification of the hydro-cell location that is coupled to the inner and/or outer surfaces of the heat-structure rod or slab element. 0 = the IDROD array is input for only the additional rods or slabs; 1 = the IDROD array is input for all rods or slabs; 2 = the IDROD array is input for all rods or slabs for both surfaces of the heat structure.

NRODS	Number of computational rods including "hot" rods. See also NCRX.
NRPWRF	Number of rate-factor table pairs whose rate factor is applied to the power or reactivity table's independent variable.
NRPWSV	Reactivity-power rate-factor table's abscissa-coordinate variable ID number.
NRPWTB	Number of entry pairs in the reactivity-power table.
NRTS	Number of time steps over which programmed reactivity and reactivity-feedback changes are summed for printout.
NSET	Absolute value of the reflood fine axial mesh trip set-status number during the previous time step.
NZMAX	Maximum number of rows of heat-transfer nodes used in reflood calculation.
NZPWRF	Number of entry pairs in the axial power-shape rate-factor table
NZPWSV	Axial power-shape rate-factor table's abscissa-coordinate variable ID number.
NZPWTB	Number of axial power shapes in the axial power-shape table.
NZPWI	Axial power shape integration option for the heat-transfer calculation. −1 = histogram with step changes at the axial locations; 0 = histogram with step change. way between the axial locations; 1 = trapezoidal integration.
NZPWZ	Number of axial locations defining the axial-power shape.
NZZNHC	The number of hydro-cell axial-direction channels that this powered heat structure is coupled to.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.5.2. RODPT–Heat-Structure Pointer Table

GENERAL ROD-DATA POINTERS:

Name	Array	Dimension	Description
LBETA	BETA	NDGX	Delayed neutron group fraction.
LCDG	CDG	NDGX	Old delayed neutron group concentrations.
LCDGN	CDGN	NDGX	New delayed neutron group concentrations.
LCDH	CDH	NDHX	Old concentration of decay-heat groups.
LCDHN	CDHN	NDHX	New concentration of decay-heat groups.
LCLEN	CLEN	NCRX	Old total cladding length.

LCLENN	CLENN	NCRX	New total cladding length.
LCPOWR	CPOWR	NCRX	Relative power per rod.
LEDH	EDH	NDHX	Energy yield fraction of decay-heat groups.
LFPUO2	FPUO2	NCRX	Fraction of plutonium oxide in mixed-oxide fuel fraction.
LFTD	FTD	NCRX	Fuel density (fraction of theoretical).
LGMIX	GMIX	NCRX*7	Mole fraction of gap-gas constituents.
LGMLES	GMLES	NCRX	Moles of gap gas.
LGRAVR	GRAVR	NCRZ	Cosine of the angle between a vector pointing upward and a vector from the lower-to-higher numbered axial cells.
LHCELI	NHCELI	NCRZ+2	Cell number coupled to the heat-structure nodes at the inner surface.
LHCELO	NHCELO	NCRZ+2	Cell number coupled to the heat-structure nodes at the outer surface.
LHCOMI	NHCOMI	NCRZ+2	Component number of the hydro cells coupled to the heat-structure inner surface.
LHCOMO	NHCOMO	NCRZ+2	Component number of the hydro cells coupled to the heat-structure outer surface.
LHIGH			Not used.
LHS	HS	NCRX*(NFBPWT/4)	Pointer variable for the horizontal plane shape weight function used.
LIDROD	IDROD	NRODS	Cell identifier for rods.
LLAMDA	LAMDA	NDGX	Decay constant of delayed groups.
LLAMDH	LAMDH	NDHX	Decay constant of decay-heat groups.
LLCHCI	LCHCI	2*(NCRZ+2)	The hydro-cell parameters for heat-transfer coupling to the heat-structure inner surface.
LLCHCO	LCHCO	2*(NCRZ+2)	The hydro-cell parameters for heat-transfer coupling to the heat-structure outer surface.
LMATRD	MATRD	NINT	Rod material identification.
LNFAX	NFAX	NCRZ	Rod fine-mesh noding factor.
LNRDX	NRDX	NCRX	Number of rods in bundle.
LNTSXX	NTSXX	MAX(1, NRIDR)	Number of mesh cells in the plane transverse to the axial direction.

LPGAPT	PGAPT	NCRX	Gap total gas pressure.
LPLVOL	PLVOL	NCRX	Rod plenum volume.
LPOWLI	POWLI	NCRZ	Total power across the heat-structure inner surface to the liquid.
LPOWLO	POWLO	NCRZ	Total power across the heat-structure outer surface to the liquid.
LPOWVI	POWVI	NCRZ	Total power across the heat-structure inner surface to the gas (vapor).
LPOWVO	POWVO	NCRZ	Total power across the heat-structure outer surface to the gas (vapor)
LPSLEN	PSLEN	NCRX	Pellet stack length.
LRADRD	RADRD	NODES	Rod node radius (cold).
LRCAL	RCAL	ΣIRCJTB(i,3) + π_iIRCJTB(i,3)	Coolant void-fraction reactivity-coefficient table. The symbol π_i indicates the product of the following variable taken over the i subscript.
LRCBM	RCBM	ΣIRCJTB(i,4) + π_iIRCJTB(i,4)	Boron reactivity-coefficient table. The symbol π_i indicates the product of the following variable taken over the i subscript.
LRCN	RCN	0 or 4	Reactivity-coefficient values at the beginning of the previous time step.
LRCTC	RCTC	ΣIRCJTB(i,2) + π_iIRCJTB(i,2)	Coolant temperature reactivity-coefficient table. The symbol π_i indicates the product of the following variable taken over the i subscript.
LRCTF	RCTF	ΣIRCJTB(i,1) + π_iIRCJTB(i,1)	Fuel temperature reactivity-coefficient table. The symbol π_i indicates the product of the following variable taken over the i subscript.
LRDPWR	RDPWR	NODES	Rod relative radial power density
LRDZ	RDZ	NCRZ+1	Axial node positions.
LRPKF	RPKF	NRODS	Rod power peaking factor.
LRPWRF	RPWRF	|NRPWRF|*2	Rate-factor table for the power or reactivity table.
LRPWTB	RPWTB	|NRPWTB|*2	Power or reactivity table.
LRS	RS	NODES	Pointer variable for the fuel-rod radial shape

		MOD(NFBPWT,2)	weight function used to average reactivity feedback parameters over the core volume, MOD(N,2) = N − (N/2)*2.
LSRP	SRP	0 or 1	Summed programmed and feedback reactivity changes.
LTC	TC	10	Thermocouple-model input parameters.
LXN	XN	0 or 4	New reactivity-feedback parameter values.
LXO	XO	0 or 4	Old reactivity-feedback parameter values.
LZPW	ZPW	NCRZ+1	Last interpolated axial power shape.
LZPWFB	ZPWFB	NCRZ+1	Subroutine ZPWHCI evaluated axial-power shape at NCRZ+1 nodes based on the input axial-power shaped defined at NZPWZ node locations.
LZPWRF	ZPWRF	|NZPWRF|*2	Axial power-shape rate-factor table.
LZPWTB	ZPWTB	|NZPWTB|* NZPWZ+1	Relative power density axial power-shape table.
LZPWZT	ZPWZT	NZPWZ	Axial locations where the axial-power shape ralative power densities are defined.
LZS	ZS	NCRZP1*(MOD (NFBPWT,4)/2)	Pointer variable for the axial-direction shape, MOD(N,2) = N - (N/2)*2.
LZZRD			Dummy pointer that provides a known end to the common block.

C.5.3. RODPT1–Heat-Structure Pointer Table

ROD DATA POINTERS:

Name	Array	Dimension	Description
LALPR	ALPR	NCRZ+2	Coolant vapor fraction.
LALVR	ALVR	NCRZ+2	Liquid HTC times interfacial area.
LBITR	BITR	0	Variable not currently implemented.
LBITRN	BITRN	0	Variable not currently implemented.
LBURN	BURN	NCRZ+1	Fuel burnup.
LCHTIR	CHTIR	NCRZ+2	Vapor HTC times interfacial area.
LCLR	CLR	NCRZ+2	Liquid conductivity.
LCND	CND	NODES* (NCRZ+1)	Rod conductivity.

LCNDR	CNDR	NINT*(NCRZ+1)	Rod conductivity to right of interface.
LCONCR	CONCR	NCRZ+2	Mass concentration of dissolved solute in the coolant (kg solute/kg water).
LCPDR	CPDR	NINT*(NCRZ+1)	Rod specific heat to right of interface.
LCPLR	CPLR	NCRZ+2	Liquid specific heat.
LCPND	CPND	NODES*(NCRZ+1)	Rod specific heat.
LCPVR	CPVR	NCRZ+2	Vapor specific heat.
LCVR	CVR	NCRZ+2	Vapor conductivity.
LDRLDT	DRLDT	NCRZ+2	Derivative of liquid density with respect to liquid temperature.
LDRVDT	DRVDT	NCRZ+2	Derivative of vapor density with respect to vapor temperature.
LDRZ	DRZ	NCRZ+1	Old zirconium dioxide reaction depth.
LDRZN	DRZN	NCRZ+1	New zirconium dioxide reaction depth.
LEAR	EAR	NCRZ+2	Specific internal energy of the noncondensable gas component.
LELR	ELR	NCRZ+2	Liquid internal energy.
LEMIS	EMIS	NODES*(NCRZ+1)	Rod emissivity.
LEVR	EVR	NCRZ+2	Vapor internal energy.
LFINAR	FINAR	NCRZ+2	Not used.
LHDR	HDR	NCRZ+2	Rod-bundle hydraulic diameter.
LHFGR	HFGR	NCRZ+2	Latent heat of vaporization of fluid.
LHGAMR	HGAMR	NCRZ	Contribution to subcooled boiling.
LHGAP	HGAP	NCRZ+1	Gap conductance.
LHLAR	HLAR	NCRZ	Sum of all products of the liquid HTC and the heat-transfer area.
LHLATR	HLATR	NCRZ	Sum of all products of the liquid HTC, the heat-transfer area, and the wall temperature.

LHLSR	HLSR	NCRZ+2	Specific enthalpy of the liquid phase at saturation (corresponding to saturation temperature at partial pressure of steam).
LHRFG	HRFG	NCRZ+1	New subcooled boiling HTC.
LHRFGO	HRFGO	NCRZ+1	Old subcooled boiling HTC.
LHRFL	HRFL	NZMAX	New fine-mesh liquid HTC.
LHRFLO	HRFLO	NZMAX	Old fine-mesh liquid HTC.
LHRFV	HRFV	NZMAX	New fine-mesh vapor HTC.
LHRFVO	HRFVO	NZMAX	Old fine-mesh vapor HTC.
LHRLG	HRLG	NZMAX	New fine-mesh subcooled boiling HTC.
LHRLGO	HRLGO	NZMAX	Old fine-mesh subcooled boiling HTC.
LHRLL	HRLL	NCRZ+1	New liquid HTC for lower half-node.
LHRLLO	HRLLO	NCRZ+1	Old liquid HTC for lower half-node.
LHRLV	HRLV	NCRZ+1	New vapor HTC for lower half-node.
LHRLVO	HRLVO	NCRZ+1	Old vapor HTC for lower half-node.
LHVAR	HVAR	NCRZ	Sum of all products of the vapor HTC and the heat-transfer area.
LHVATR	HVATR	NCRZ	Sum of all products of the vapor HTC, the heat-transfer area, and the wall temperature.
LHVSR	HVSR	NCRZ+2	Specific enthalpy of the steam (not gas) at saturation (at partial pressure of steam and saturation temperature).
LIDHT	IDHT	NZMAX	Rod node identifier.
LIDRGR	IDRGR	NCRZ+2	Flow-regime flag.
LIHTF	IHTF	NZMAX	Fine-mesh heat-transfer regime flag.
LNOHT	NOHT	1	Number of rows of heat-transfer nodes for each rod.
LPAR	PAR	NCRZ+2	Partial pressure of the noncondensable gas component.
LPGAP	PGAP	NCRZ+1	Gap local gas pressure.
LPINT	PINT	NCRZ+1	Pellet-cladding contact pressure.
LPLDV	PLDV	NCRZ	Pellet dish volume.

LPR	PR	NCRZ+2	Coolant pressure.
LQCHFF	QCHFF	NCRZ+1	New CHF.
LQCHFO	QCHFO	NCRZ+1	Old CHF.
LQCHFR	QCHFR	NZMAX	New fine-mesh CHF.
LQCHRO	QCHRO	NZMAX	Old fine-mesh CHF.
LQWRX	QWRX	NCRZ+1	Metal-water reaction heat source.
LRADR	RADR	NODES*(NCRZ+1)	Old radial node positions.
LRADRN	RADRN	NODES*(NCRZ+1)	New radial node positions.
LRDHLO	RDHLO	NCRZ	Variable not currently implemented.
LRDHLR	RDHLR	NCRZ	Liquid HTC.
LRDHVO	RDHVO	NCRZ	Variable not currently implemented.
LRDHVR	RDHVR	NCRZ	Vapor HTC.
LRFT	RFT	NODES*NZMAX	Old fine mesh rod temperatures.
LRFTN	RFTN	NODES*NZMAX	New fine-mesh rod temperatures.
LRLQLV			Not used.
LRND	RND	NODES*(NCRZ+1)	Rod density.
LRNDR	RNDR	NINT*(NCRZ+1)-1	Rod density to right of material interface.
LROAR	ROAR	NCRZ+2	Density of the noncondensable gas component.
LROLR	ROLR	NCRZ+2	Liquid density.
LROMR	ROMR	NCRZ+2	Mixture density.
LROVR	ROVR	NCRZ+2	Vapor density.
LRPOWF	RPOWF	NODES	Rod power density.
LSIGR	SIGR	NCRZ+2	Surface tension.
LSR	SR	NCRZ+2	Amount of plated-out solute ($kg \cdot m^{-3}$).
LSTNU	STNU	NZMAX	Stanton number.
LTCHFF	TCHFF	NZMAX	Fine-mesh wall temperature at CHF point.
LTCHFR	TCHFR	NCRZ	Wall temperature at CHF

LTLD	TLD	NZMAX	Liquid temperature at bubble departure.
LTLR	TLR	NCRZ+2	Liquid temperature.
LTSATR	TSATR	NCRZ+2	Saturation temperature.
LTSSNR	TSSNR	NCRZ+2	Saturation temperature corresponding to partial pressure of steam.
LTVR	TVR	NCRZ+2	Vapor temperature.
LVISLR	VISLR	NCRZ+2	Liquid viscosity.
LVISVR	VISVR	NCRZ+2	Vapor viscosity.
LVLCR	VLCR	NCRZ+2	Not used.
LVLZR	VLZR	NCRZ+2	Axial liquid velocity.
LVMZR	VMZR	NCRZ+2	Axial mixture velocity.
LVOLR	VOLR	NCRZ+2	Fluid volume in hydrodynamic mesh cells.
LVVCR	VVCR	NCRZ+2	Vapor cross-flow velocity.
LVVZR	VVZR	NCRZ+2	Axial vapor velocity.
LWATR	WATR	NCRZ	Total rod heat-transfer area.
LZHT	ZHT	NZMAX	Axial location of heat-transfer node.

C.5.4. RODDAT–Heat-Structure Data Table

This data table includes the following COMMON blocks: RODVLT, defined in Sec. C.5.1; RODPT, defined in Sec. C.5.2; and RODPT1, defined in Sec. C.5.3.

C.6. PIPE COMPONENT

C.6.1. PIPEVLT–PIPE Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
BSMASS	Time-integrated mass flow from pipe.
CPOW	Special pipe power input.
ENINP	Total (time-integrated) energy directly input to the pipe.
EPSW	Wall surface roughness.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
HOUTL	HTC between outer boundary of pipe wall and liquid.

HOUTV	HTC between outer boundary of pipe wall and vapor.
PLENT	Total length of the pipe.
POWIN	Initial power deposited in the liquid.
POWOFF	Power deposited in the liquid when the trip is OFF after it was ON.
QINT	Initial water volume in pipe.
QOUT	Volume of liquid that has been discharged from pipe used as accumulator.
QP3IN	Initial QPPP factor.
QP3OFF	QPPP factor when its trip is OFF after it was ON.
RADIN	Inner radius of pipe wall.
RPOWMX	Maximum rate of change of power deposited in the coolant.
RQP3MX	Maximum rate of change of the QPPP factor.
TH	Thickness of pipe wall.
TOUTL	Liquid temperature outside pipe.
TOUTV	Vapor temperature outside pipe.
VFLOW	Volume flow rate at discharge from pipe used as accumulator.
Z	Water height above discharge.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
IACC	Pipe accumulator option switch.
ICHF	CHF calculation option.
ICJ1	Not used.
ICJ2	Not used.
ICONC	Indicator for presence of solute in the coolant input.
IONOFF	Number of time steps the power deposited in the coolant trip has been ON.
IPF	Last interpolated interval in the power deposited in the coolant's rate-factor table.
IPOW	Indicator for presence of power deposited in the coolant.

IPOWSV	Power deposited in the coolant table's abscissa-coordinate variable ID number.
IPOWTR	Trip ID number that controls evaluation of the power deposited in the coolant table.
IPP	Last interpolated interval in the power deposited in the coolant table.
IQF	Last interpolated interval in the QPPP factor table's rate-factor table.
IQP	Last interpolated interval in the QPPP factor table.
IQP3SV	QPPP factor table's abscissa-coordinate variable ID number.
IQP3TR	Trip ID number that controls evaluation of the QPPP factor table.
ISOLLB	Indicator for velocity update at JUN1.
ISOLRB	Indicator for velocity update at JUN2.
JS1	Junction sequence number at cell 1 of the pipe.
JS2	Junction sequence number at cell NCELLS of the pipe.
JUN1	Junction number of the junction at cell 1.
JUN2	Junction number of the junction at cell NCELLS.
NCELLS	Number of fluid cells.
NONOFF	Number of time steps the QPPP factor table's controlling trip has been ON.
NPOWRF	Number of pairs in the power deposited in the coolant table's rate-factor table.
NPOWSV	Power deposited in the coolant rate-factor table's abscissa-coordinate variable ID number.
NPOWTB	Length of pipe power table.
NQP3RF	Number of pairs in the QPPP factor table's rate-factor table.
NQP3SV	QPPP factor rate-factor table's abscissa-coordinate variable ID number.
NQP3TB	Number of pairs in the QPPP factor table.
TYPE1	Type of adjacent component at JUN1.
TYPE2	Type of adjacent component at JUN2.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.6.2. PIPEPT–PIPE Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.

HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.
LPOWRF	POWRF	|NPOWRF|*2	Rate-factor tables for the power deposited in the coolant tables.
LPOWTB	POWTB	|NPOWTB|*2	Power deposited in the coolant table.
LQP3RF	QP3RF	|NQP3RF|*2	Rate-factor table for the QPPP factor tables.
LQP3TB	QP3TB	|NQP3TB|*2	QPPP factor tables.

C.6.3. PIPEDATA–PIPE Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; PIPEVLT, defined in Sec. C.6.1; and PIPEPT, defined in Sec. C.6.2.

C.7. PLENUM COMPONENT

The plenum data are all contained in the PLENDATA COMMON block that consists of the following COMMON blocks: DIMNSION, IOUNITS, JUNCTION, FIXEDLT, and BLANKCOM, all defined in Appendix D; DUALPT, defined in Sec. C.1.1; HYDROPT, defined in Sec. C.1.2; VLTAB, defined in Sec. C.7.1; and PTAB, defined in Sec. C.7.2.

C.7.1. VLTAB–PLENUM Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA11xx	Dummy variable that provides a known start to the COMMON block.
BL	Temporary storage for liquid mass-conservation checks.
BSMASS	Time-integrated mass flow from plenum.
BV	Temporary storage for vapor mass-conservation checks.
EPSW	Wall surface roughness.
FAS1	Summed flow area of all junctions on side 1 of the plenum cell.
FAS2	Summed flow area of all junctions on side 2 of the plenum cell.
FLXA	Total air mass flow into the plenum during a time step.
FLXAL	Total liquid volumetric flow into the plenum during a time step.
FLXAV	Total vapor (gas phase) volumetric flow into the plenum during a time step.
FLXC	Total solute mass flow into the plenum during a time step.
FLXEL	Total liquid internal energy flow into the plenum during a time step.

FLXEV	Total vapor internal energy flow into the plenum during a time step.
FLXL	Total liquid mass flow into the plenum during a time step.
FLXV	Total vapor mass flow into the plenum during a time step.
RXCL	Temporary storage for the right-hand side of the liquid stabilizer mass and energy equations.
RXCV	Temporary storage for the right-hand side of the vapor stabilizer mass and energy equations.
XL	Gross total liquid volumetric flow from the plenum during a time step.
XV	Gross total vapor volumetric flow from the plenum during a time step.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	Description
IA1111	Dummy variable that provides a known start to the COMMON block.
K	Address location that designates the location of the array data variables.
ICONC	Indicator for the presence of solute in the coolant or input.
IPOW	Indicator for the presence of power deposited in the coolant.
JUNS1	Number of junctions on side 1 of the plenum cell that convect momentum across the cell.
JUNS2	Number of junctions on side 2 of the plenum cell that convect momentum across the cell.
NCELLS	Number of fluid cells (equals one for a PLENUM).
NPLJN	Number of plenum junctions.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.7.2. PTAB–PLENUM Pointer Table

Name	Array	Dimension	Description
LALW	ALW	NPLJN	Temporary storage for the right-hand side of the liquid stabilizer mass and energy equations.
LAVW	AVW	NPLJN	Temporary storage for the right-hand side of the vapor stabilizer mass and energy equations.
LDBND	DBND	5*NPLJN	Donor-cell quantities $\alpha\rho_v$, $(1-\alpha)\rho_\ell$, $\alpha\rho_a$, $\alpha\rho_v e_v$, and $(1-\alpha)\rho_\ell e_\ell$.

LDNFL	DONFL	NPLJN	Donor-cell flag for liquid. 0.0 = indicates flow into the plenum; 1.0 = indicates flow from the plenum.
LDNFV	DONFV	NPLJN	Donor-cell flag for vapor. 0.0 = indicates flow into the plenum; 1.0 = indicates flow from the plenum.
LI0J	I0J	NPLJN	Network junction numbers.
LJUNJ	JUNJ	NPLJN	Plenum junction numbers.
LJSN	JSN	NPLJN	Plenum junction sequence numbers.
LPAK	PAK	NPLJN	BIT array for the plenum junctions; however, it is used only for storing the water packing and stretching bits.
LSGN	SGN	NPLJN	Junction flow-reversal indicators.
LZZZZZ	—	1	Dummy variable that provides a known end to the COMMON block.

C.7.3. Equivalences Defined for BLANKCOM

Mnemonic	Variable	Description
ALP(1)	A(01)	Old void fraction.
ALPMN(1)	A(78)	Minimum value of void fraction among the plenum and all its neighbors.
ALPMX(1)	A(79)	Maximum value of void fraction among the plenum and all its neighbors.
ALPN(1)	A(27)	New void fraction.
ALPO(1)	A(57)	Void fraction from previous time step (α^{n-1}).
ALV(1)	A(02)	Old value of liquid-to-interface HTC times the interfacial area due to flashing.
ALVE(1)	A(03)	Old value of liquid-to-interface HTC times the interfacial area due to evaporation.
ALVEN(1)	A(29)	New value of liquid-to-interface HTC times the interfacial area due to evaporation.
ALVN(1)	A(28)	New value of liquid-to-interface HTC times the interfacial area due to flashing.
AM(1)	A(58)	Air mass.
ARA(1)	A(04)	Old stabilizer value for $\alpha\rho_a$.

ARAN(1)	A(30)	New stabilizer value for $\alpha\rho_a$.
ARC(1)	A(59)	Solute density.
AREL(1)	A(05)	Old stabilizer value for $(1 - \alpha)\rho_\ell e_\ell$.
ARELN(1)	A(31)	New stabilizer value for $(1 - \alpha)\rho_\ell e_\ell$.
AREV(1)	A(06)	Old stabilizer value for $\alpha\rho_v e_v$.
AREVN(1)	A(32)	New stabilizer value for $\alpha\rho_v e_v$.
ARL(1)	A(07)	Old stabilizer value for $(1 - \alpha)\rho_\ell$.
ARLN(1)	A(33)	New stabilizer value for $(1 - \alpha)\rho_\ell$.
ARV(1)	A(08)	Old stabilizer value for $\alpha\rho_v$.
ARVN(1)	A(34)	New stabilizer value for $\alpha\rho_v$.
BIT(1)	A(24)	Old bit flag.
BITN(1)	A(50)	New bit flag.
BOR(1)	A(09)	Old solute-to-coolant mass ratio.
BORN(1)	A(35)	New solute-to-coolant mass ratio.
CHTAN(1)	A(40)	New value of noncondensible-to-interface HTC times the interfacial area.
CHTI(1)	A(13)	Old value of vapor-to-interface HTC times the interfacial area.
CHTIA(1)	A(14)	Old value of noncondensible gas-to-interface HTC times the interfacial area.
CHTIN(1)	A(39)	New value of vapor-to-interface HTC times the interfacial area.
CL(1)	A(53)	Liquid conductivity.
CPL(1)	A(54)	Liquid specific heat at constant pressure.
CPV(1)	A(55)	Liquid specific heat at constant volume.
CV(1)	A(56)	Vapor conductivity.
DALP(1)	A(61)	Weighting factor XVSET.
DALVA(1)	A(72)	Not implemented.
DELDP(1)	A(84)	Derivative of the liquid internal energy with respect to pressure at constant temperature.
DELDT(1)	A(86)	Derivative of the liquid internal energy with respect to temperature at constant pressure.

DEVAP(1)	A(98)	Derivative of air internal energy with respect to pressure at constant temperature.
DEVAT(1)	A(97)	Derivative of air internal energy with respect to temperature at constant pressure.
DEVDP(1)	A(85)	Derivative of the steam internal energy with respect to pressure at constant temperature.
DEVDT(1)	A(87)	Derivative of the steam internal energy with respect to temperature at constant pressure.
DHLSP(1)	A(95)	Derivative of HLST with respect to pressure.
DHVSP(1)	A(94)	Derivative of HVST with respect to pressure.
DROLP(1)	A(88)	Derivative of the liquid density with respect to pressure at constant temperature.
DROLT(1)	A(90)	Derivative of the liquid density with respect to temperature at constant pressure.
DROVP(1)	A(89)	Derivative of the steam density with respect to pressure at constant temperature.
DROVT(1)	A(91)	Derivative of the steam density with respect to temperature at constant pressure.
DRVAP(1)	A(99)	Derivative of air density with respect to pressure at constant temperature.
DRVAT(1)	A(100)	Derivative of air density with respect to temperature at constant pressure.
DTSDP(1)	A(83)	Derivative of TSAT with respect to pressure.
DTSSP(1)	A(96)	Derivative of TSSN with respect to pressure.
DXVOL(1)	A(73)	Plenum average length.
EL(1)	A(11)	Old liquid internal energy.
ELEV(1)	A(70)	Plenum center elevation. This is used only if IELV is set to 1 in the NAMELIST input.
ELN(1)	A(37)	New liquid internal energy.
EV(1)	A(12)	Old vapor internal energy.
EVA(1)	A(10)	Old air internal energy.
EVAN(1)	A(36)	New air internal energy.
EVN(1)	A(38)	New vapor internal energy.
FASMLT(1)	A(81)	Interphase area multiplier during condensation.

FAVOL(1)	A(74)	Plenum average flow area.
FINAN(1)	A(106)	Inverted annular flow factor (currently not used).
GAM(1)	A(15)	Old vapor generation rate per unit volume.
GAMN(1)	A(41)	New vapor generation rate per unit volume.
GRAVOL(1)	A(77)	Plenum average GRAV.
HFG(1)	A(60)	Latent heat of vaporization.
HGAM(1)	A(101)	Subcooled liquid HTC.
HIL(1)	A(25)	Old HTC between inside wall and liquid.
HILN(1)	A(51)	New HTC between inside wall and liquid.
HIV(1)	A(26)	Old HTC between inside wall and vapor.
HIVN(1)	A(52)	New HTC between inside wall and vapor.
HLA(1)	A(102)	Average product of the HTC to liquid and the wall surface area of the liquid.
HLATW(1)	A(104)	Average product of the HTC to liquid, the wall surface area of the liquid, and the wall temperature.
HLST(1)	A(93)	Saturated liquid enthalpy (at TSSN and total pressure).
HVA(1)	A(103)	Average product of the HTC to vapor and the wall surface area.
HVATW(1)	A(105)	Average product of the HTC to vapor, the wall surface area of the vapor, and the wall temperature.
HVST(1)	A(92)	Saturated steam enthalpy (at TSSN and steam partial pressure).
P(1)	A(16)	Old pressure.
PA(1)	A(17)	Old air partial pressure.
PAN(1)	A(43)	New air partial pressure.
PN(1)	A(42)	New pressure.
QP3F(1)	A(71)	QPPP factor applied to the wall heat source.
ROL(1)	A(19)	Old liquid density.
ROLN(1)	A(45)	New liquid density.
ROM(1)	A(62)	Mixture density.
ROV(1)	A(20)	Old vapor density.
ROVA(1)	A(18)	Old air density.

ROVAN(1)	A(44)	New air density.
ROVN(1)	A(46)	New vapor density.
SIG(1)	A(63)	Surface tension.
SOLID(1)	A(21)	Old solute mass plated on structure surface.
SOLIDN(1)	A(47)	New boron solute mass plated on structure surface.
TL(1)	A(22)	Old liquid temperature.
TLN(1)	A(48)	New liquid temperature.
TSAT(1)	A(64)	Saturation temperature corresponding to total vapor pressure.
TSSN(1)	A(65)	Saturation temperature corresponding to steam partial pressure.
TV(1)	A(23)	Old vapor temperature.
TVN(1)	A(49)	New vapor temperature.
VISL(1)	A(66)	Liquid viscosity.
VISV(1)	A(67)	Vapor viscosity.
VLALP(1)	A(82)	Maximum value of the liquid mass flux entering the plenum from junctions located above the plenum.
VLVC(1)	A(80)	Absolute value of the liquid velocity at a junction where the donor-celled liquid fraction is maximum.
VLVOL(1)	A(75)	Plenum average liquid velocity.
VOL(1)	A(68)	Plenum volume.
VVVOL(1)	A(76)	Plenum average vapor velocity.
VRVPL(1)	A(108)	Volume average relative velocity in the plenum component (currently not used).
WA(1)	A(69)	Wall area.
WAT(1)	A(107)	Total wall area.

C.8. PRESSURIZER COMPONENT

C.8.1. PRIZEVLT–PRIZER Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.

BSMASS	Time-integrated mass flow from pressurizer.
BSMSSP	Current mass-flow rate during transient.
BXMASS	Current mass-flow rate during steady state.
EPSW	Wall surface roughness.
DPMAX	Differential pressure at which heaters have maximum power.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FLOW	Volume flow rate at discharge.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
HOUTL	HTC between outer boundary of pressurizer wall and liquid.
HOUTV	HTC between outer boundary of pressurizer wall and vapor.
PSET	Pressurizer pressure set point for heater-spray control.
QHEAT	Total heater power.
QIN	Heater power being input to water.
QINT	Initial water volume in pressurizer.
QOUT	Volume of liquid that has discharged from the pressurizer.
QP3IN	Initial QPPP factor.
RADIN	Inner radius of pressurizer wall.
TH	Thickness of pressurizer wall.
TOUTL	Liquid temperature outside pressurizer.
TOUTV	Vapor temperature outside pressurizer.
Z	Water height above discharge.
ZHTR	Water height for heater cutoff.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICHF	CHF calculation option.
ICJ	Not used.
ICONC	Indicator for presence of solute in the coolant input.

ICT1	The sequence number (position in the IORDER array) of the component next to the junction of the pressurizer. This variable is computed but not used.
IUV1	Indicator for velocity update at JUN1.
IUV2	Indicator for velocity update at JUN2.
JS1	Junction sequence number at cell 1 of the pressurizer.
JS2	Junction sequence number at cell NCELLS of the pressurizer.
JUN1	Junction number of the junction at cell 1.
JUN2	Junction number of the junction at cell NCELLS.
NCELLS	Number of fluid cells.
TYPE1	Not used.
TYPE2	Not used.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.8.2. PRIZEPT–PRIZER Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.

C.8.3. PRZDATA–PRIZER Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; PRIZEVLT, defined in Sec. C.8.1; and PRIZEPT, defined in Sec. C.8.2.

C.9. PUMP COMPONENT

C.9.1. PUMPVLT–PUMP Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
AEFFMI	The coefficient for the (OMEGA/ROMEGA)**2 term in the calculation of the variable moment of inertia ($kg \cdot m^2$).
ALPHA	Pump void fraction.
ALPHAO	Void fraction used on previous time step for pump head calculation.

BEFFMI	The coefficient for the (OMEGA/ROMEGA) term in the calculation of the variable moment of inertia ($kg \cdot m^2$).
BSMASS	Time-integrated mass flow from pump.
CEFFMI	The constant term in the calculation of the variable moment of inertia ($kg \cdot m^2$).
DELP	Delta P across pump.
DSMOM	Derivative of pump head with velocity.
EFFMI	Moment of inertia.
EFFMI1	The alternate effective moment of inertia.
EPSW	Wall surface roughness.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FLOW	Pump volumetric flow rate.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
HEAD	Pump head.
HOUTL	HTC between outer boundary of pump wall and liquid.
HOUTV	HTC between outer boundary of pump wall and vapor.
MFLOW	Pump mass-flow rate.
OMEGA	Angular velocity at old time.
OMEGAN	Angular velocity at new time.
OMGOFF	Pump rotational speed when its controlling trip is OFF after it was ON.
OMTEST	The PUMP speed below which EFFMI1 (the alternate effective moment of inertia) is used ($rad \cdot s^{-1}$).
QP3IN	Initial QPPP factor.
QP3OFF	QPPP factor when its controlling trip is OFF after it was ON.
RADIN	Inner radius of wall.
RFLOW	Rated flow.
RHEAD	Rated head.
RHO	Pump mixture density.
ROMEGA	Rated angular velocity.
ROMGMX	Maximum rate of change of the pump rotational speed.
RQP3MX	Maximum rate of change of the QPPP factor.

RRHO	Rated density.
RTORK	Rated torque.
SMOM	Momentum source.
TFR0	Frictional torque constant coefficient.
TFR1	Frictional torque linear coefficient.
TFR2	Frictional torque quadratic coefficient.
TFR3	Frictional torque third-order coefficient.
TFRB	Pump speed that defines the low-speed regime.
TFRL0	Low pump speed frictional torque constant coefficient.
TFRL1	Low pump speed frictional torque linear coefficient.
TFRL2	Low pump speed frictional torque quadratic coefficient.
TFRL3	Low pump speed frictional torque third-order coefficient.
TH	Wall thickness.
TORQUE	Pump torque.
TOUTL	Liquid temperature outside wall.
TOUTV	Vapor temperature outside wall.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICHF	CHF calculation option.
ICJ1	Not used.
ICJ2	Not used.
ICONC	Indicator for presence of solute in the coolant input.
INDXHM	Index on head degradation multiplier curve.
INDXTM	Index on torque degradation multiplier curve.
IONOFF	Number of time steps the pump-speed controlling trip has been ON.
IPF	Last interpolated interval in the pump-speed table's rate-factor table.
IPM	Two-phase indicator. 0 = use single-phase curves; 1 = use two-phase curves.

IPMPS	Flag that indicates whether or not the pump speed previously has dropped below OMTEST. 0 = pump speed always has been greater than OMTEST; 1 = pump speed has dropped below OMTEST at some time.
IPMPS2	Flag that indicates the use of the variable pump inertia; set in subroutine RPUMP.
IPMPSV	Signal-variable ID number that defines the pump-speed table's independent variable.
IPMPTR	Pump trip identification.
IPMPTY	Pump type (1 or 2).
IPP	Last interpolated interval in the pump-speed table.
IQF	Last interpolated interval in the QPPP factor table's rate-factor table.
IQP	Last interpolated interval in the QPPP factor table.
IQP3SV	QPPP factor rate-factor table's abscissa-coordinate variable ID number.
IQP3TR	Trip ID number that controls evaluation of the QPPP factor table.
IRP	Reverse speed indicator. 0 = reverse not allowed; 1 = reverse allowed.
ISOL1	Indicator for velocity update at JUN1.
ISOL2	Indicator for velocity update at JUN2.
JS1	Junction sequence number at cell 1 of the pump.
JS2	Junction sequence number at cell NCELLS of the pump.
JUN1	Junction number of the junction at cell 1.
JUN2	Junction number of the junction at cell NCELLS.
NCELLS	Number of fluid cells.
NDATA(16)	Number of sets of points in head and torque curves.
NDMAX	Size of scratch storage array.
NHDM	Number of points on the head degradation multiplier curve.
NONOFF	Number of time steps the QPPP factor table's controlling trip has been ON.
NPMPRF	The number of rate-factor table pairs whose rate factor is applied to the pump-speed table's independent variable.

NPMPSD	Signal-variable or control-block ID number that defines the pump rotational speed when the pump-speed controlling trip is initially OFF.
NPMPSV	Pump-speed rate-factor table's abscissa-coordinate variable ID number.
NPMPTB	Number of pairs in the pump-speed table.
NQP3RF	Number of pairs in the QPPP factor table's rate-factor table.
NQP3SV	QPPP factor rate-factor table's abscissa-coordinate variable ID number.
NQP3TB	Number of pairs in the QPPP factor table.
NTDM	Number of points on the torque degradation multiplier curve.
OPTION	Pump curve option.
TYPE1	Type of adjacent component at JUN1.
TYPE2	Type of adjacent component at JUN2.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.9.2. PUMPPT–PUMP Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.

HEAD AND TORQUE TABLE:

Name	Array	Dimension	Description
LHSP1	HSP1	2*NDATA(1)	Single-phase head curve 1.
LHSP2	HSP2	2*NDATA(2)	Single-phase head curve 2.
LHSP3	HSP3	2*NDATA(3)	Single-phase head curve 3.
LHSP4	HSP4	2*NDATA(4)	Single-phase head curve 4.
LHTP1	HTP1	2*NDATA(5)	Two-phase head curve 1.
LHTP2	HTP2	2*NDATA(6)	Two-phase head curve 2.
LHTP3	HTP3	2*NDATA(7)	Two-phase head curve 3.
LHTP4	HTP4	2*NDATA(8)	Two-phase head curve 4.
LTSP1	TSP1	2*NDATA(9)	Single-phase torque curve 1.
LTSP2	TSP2	2*NDATA(10)	Single-phase torque curve 2.
LTSP3	TSP3	2*NDATA(11)	Single-phase torque curve 3.

LTSP4	TSP4	2*NDATA(12)	Single-phase torque curve 4.
LTTP1	TTP1	2*NDATA(13)	Two-phase torque curve 1.
LTTP2	TTP2	2*NDATA(14)	Two-phase torque curve 2.
LTTP3	TTP3	2*NDATA(15)	Two-phase torque curve 3.
LTTP4	TTP4	2*NDATA(16)	Two-phase torque curve 4.

MISCELLANEOUS TABLE:

Name	Array	Dimension	Description
LBD4	BD4	LENBD	Dummy variable.
LHDM	HDM	2*NHDM	Head degradation multiplier curve.
LIDXCS	IDXCS	16	Curve set index array.
LNDATA	NDATA	16	Number of sets of points in head and torque curves.
LPMPRF	PMPRF	|NPMPRF|*2	Rate-factor table for the pump-speed table.
LPMPTB	PMPTB	|NPMPTB|*2	Pump rotational speed table.
LQP3RF	QP3RF	|NQP3RF|*2	Rate-factor table for the QPPP factor table.
LQP3TB	QP3TB	|NQP3TB|*2	QPPP factor table.
LTDM	TDM	2*NTDM	Torque degradation multiplier curve.

C.9.3. PUMPDATA–PUMP Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; PUMPVLT, defined in Sec. C.9.1; and PUMPPT, defined in Sec. C.9.2.

C.10. STEAM-GENERATOR COMPONENT

C.10.1. STGENVLT–STGEN Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
BSMSS1	Time-integrated mass flow from primary side.
BSMSS2	Time-integrated mass flow from secondary side.
CA1P	Fraction of liquid velocity at the right face of the primary tee junction cell that contributes to the momentum transfer into the primary tee side leg.

CA1VP	Fraction of vapor velocity at the right face of the primary tee junction cell that contributes to the momentum transfer into the primary tee side leg.
CAP	Fraction of liquid velocity at the left face of the primary tee junction cell that contributes to the momentum transfer into the tee side leg.
CAVP	Fraction of vapor velocity at the left face of the primary tee junction cell that contributes to the momentum transfer into the primary tee side leg.
COSP	Cosine of the angle measured from the low-numbered side of the primary tube to the primary tee tube.
EPSW	Wall surface roughness.
FL(4)	Liquid mass-flow corrections for mass-conservation checks.
FV(4)	Vapor mass-flow corrections for mass-conservation checks.
HTLSGI	Heat loss on the inside of a general surface (HAAT).
HTLSGO	Heat loss on the outside of a general surface (HAAT).
QP3IN	Initial QPPP factor.
RADIN	Inner radius of a tube wall.
TH	Tube wall thickness.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICHF1	Indicator for a CHF calculation on the primary side. 0 = no CHF calculation; 1 = CHF calculation.
ICHF2	Indicator for a CHF calculation on the secondary side. 0 = no CHF calculation; 1 = CHF calculation.
ICNC2	Presence of solute in the secondary input flag. 0 = no boron present; 1 = boron present.
ICONC	Presence of solute in the primary input flag. 0 = no boron present; 1 = boron present.
ISOLP	Indicator for velocity update at JUNP.

ISVLB1	Indicator for velocity update at JUN11.
ISVLB2	Indicator for velocity update at JUN21.
ISVRB1	Indicator for velocity update at JUN12.
ISVRB2	Indicator for velocity update at JUN22.
JCLP	Junction cell index of a primary tee connection.
JINL	Junction cell index for the secondary inlet junction.
JOTL	Junction cell index for the secondary outlet junction.
JS11	Junction sequence number at JUN1.
JS12	Junction sequence number at JUN2.
JSP	Junction sequence number at JUNP.
JUN11	Junction number adjacent to cell 1 on primary side.
JUN12	Junction number adjacent to cell NCELL1 on primary side.
JUNP	Junction number of the high-numbered-cell end of a primary tee.
LGHT	Location in the pointer table of the old-time generalized heat-transfer variables.
LGHTN	Location in the pointer table of the new-time generalized heat-transfer variables.
LNGHT	Length of the variables of the generalized heat-transfer information for which old- and new-time values are stored.
NCELL1	Number of fluid cells on tube side (primary side) excluding the side leg if the primary component is a tee.
NCELL2	Number of fluid cells on shell side (secondary side).
NCELLS	Total number of fluid cells (NCELL1 + NCELL2 + 1) excluding, if the primary component is a tee, the cells on the primary tee side leg.
NCLP	Number of cells on the primary tee.
NCLS(10)	Number of cells on the primary side of a secondary component.
NCLT(10)	Number of cells on the side leg of a secondary component (a TEE).
NDHT	Number of nodes used in the second set of heat conduction paths.
NGHT	Number of heat conduction paths used to model structures in the second set of generalized heat-transfer volumes.
NITJN	Number of junctions internal to the secondary flow path (includes the junctions).

NODMX	Maximum number of nodes for heat conduction paths (maximum of NODES and NOHT).
NOTEE	Number of tees used to construct the secondary flow path.
NSCMP	Number of components used to construct the secondary flow path.
NSJNE	Total number of junctions in the secondary flow path (includes tee junctions and external connections).
NSJUN	On input, the total number of junctions in the secondary flow path. This number then is reduced by the number of fills or breaks that are connected to the secondary external connections.
NSTJN	Number of external connections on secondary steam generator.
NTUBE	The number of conduction paths used to model the first set of generalized heat-transfer volumes.
STYPE(10)	The component types (PIPEs or TEEs) used to construct the secondary flow path.
TYPE11	Type of adjacent component at JUN11.
TYPE12	Type of adjacent component at JUN12.
TYPEP	Type of adjacent component at JUNP.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.10.2. STGENPT–STGEN Pointer Table (For STGEN, NCELLS = NCELL1 + NCELL2 + NCELL3 + NCELL4 + 3 and NCELLT = NCELL1 + NCELL2 + 1)

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
LQPPL	QPPL	NCELLS-1	Heat flux ($W \cdot m^{-3}$) from wall to liquid.
LQPPV	QPPV	NCELLS-1	Heat flux ($W \cdot m^{-3}$) from wall to vapor.

COMPONENT POINTERS:

Name	Array	Dimension	Description
LCAS	CAS	NSCMP	Source term for a fluid cell containing a side tee junction.
LCA1S	CA1S	NSCMP	Source term for a fluid cell that contains a side tee junction.
LCA1VS	CA1VS	NSCMP	Source term for a fluid cell that contains a side tee junction.

LCAVS	CAVS	NSCMP	Source term for a fluid cell that contains a side tee junction.
LCOSS	COSS	NSCMP	Cosine of the angle measured from the low-numbered side of the primary tube to the side tube for a secondary TEE component.
LFLS	FLS	4*NSCMP	Liquid volumetric flow rate.
LFVS	FVS	4*NSCMP	Vapor volumetric flow rate.
LJCLSC	JCLSC	NSJUN	Secondary cell where secondary junction is located.
LJCLT	JCLT	NSCMP	Fluid cell number that contains a side-leg tee connection.
LJNPOS	JNPOS	NSJUN	Junction location parameter (inflow, outflow, or tee).
LJNS	JNS	3*NSCMP	Junction numbers for components composing the steam-generator secondary side.
LJNSC	JNSC	NSJUN	Secondary external junction number (from input).
LJSINT	JSINT	4*NSCMP	Sequence numbers for the junctions composing the steam-generator secondary-side flow path.
LJSSN	JSSN	NSJUN	BD array for the external junction.
LJUNS	JUNS	8*(NSJUN -NOTEE)	An array that contains junction information for the components composing the steam-generator secondary-side flow path.
LNCMSC	NCMSC	NSJUN	Secondary component number that contains the junction.
LNCTS	NCTS	NSJUN	A vector that contains the junction numbers for the components composing the steam-generator secondary side.
LNSOL	NSOL	4*NSCMP	An array that contains information about the method of connecting secondary-side steam-generator components.
LNUMS	NUMS	NSCMP	User-specified steam-generator secondary-side component numbers.
LVSS	VSS	NSJUN	An array that contains information about the method of connecting secondary-side steam-generator components.

HEAT-TRANSFER POINTERS:

Name	Array	Dimension	Description
LCPWG	CPWG	NGHT*NDHM1	Wall specific heat ($J \cdot kg^{-1} \cdot K^{-1}$).
LCWG	CWG	NGHT*NDHM1	Wall conductivity ($W \cdot m^{-1} \cdot K^{-1}$).
LDRG	DRG	NGHT*NDHM1	Internodal spacing (Δr in m) between nodes in the wall.
LEMSG	EMSG	NGHT	Wall emissivity.
LHILG	HHILG	NGHT	HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the liquid on the interior of a wall.
LHILGN	HILGN	NGHT	New-time HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the liquid on the interior of a wall.
LHIVG	HIVG	NGHT	HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the vapor on the interior of a wall.
LHIVGN	HIVGN	NGHT	New-time HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the vapor on the interior of a wall.
LHOLG	HOLG	NGHT	HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the liquid on the exterior of a wall.
LHOLGN	HOLGN	NGHT	New-time HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the liquid on the exterior of a wall.
LHOVG	HOVG	NGHT	HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the vapor on the exterior of a wall.
LHOVGN	HOVGN	NGHT	New-time HTC ($W \cdot m^{-2} \cdot K^{-1}$) to the vapor on the exterior of a wall.
LIDGHI	IDGHI	NGHT	Heat-transfer regime flag for the interior of a wall.
LIDGHO	IDGHO	NGHT	Heat-transfer regime flag for the exterior of a wall.
LIDGI	IDGI	NGHT	Fluid cell identifier for heat transfer with the interior of a wall.
LIDGO	IDGO	NGHT	Fluid cell identifier for heat transfer with the exterior of a wall.
LMATG	MATG	NGHT*NDHM1	Wall material identifier.
LQPCGO	QPCGO	NGHT*NODMX	Old wall volumetric heat source (currently not used).
LQPPCG	QPPCG	NGHT*NODMX	Wall volumetric heat source.

LQPPG	QPPG	NGHT*NODMX	Wall volumetric heat source ($W \cdot m^{-3}$).
LRADIG	RADIG	NGHT	Wall interior radius (m).
LRNG	RNG	NGHT*NODMX	Radial locations (m) of wall heat-transfer nodes.
LRN2G	RN2G	NGHT*NDHM1	Radial locations (m) of the heat conduction cell edges.
LROWG	ROWG	NGHT*NDHM1	Wall density ($kg \cdot m^{-3}$).
LTCHFG	TCHFG	NGHT*NODMX	CHF temperature (K).
LTHG	THG	NGHT	Wall thickness (m).
LTILG	TILG	NGHT	Liquid temperature (K) of the fluid interior to the wall.
LTIVG	TIVG	NGHT	Vapor temperature (K) of the fluid interior to the wall.
LTOLG	TOLG	NGHT	Liquid temperature (K) of the fluid exterior to the wall.
LTOVG	TOVG	NGHT	Vapor temperature (K) of the fluid exterior to the wall.
LTWG	TWG	NGHT*NODMX	Old wall temperature distribution (K).
LTWGN	TWGN	NGHT*NODMX	New wall temperature distribution (K).
LWAIG	WAIG	NGHT	Interior wall surface area (m^2).
LWAOG	WAOG	NGHT	Exterior wall surface area (m^2).

NETWORK POINTERS:

Name	Array	Dimension	Description
LAOLS	AOLS	NSJUN* (NSJUN+1)	Steam-generator network matrix.
LAOUS	AOUS	NSJUN*NSJUN	Steam-generator network matrix.
LAOVS	AOVS	NSJUN*NSJUN	Steam-generator network matrix.
LBDP	BDP	LENBD	Boundary array for the primary tee connection.
LBDS	BDS	NSJUN*LENBD	Boundary arrays for the steam-generator secondary components.
LDRAS	DRAS	NSJUN	Steam-generator network vector.
LDRCS	DRCS	NSJUN	Steam-generator network vector.

LDRELS	DRELS	NSJUN	Steam-generator network vector.
LDREVS	DREVS	NSJUN	Steam-generator network vector.
LDRLS	DRLS	NSJUN	Steam-generator network vector.
LDRVS	DRVS	NSJUN	Steam-generator network vector.
LDVBS	DVBS	NSJUN	Steam-generator network vector.
LIOJS	IIOJS	NSJUN	Vector that contains information regarding the association of the steam-generator junctions and the external network matrix.
LIOUS	IOUS	NSJUN	Vector containing information regarding the sequence numbers of the steam-generator secondary junctions.
LODS	ODS	4*NSJUN	Steam-generator network matrix.
LVRHS	VRHS	NSJUN	Steam-generator network matrix.

C.10.3. STGNDATA–STGEN Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; STGENVLT, defined in Sec. C.10.1; and STGENPT, defined in Sec. C.10.2.

C.11. TEE COMPONENT

C.11.1. TEEVLT–Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
AI	Standpipe flow area.
ALPD	JCELL void fraction for the separator component.
ALPOT	Old offtake void fraction.
ALPOTN	New offtake void fraction.
ALPOTO	Old-old offtake [illegible] fraction.
ALPS	Side-arm sep[illegible]ior void fraction for the separator component.
AN	Separator nozzle exit area.
BSMASS	Time-integrated mass flow from tee.
CA	Fraction of liquid velocity at the left face of the tee junction cell that contributes to the momentum transfer into the tee side leg.

CA1	Fraction of liquid velocity at the right face of the tee junction cell that contributes to the momentum transfer into the side leg.
CA1V	Fraction of vapor velocity at the right face of the tee junction cell that contributes to the momentum transfer into the tee side leg.
CAV	Fraction of vapor velocity at the left face of the tee junction cell that contributes to the momentum transfer into the tee side leg.
COST	Cosine of the angle from the low-numbered segment to the secondary tube.
DELDIM	Constant in the dryer model (currently not used).
DPSEP	Pressure drop across separator.
DPSS	Desired pressure drop across separator.
ENIN1	Total (time-integrated) energy directly input to the primary.
ENIN2	Total (time-integrated) energy directly input to the secondary.
EPSW	Wall surface roughness.
FL(4)	Liquid mass-flow corrections for mass-conservation checks.
FV(4)	Vapor mass-flow corrections for mass-conservation checks.
HOUTL1	HTC to liquid at the outer boundary of the primary tube wall.
HOUTL2	HTC to liquid at the outer boundary of the secondary tube wall.
HOUTV1	HTC to vapor at the outer boundary of the primary tube wall.
HOUTV2	HTC to vapor at the outer boundary of the secondary tube wall.
POWR1	Power per length added to the tee primary.
POWR2	Power per length added to the tee secondary.
PWIN1	Initial power deposited in the coolant of the tee primary tube.
PWIN2	Initial power deposited in the coolant of the tee secondary tube.
PWOFF1	Power deposited in the coolant of the tee primary tube when its controlling trip is OFF after it was ON.
PWOFF2	Power deposited in the coolant of the tee secondary tube when its controlling trip is OFF after it was ON.
QPIN1	Initial QPPP factor in the tee primary tube.
QPIN2	Initial QPPP factor in the tee secondary tube.
QPOFF1	QPPP factor for the tee primary tube when its controlling trip is OFF after it was ON.

QPOFF2	QPPP factor for the tee secondary tube when its controlling trip is OFF after it was ON.
RADIN1	Inner radius of the primary tube.
RADIN2	Inner radius of the secondary tube.
RH	Radius of the separator hub at inlet.
RPWMX1	Maximum rate of change of power deposite[illegible] n the coolant [illegible] tee primary tube.
RPWMX2	Maximum rate of change of power deposited in the coolant for the tee secondary tube.
RQPMX1	Maximum rate of change of the QPPP factor for the tee secondary tube.
RQPMX2	Maximum rate of change of the QPPP factor for the tee secondary tube.
RR1	Radius of larger pickoff ring at first stage of two-stage separator.
TH1	Wall thickness of the primary tube.
TH2	Wall thickness of the secondary tube.
THETA	Angle between swirling vane and horizontal plane.
TLEN1	Length of the primary.
TLEN2	Length of the secondary.
TOUTL1	Tempera[illegible] of liquid outside the primary tube wall.
TOUTL2	Temperature of liquid outside the secondary tube wall.
TOUTV1	Temperature of vapor outside the primary tube wall.
TOUTV2	Temperature of vapor outside the secondary tube wall.
VDRYL	Lower limit for dryer velocity (currently not available).
VDRYU	Upper limit for dryer velocity (currently not available).
WLI0	Liquid flow rate into the separator from the previous time step.
XCO	Carryover ratio of liquid mass flow to total mass flow.
XCU	Carryunder ratio of vapor mass flow to total mass flow.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICBS1	Control-block ID number that defines the separator carryover (the liquid mass flow divided by the total mass flow at the JCELL + 1 interface).

ICBS2	Control-block ID number that defines the separator carryunder (the vapor mass flow divided by the total mass flow at the JCELL + 1 interface).
ICHF	CHF calculation option.
ICJ1	Iteration index of adjacent component to tee at JUN1.
ICJ2	Iteration index of adjacent component to tee at JUN2.
ICJ3	Iteration index of adjacent component to tee at JUN3.
ICONC1	Indicator for presence of boron in the coolant of the tee primary tube.
ICONC2	Indicator for presence of boron in the coolant of the tee secondary tube.
IDRY	Dryer option flag (currently not available).
IENTRN	Offtake model option indicator. 0 = model off; 1 = model on (side-tube internal-junction mass flow determined using offtake model.
IONOF1	Number of time steps the power deposited in the coolant table for the tee primary tube's controlling trip has been ON.
IONOF2	Number of time steps the power deposited in the coolant table for the tee secondary tube's controlling trip has been ON.
IPF1	Last interpolated interval number of the rate-factor table for the power deposited in the coolant of the tee primary tube.
IPF2	Last interpolated interval number of the rate-factor table for the power deposited in the coolant of the tee secondary tube.
IPOW1	Indicator for presence of power deposited in the coolant of the tee primary tube.
IPOW2	Indicator for presence of power deposited in the coolant of the tee secondary tube.
IPP1	Last interpolated interval number of the power deposited in the coolant table for the tee primary tube.
IPP2	Last interpolated interval number of the power deposited in the coolant table for the tee secondary tube.
IPWSV1	Power deposited in the coolant table's abscissa-coordinate variable ID number for the tee primary tube.
IPWSV2	Power deposited in the coolant table's abscissa-coordinate variable ID number for the tee secondary tube.
IPWTR1	Trip ID number that controls evaluation of the power deposited in the coolant table for the tee primary tube.

IPWTR2	Trip ID number that controls evaluation of the power deposited in the coolant table for the tee secondary tube.
IQF1	Last interpolated interval number of the rate-factor table for the QPPP factor table of the tee primary tube.
IQF2	Last interpolated interval number of the rate-factor table for the QPPP factor of the tee secondary tube.
IQP1	Last interpolated interval number of the QPPP factor table for the tee primary tube.
IQP2	Last interpolated interval number of the factor table for the tee secondary tube.
IQPSV1	QPPP factor table's abscissa-coordinate variable ID number for the tee primary tube.
IQPSV2	QPPP factor table's abscissa-coordinate variable ID number for the tee secondary tube.
IQPTR1	Trip ID number that controls evaluation of the QPPP factor table for the tee primary tube.
IQPTR2	Trip ID number that controls evaluation of the QPPP factor table for the tee secondary tube.
ISEP	Separator flag.
ISOL1	Indicator for velocity update at JUN1.
ISOL2	Indicator for velocity update at JUN2.
ISOL3	Indicator for velocity update at JUN3.
ISOLN	Advanced separator flag.
ISTAGE	Separator-type option.
JCELL	Index of the junction cell within the primary tube.
JS1	Junction sequence number at cell 1 of the primary tube.
JS2	Junction sequence number at cell NCELL1 of the primary tube.
JS3	Junction sequence number at cell NCELL2 of the side tube.
JUN1	Junction number of the junction at cell 1 of the primary tube.
JUN2	Junction number of the junction at cell NCELL1 of the primary tube.
JUN3	Junction number of the junction at cell NCELL2 of the side tube.
NCELL1	Number of fluid cells in the primary tube of the tee.
NCELL2	Number of fluid cells in the side tube of the tee.

NCELLS	NCELL1 + NCELL2 + 1.
NCSEP	Separator flag.
NDRYR	Dryer option flag (dryer not available).
NONOF1	Number of time steps the QPPP factor table for the tee primary tube's controlling trip has been ON.
NONOF2	Number of time steps the QPPP factor table for the tee secondary tube's controlling trip has been ON.
NPWRF1	Number of pairs in the rate-factor table for the power deposited in the coolant table of the tee primary tube.
NPWRF2	Number of pairs in the rate-factor table for the power deposited in the coolant table of the tee secondary tube.
NPWSV1	Rate-factor table's abscissa-coordinate variable ID number for the power deposited in the coolant table of the tee primary tube.
NPWSV2	Rate-factor table's abscissa-coordinate variable ID number for the power deposited in the coolant table of the tee secondary tube.
NPWTB1	Number of pairs in the power deposited in the coolant table for the tee primary tube.
NPWTB2	Number of pairs in the power deposited in the coolant table for the tee secondary tube.
NQPRF1	Number of pairs in the rate-factor table for the QPPP factor table of the tee primary tube.
NQPRF2	Number of pairs in the rate-factor table for the QPPP factor table of the tee secondary tube.
NQPSV1	Rate-factor table's abscissa-coordinate variable ID number for the QPPP factor table of the tee primary tube.
NQPSV2	Rate-factor table's abscissa-coordinate variable ID number for the QPPP factor table of the tee secondary tube.
NQPTB1	Number of pairs in the QPPP factor table for the tee primary tube.
NQPTB2	Number of pairs in the QPPP factor table for the tee secondary tube.
NSEPS	Number of physical separators modeled.
TYPE1	Type of adjacent component at JUN1.
TYPE2	Type of adjacent component at JUN2.
TYPE3	Type of adjacent component at JUN3.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.11.2. TEEPT–TEE Pointer Table (For TEE, NCELLS = NCELL1 + NCELL2 + 1)

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.
LAA	AA	ISTAGE	Void profile coefficient inside water layer radius.
LADS	ADS	ISTAGE	Flow area of discharge path.
LBB	BP	ISTAGE	Void profile coefficient within water layer.
LBD4	BD4	LENBD	BD4 array.
LCKS	CKS	ISTAGE	Loss coefficient for discharge passage.
LDDS	DDS	ISTAGE	Hydraulic diameter of discharge passage.
LEFFLD	EFFLD	ISTAGE	Effective L/D coefficient at pickoff ring.
LHBS	HBS	ISTAGE	Length of the separator band.
LHSK	HSK	ISTAGE	Axial distance between discharge and swirling vane.
LPOWRF	POWRF	(|NPWRF1| +|NPWRF2|)*2	Rate-factor tables for the power deposited in the coolant tables.
LPOWTB	POWTB	(|NPWTB1| +|NPWTB2|)*2	Power deposited in the coolant table.
LRWS	RWS	ISTAGE	Inner radius of separator wall.
LRRS	RRS	ISTAGE	Inner radius of the pickoff ring.
LQP3RF	QP3RF	(|NQPRF1| +|NQPRF2|)*2	Rate-factor table for the QPPP factor tables.
LQP3TB	QP3TB	(|NQPTB1| +|NQPTB2|)*2	QPPP factor tables.

C.11.3. TEEDATA–TEE Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; TEEVLT, defined in Sec. C.11.1; and TEEPT, defined in Sec. C.11.2.

C.12. TURBINE COMPONENT

C.12.1. TURBNVLT–TURB Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
ALPHA1	Upstream void fraction.
ALPHA2	Downstream void fraction.
AR	Area ratio (bucket exit area/nozzle exit area).
BSMASS	Time-integrated mass flow from turbine.
COEF1	Nozzle coefficient.
COEF2	Bucket coefficient.
COF3SQ	Fraction of reaction energy actually delivered in the stage.
CP	Specific heat at constant pressure.
CPOW	Special turbine input.
DIA	Bucket centerline diameter.
DSMOM	Derivative of SMOM with respect to velocity.
EFFDSN	Stage efficiency at design conditions.
EFFSTG	Stage efficiency.
ENINP	Total (time-integrated) energy directly input to the turbine.
EPSW	Wall surface roughness.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FLODIR	Flow direction flag. −1 = indicates normal flow direction is from JUN2 to JUN1; 1 = indicates normal flow direction is from JUN1 to JUN2.
FLOW	Mass-flow rate.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
GAMMA	Isentropic exponent of expansion.
PHIREM	Remaining losses (rotation or diaphragm-packing).
PLENT	Total length of the turbine stage.
POWIN	Initial power in the coolant.
POWDSN	Stage power output at design conditions.
POWOFF	Power in the coolant when the controlling trip is OFF after it was ON.
POWSTG	Stage power output.
PRES1	Upstream pressure.

PRES2	Downstream pressure.
QUALTY	Thermodynamic quality of steam.
REACTN	Degree of reaction at design conditions.
RHOL1	Upstream liquid density.
RHOL2	Downstream liquid density.
RHOM1	Upstream mixture density.
RHOM2	Downstream mixture density.
RHOV1	Upstream steam density.
RHOV2	Downstream steam density.
RPOWMX	Maximum rate of change of the power deposited in the coolant.
SMOM	Source term in the momentum equation (head gain).
SUPRHT	Upstream degree of superheat of steam.
TEMPL1	Upstream liquid temperature.
TEMPL2	Downstream liquid temperature.
TEMPV1	Upstream steam temperature.
TEMPV2	Downstream steam temperature.
VELL1	Upstream liquid velocity.
VELL2	Downstream liquid velocity.
VELM1	Upstream mixture velocity.
VELM2	Downstream mixture velocity.
VELV1	Upstream steam velocity.
VELV2	Downstream steam velocity.
VSTAG	Stagnation velocity.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICJ1	Iteration index of adjacent component at JUN1.
ICJ2	Iteration index of adjacent component at JUN2.
ICONC	Presence of boron dissolved in the liquid coolant flag.

IONOFF	Number of time steps the power deposited in the coolant trip has been ON.
IPF	Power deposited in the coolant table's rate-factor table interval last interpolated.
IPOW	Presence of power in the coolant flag.
IPOWSV	Power deposited in the coolant table's abscissa-coordinate variable ID number.
IPOWTR	Trip ID number that controls power deposited in the coolant table evaluation.
IPP	Power deposited in the coolant table interval last interpolated.
ISOLLB	Indicator for velocity update at JUN1.
ISOLRB	Indicator for velocity update at JUN2.
ISTG	Stage number.
JS1	Junction sequence number at cell 1 of the turbine.
JS2	Junction sequence number at cell NCELLS of the turbine.
JUN1	Junction number of the junction at cell 1.
JUN2	Junction number of the junction at cell NCELLS.
LENTRB	Length of the turbine block in array data (information pertaining to the entire turbine-generator assembly, that is, the sum over all stages).
NCELLS	Number of fluid calculation cells in the turbine component.
NEFCON	Turbine efficiency. 0 = stage efficiency to be computed at off-design conditions; 1 = constant efficiency.
NPOWRF	Number of entry pairs in the power deposited in the coolant table's rate-factor table.
NPOWSV	Power deposited in the coolant rate-factor table's abscissa-coordinate variable ID number.
NPOWTB	Number of entry pairs in the power deposited in the coolant table.
NROWS	Number of rows of moving blades.
TYPE1	Type of adjacent component at JUN1.
TYPE2	Type of adjacent component at JUN2.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.12.2. TURBPT–TURB Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.
LANGL	ANGL	NROWS2	Pointer for blade angles.
LPOWRF	POWR	|NPOWRF|*2	Pointer variable address for the power deposited in the coolant table's rate-factor table.
LPOWTB	POWTB	|NPOWTB|*2	Pointer variable address for the power deposited in the coolant table.
LTURB	TURB	−1	Absolute LCM address for the turbine data common among all stages.

C.12.3. TURBDATA–TURB Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; TURBNVLT, defined in Sec. C.12.1; and TURBPT, defined in Sec. C.12.2.

C.13. VALVE COMPONENT

C.13.1. VALVEVLT–VALVE Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
AVLVE	Valve open flow area.
BSMASS	Time-integrated mass flow from the valve.
EPSW	Wall surface roughness.
FAVLVE	Fraction of the fully open flow area AVLVE to which the adjustable valve cross section is set.
FL(2)	Liquid mass-flow corrections for mass-conservation checks.
FMAXOV	Maximum flow area fraction or relative valve stem position during valve adjustment by the overriding trip.
FMINOV	Minimum flow area fraction or relative valve stem position during valve adjustment by the overriding trip.

FRIC0	Fully open valve form-loss FRIC forward flow.
FRIC0R	Fully open valve form-loss FRIC reverse flow.
FV(2)	Vapor mass-flow corrections for mass-conservation checks.
HDRDX	Fully open valve hydraulic diameter over DX.
HOUTL	HTC between outer boundary of valve wall and liquid.
HOUTV	HTC between outer boundary of valve wall and vapor.
HVLVE	Valve open hydraulic diameter.
QP3IN	Initial QPPP factor.
QP3OFF	QPPP factor when the controlling trip is OFF after it was ON.
RADIN	Inner radius of pipe wall.
RQP3MX	Maximum allowed rate of change of the QPPP factor(s).
RVMX	Maximum rate of change of valve flow area fraction or relative valve stem position.
RVOV	Rate of change of valve flow area fraction or relative valve stem position when controlled by the overriding trip being ON.
TH	Thickness of pipe wall.
TOUTL	Liquid temperature outside valve.
TOUTV	Vapor temperature outside valve.
XPOS	Variable flag for valve operation in progress. 0 = no movement; 1 = opening movement.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
ICHF	CHF calculation option.
ICJ1	Iteration index of adjacent component at JUN1.
ICJ2	Iteration index of adjacent component at JUN2.
ICONC	Indicator for presence of boron in the coolant.
IONOFF	Number of time steps the valve table's controlling trip has been ON.
IQF	Last interpolated interval number in the rate-factor table for the QPPP factor table.

IQP	Last interpolated interval number in the QPPP factor table.
IQP3SV	QPPP factor table's abscissa-coordinate variable ID number.
IQP3TR	Trip ID number that controls evaluation of the QPPP factor table.
ISOLLB	Indicator for velocity update at JUN1.
ISOLRB	Indicator for velocity update at JUN2.
IVF	Last interpolated interval number in the rate-factor table for the valve adjustment table.
IVP1	Last interpolated interval number in the first valve adjustment table.
IVP2	Last interpolated interval number in the second valve adjustment table.
IVPS	Adjustable valve interface position.
IVSV	Signal-variable ID number that defines the valve table's independent variable.
IVTR	Trip ID number that controls evaluation of the valve adjustment table(s).
IVTROV	Trip ID number that overrides trip IVTR control of the adjustable valve.
IVTY	Valve type option indicator.
IVTYOV	Type of valve flow adjustment by the overriding trip IVTROV.
JS1	Junction sequence number at cell 1 of the valve.
JS2	Junction sequence number at cell NCELLS of the valve.
JUN1	Junction number of the junction at cell 1.
JUN2	Junction number of the junction at cell NCELLS.
MODE	Indicator for valve movement over the previous time step. −1 = closing; 0 = no movement; 1 = opening.
NCELLS	Number of fluid cells.
NONOFF	Number of time steps the QPPP factor table's controlling trip has been ON.
NQP3RF	Number of pairs in the rate-factor table for the QPPP factor table.
NQP3SV	Rate-factor table's abscissa-coordinate variable ID number for the QPPP factor table.
NQP3TB	Number of pairs in the QPPP factor table.
NVRF	Number of rate-factor table pairs whose rate factor is applied to the valve table's independent variable.

NVSV	Rate-factor table's abscissa-coordinate variable ID number for the valve adjustment table(s).
NVTB1	Number of pairs in the first valve adjustment table.
NVTB2	Number of pairs in the second valve adjustment table.
TYPE1	Type of adjacent component at JUN1.
TYPE2	Type of adjacent component at JUN2.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.13.2. VLVEPT–VALVE Pointer Table

Name	Array	Dimension	Description
DUALPT	—	—	General pointer table.
HYDROPT	—	—	General pointer table.
INTPT	—	—	General pointer table.
HEATPT	—	—	General pointer table.
LQP3RF	QP3RF	|NQP3RF|*2	Rate-factor table for the QPPP factor table.
LQP3TB	QP3TB	|NQP3TB|*2	QPPP factor table.
LVRF	VRF	|NVRF|*2	Rate-factor table for the valve adjustment table(s).
LVTB1	VTB1	|NVTB1|*2	First valve adjustment table.
LVTB2	VTB2	|NVTB2|*2	Second valve adjustment table.

C.13.3. VLVEDATA–VALVE Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; VALVEVLT, defined in Sec. C.13.1; and VLVEPT, defined in Sec. C.13.2.

C.14. VESSEL COMPONENT

C.14.1. VSSELVLT–VESSEL Variable-Length Table

REAL VARIABLES:

Parameter	Description
AA1111	Dummy variable that provides a known start to the COMMON block.
BSMASS	Integrated fluid flow from vessel at start of time step.
BSMSSN	Integrated fluid flow from vessel at end of time step.
CIMFR	Core inlet mass-flow rate.
CIMFRL	Core inlet liquid mass-flow rate.

CIMFRV	Core liquid volume fraction.
COMFR	Core outlet mass-flow rate.
COMFRL	Core liquid outlet mass-flow rate.
COMFRV	Core outlet vapor pressure mass-flow rate.
CORELQ	Core liquid volume fraction.
DCFLOW	Downcomer mass-flow rate.
DCLQVL	Downcomer liquid volume fraction.
EPSW	Wall surface roughness.
GCC	Gravity-acceleration constant.
GEOMFC	Geometry factor (1.0 = cylindrical, 0.0 = Cartesian).
GRAVZ	GRAV component in the z-direction.
PCORE	Average core pressure.
PDC	Downcomer average pressure.
PLP	Lower-plenum average pressure.
PUP	Upper-plenum average pressure.
QHSTOT	Total heat flux from heat-structure components coupled to the vessel component.
QSLTOT	Total heat flux from heat-structure components coupled to the vessel component (not evaluated).
SHELV	Addition to the input vessel Z coordinates to get elevations for computing GRAV in one dimension.
TCILMF	Integrated core inlet liquid mass flow (kg).
TCIVMF	Integrated core inlet vapor mass flow (kg).
TCOLMF	Integrated core outlet liquid mass flow (kg).
TCORE	Average core temperature.
TCOVMF	Integrated core outlet vapor mass flow (kg).
TDC	Downcomer average liquid temperature.
TLP	Lower-plenum average temperature.
TSCORE	Average core saturation temperature.
TSDC	Downcomer average saturation temperature.
TSLP	Lower-plenum average saturation temperature.

TSUP	Upper-plenum average liquid temperature.
TUP	Upper-plenum average liquid temperature.
VBMASS	Mass counter for internal break sources.
VBMSSN	Mass counter for internal break sources.
VCORE	Total liquid mass in the core.
VDCLQ	Total liquid mass in the downcomer.
VFMASS	Mass counter for internal fill source.
VFMSSN	Mass counter for internal fill source.
VLCORE	Core liquid mass.
VLPLIQ	Lower-plenum liquid volume fraction.
VLPLM	Lower-plenum liquid mass.
VLPLQ	Total liquid mass in the lower plenum.
VLQMSS	Total liquid mass in the vessel.
VOLDC	Downcomer volume.
VOLLP	Lower-plenum volume.
VOLUP	Upper-plenum volume.
VSFLOW	Vessel mass flow.
VUPLIQ	Upper-plenum liquid volume fraction.
VUPLM	Upper-plenum liquid mass.
Z11111	Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

Parameter	**Description**
IA1111	Dummy variable that provides a known start to the COMMON block.
IALL	IALLL.
IALLL	ICXL + NXBCP*NV.
IC0	IC0MM + NXBCM*NV.
IC0L	IC0MM + NXBCM*NV.
IC0M	IC0MM + (NXBCM-1)*NV.
IC0ML	IC0MM + (NXBCM-1)*NV.
IC0MM	A array starting location for vessel three-dimensional arrays.

IC0MML	IC0MM.
ICONC	Presence of boron in the coolant flag.
ICRL	Core lower-boundary segment number, Z(ICRL).
ICRR	Core outer radial-boundary segment number, RAD(ICRR).
ICRU	Core upper-boundary segment number, Z(ICRU).
ICX	ICXL.
ICXL	IC0MM + (NXBCM + NXR-2)*NV.
ICXP	ICXPL.
ICXPL	ICXL + NV.
IDCL	Downcomer lower-boundary segment number, Z(IDCL).
IDCR	Downcomer radial-boundary segment number, RAD(IDCR).
IDCU	Downcomer upper-boundary segment number, Z(IDCU).
IEXT	Specifies if this VESSEL input was generated by the post processor EXTRACT. 0 = no; 1 = yes.
IF0	IF0L.
IF0L	IC0ML if IGEOM.EQ.1.AND.IGBCXR.EQ.1, else IC0L.
IFX	IFXL.
IFXL	IF0L + (NXRV-1)*NV.
IGBC	IGBCXR + IGBCYT + IGBCZ.
IGBCXR	Flag (0 or 1) for internal pressure/velocity boundary conditions on the x- or r-direction walls of the VESSEL component.
IGBCYT	Flag (0 or 1) for internal pressure/velocity boundary conditions on the y- or θ-direction walls of the VESSEL component.
IGBCZ	Flag (0 or 1) for internal pressure/velocity boundary conditions on the z-direction walls of the VESSEL component.
IGEOM	Vessel geometry option. 0 = cylindrival geometry; 1 = Cartesian geometry.
ILCSP	Lower-core support-plate axial segment number.
INHSMX	Number of interfaces between dissimilar materials in the vessel slabs.
IUCSP	Upper-core support-plate axial segment number.

IUHP	Upper head-plate axial segment number.
IVSSBF	Internal vessel boundary condition. 0 = no internal boundaries (default); 2 = first axial level acts like a fill, last axial level acts like a break; 20 = first axial level acts like a break, last axial level acts like a fill; 22 = both the first and last axial levels act like breaks.
IZBK	Switch for back-up on water pack.
IZBK2	Switch for re-donor-cell logic.
IZNX	Variable used in water-packing logic.
JALL	JCX + NYBCP.
JC0	NYBCM + 1.
JC0M	NYBCM.
JC0MM	NYBCM-1.
JCX	JC0 + NYT-1.
JCXP	JCX + 1.
JF0	JC0M if IGEOM.EQ.1.AND.IGBCYT.EQ.1, else JC0.
JFX	JF0 + NYT-1.
KALL	KCX + NZBCP.
KC0	NZBCM+1.
KC0M	NZBCM.
KC0MM	NZBCM-1.
KCX	KC0 + NZZ-1.
KCXP	KCX + 1.
KF0	KC0M if IGBCZ.EQ.1, else KC0.
KFX	KF0 + NZZ-1.
LENLD	Length of level data.
LENLDO	Defined to be zero and currently not used.
LFVL	Relative position of old fundamental variables of level data.
LFVNL	Relative position of new fundamental variables of level data.
LNFVL	Length of fundamental variables of level data.
LNPTRL	Number of level data pointers.
LOCVSP	Beginning offset for the vessel pointer table.

LSTVSP	Length of the vessel pointer table.
LTEMPL	Location of temporary space in the A array to contain one level of data for editing of level data. Calculated but not used.
NASX	Number of axial segments (levels).
NCELLS	Number of fluid cells.
NCLX	Number of fluid cells per level.
NCRX	Maximum number of core volumes per level.
NCSR	Number of cell sources (connections).
NIJT	NI * JALL.
NODHS	Number of nodes in the heat slab.
NRSX	Number of radial segments.
NSGRID	Number of spacer grids present in the core region. Spacer grids are modelled only when the reflood model has been selected by inputting NAMELIST variable NEWRFD = 1.
NTSX	Number of theta segments.
NVENT	Number of cells with vent valves in outer radial surface.
NVVTB	Number of input pairs in multiple-point vent-valve table.
NXRV	NRSX if IGEOM.EQ.0.AND.IGBCXR.NE.0, else NRSXH if IGEOM.NE.0.AND. IGBCXR.NE.0, else NRSX-1.
NYTV	NTSX-1 if IGEOM.EQ.0.AND.IGBCYT.EQ.0, else NTSX+1 if IGEOM.NE.0. AND.IGBCYT.NE.0, else 0 if IGEOM.EQ.0.AND.NTSX.EQ.1, else NTSX.
NZZV	NASX+1 if IGBCZ.NE.0, else NASX-1.
ZI1111	Dummy variable that provides a known end to the COMMON block.

C.14.2. VSSLPT–VESSEL Pointer Table

COMMON DATA POINTERS:

Name	Array	Dimension	Description
LALPAG	ALPAG	NTSX*NCSX	Old void fraction at the agitated inverted annular flow.
LALPAN	ALPAN	NTSX*NRSX	New void fraction at the agitated IAF.
LALPCN	ALPCN	NTSX*NRSX	New void fraction at the CHF point.
LALPRN	ALPRN	NTSX*NRSX	New void fraction at the rough-wavy IAF.
LALPRW	ALPRW	NTSX*NRSX	Old void fraction at the rough-wavy IAF.

LALPSM	ALPSM	NTSX*NRSX	Old void fraction at the smooth IAF.
LALPSN	ALPSN	NTSX*NRSX	New void fraction at the smooth IAF.
LALPTN	ALPTN	NTSX*NRSX	New void fraction at the transition boiling.
LAVENT	AVENT	NVENT	Pointer for vent-valve areas.
LDPCVN	DPCVN	NVENT	Pointer for vent-valve maximum ΔP to be closed.
LDPOVN	DPOVN	NVENT	Pointer for vent-valve minimum ΔP to be open.
LDR	DR	NRSX	Radial segment lengths (delta R).
LDTH	DTH	NTSX	Theta segment length (delta theta).
LDVLDP	DVLDP	NCSR	Derivative of liquid source velocity with respect to pressure.
LDVVDP	DVVDP	NCSR	Derivative of vapor source velocity with respect to pressure.
LDZ	DZ	NASX	Axial segment lengths (delta Z).
LFRCVN	FRCVN	NVENT	FRIC value when vent valve closed.
LFROVN	FROVN	NVENT	FRIC value when vent valve opened.
LFUNH	FUNH	NCLX*NEWRFD	Fraction of the heat-structure surface in each horizontal-plant mesh cell that is unheated.
LGRAVR	GRAVR	NYBCM + NTSX + NYBCP	x- or y-direction component of the gravity unit vector on each y- or θ-direction mesh-cell interface.
LGRAVT	GRAVT	NYBCM + NTSX + NYBCP	y- or θ-direction component of the gravity unit vector on each y- or θ-direction mesh-cell interface.
LICJ	ICJ	NCSR	Component number adjacent to a source.
LISOLB	ISOLB	NCSR	Indicator for velocity update.
LISRC	ISRC	NCSR	Relative cell number associated with source.
LISRF	ISRF	NCSR	Face number associated with source.
LISRL	ISRL	NCSR	Level number associated with source.
LIZINL			(Not used.)
LIZINS			(Not used.)

LJSN	JSN	NCSR	Junction sequence number associated with source.
LJUNS	JUNS	NCSR	Junction number associated with source.
LLOCVN	LOCVN	NVENT	Pointer for vent-valve location.
LMSC	MSC	NCSR	Absolute cell number of source.
LNHSCA	NHSCA	NTSX*NRSX	Heat-structure component number for average rod.
LNSRL	NSRL	NASX	Number of sources on level.
LPSNEW	PSNEW	NCSR	New source pressure.
LPSOLD	PSOLD	NCSR	Old source pressure.
LRAD	RAD	NRSX	Radial segment outer radii.
LREFLD	REFLD	NTSX*NRSX	Reflood flag.
LSAC	SAC	NCSR*2	Air continuity source.
LSCC	SCC	NCSR*ISOLUT	Solute concentration source terms. ISOLUT = 0 or 1.
LSLC	SLC	NCSR*2	Liquid continuity source.
LSLE	SLE	NCSR*2	Liquid energy source.
LSMOML	SMOML	NCSR*6	Liquid momentum source.
LSMOMV	SMOMV	NCSR*6	Vapor momentum source.
LSVC	SVC	NCSR*2	Vapor continuity source.
LSVE	SVE	NCSR*2	Vapor energy source.
LTEMPS	TEMPS	LENLD	Temporary array used to edit a level of vessel data.
LTH	TH	NTSX	Theta segment angle.
LVELSL	VELSL	NCSR	Liquid source velocity.
LVELSV	VELSV	NCSR	Vapor source velocity.
LVVTB	VVTB	NVVTB*2	Pointer to multiple-point vent-valve table.
LZ	Z	NASX	Axial segment upper elevation.
LZAGS	ZAGS	NTSX*NRSX	Old location of agitated inverted annular flow (IAF).
LZAGSN	ZAGSN	NTSX*NRSX	New location of agitated IAF.
LZCHFN	ZCHFN	NTSX*NRSX	New location of CHF point.

LZDFS	ZDFS	NTSX*NRSX	Old location of dispersed IAF.
LZDFSN	ZDFSN	NTSX*NRSX	New location of disposed IAF.
LZRWS	ZRWS	NTSX*NRSX	Old location of rough-wavy IAF.
LZRWSN	ZRWSN	NTSX*NRSX	New location of rough-wavy IAF.
LZSGRD	ZSGRD	NTSX*NRSX	New location of grid spacer.
LZSMS	ZSMS	NTSX*NRSX	Old location of smooth IAF.
LZSMSN	ZSMSN	NTSX*NRSX	New location of smooth IAF.
LZTBN	ZTBN	NTSX*NRSX	New location of transition boiling.

LEVEL DATA GRAPHICS IDENTIFIERS:

Name	**Array**	**Dimension**	**Description**
LAID1	AID1	0	Variable not used.
LAID1N	AID1N	0	Variable not used.
LAID2	AID2	0	Variable not used.
LAID2N	AID2N	0	Variable not used.
LALD1	ALD1	0	Variable not used.
LALD1N	ALD1N	0	Variable not used.
LALD2	ALD2	0	Variable not used.
LALD2N	ALD2N	0	Variable not used.
LALP	ALP	0	Variable not used.
LALPN	ALPN	NA	Graphics identifier for new vapor fraction.
LALV	ALV	0	Variable not used.
LALVEN	ALVEN	NA	Graphics identifier for new interface-to-liquid evaporation coefficient times interfacial area.
LALVN	ALVN	NA	Graphics identifier for new interfacial area.
LAM	AM	NA	Graphics identifier for Γ phase-change rate.
LARC	ARC	NA	Graphics identifier for cellular solute density. ISOLUT = 0 or 1.
LARV	ARV	NA	Graphics identifier for old product of void fraction and vapor density.
LARVN	ARVN	NA	Graphics identifier for new product of void fraction and vapor density.
LBIT	BIT	NA	Graphics identifier for bit flag.

LBITN	BITN	NA	Graphics identifier for bit flag.
LC5P3			Variable not used.
LC5P4			Variable not used.
LC5P5			Variable not used.
LC5P6			Variable not used
LCINYT	CINYT	NA	Graphics identifier for interfacial drag coefficient for the θ-direction.
LCIXR	CIXR	NA	Graphics identifier for interfacial drag coefficient for radial direction.
LCIYT	CIYT	NA	Graphics identifier for interfacial drag coefficient for θ-direction.
LCIZ	CIZ	NCLX	Graphics identifier for interfacial drag coefficient for axial direction.
LCFZL	CFZL	NCLX*3*NFRC3	Graphics identifier for directional form-loss coefficient for liquid.
LCFZV	CFZV	NCLX*3*NFRC3	Graphics identifier for directional form-loss coefficient for vapor.
LCHTAN	CHTAN	NCLX	New interface-to-noncondensible HTC times the interfacial area.
LCHTIN	CHTIN	NCLX	Graphics identifier for new interface-to-vapor HTC times interfacial area.
LCL	CL	0	Variable not used.
LCNHS	CNHS	0	Variable not used.
LCNHSN	CNHSN	0	Variable not used.
LCONC	CONC	0	Variable not used.
LCONCO	CONCO	0	Variable not used.
LCPHS	CPHS	0	Variable not used.
LCPHSN	CPHSN	0	Variable not used.
LCPL	CPL	0	Variable not used.
LCPV	CPV	0	Variable not used.
LCV	CV	0	Variable not used.
LDLL	DLL	0	Variable not used.
LDRIV	DRIV	0	Variable not used.

LDROP	DROP	0	Variable not used.
LDVD1	DVD1	0	Variable not used.
LDVD2	DVD2	0	Variable not used.
LDVV	DVV	0	Variable not used.
LDZZ	DZZ	0	Variable not used.
LEA	EA	0	Variable not used.
LEAN	EAN	0	Variable not used.
LEL	EL	0	Variable not used.
LELN	ELN	0	Variable not used.
LEMHS	EMHS	0	Variable not used.
LEV	EV	0	Variable not used.
LEVN	EVN	0	Variable not used.
LFA	FA	NCLX*3	Graphics identifier for cell-edge flow areas.
LFAG	FAG	0	Variable not used.
LFINAN	FINAN	0	Variable not used.
LFRIC1	FRICI	0	Variable not used.
LFRCIN	FRCIN	0	Variable not used.
LFRICI	FRICI	0	Variable not used.
LFRICL	FRICL	0	Variable not used.
LFRICV	FRICV	0	Variable not used.
LGAM	GAM	0	Variable not used.
LGAMN	GAMN	0	Variable not used.
LGCOND	GCOND	0	Variable not used.
LGEVAP	GEVAP	0	Variable not used.
LHD	HD	0	Variable not used.
LHDYT	HDYT	NCLX*3	Interface hydraulic diameters.
LHFG	HFG	0	Variable not used.
LHGAM	HGAM	0	Variable not used.
LHLA	HLA	0	Variable not used.
LHLATW	HLATW	0	Variable not used.

LHLV	HLV	0	Variable not used.
LHLVN	HLVN	0	Variable not used.
LHSA	HSA	0	Variable not used.
LHSHL	HSHL	0	Variable not used.
LHSHLO	HSHLO	0	Variable not used.
LHSHV	HSHV	0	Variable not used.
LHSHVO	HSHVO	0	Variable not used.
LHST	HST	0	Variable not used.
LHSTN	HSTN	0	Variable not used.
LHSX	HSX	0	Variable not used.
LHVA	HVA	0	Variable not used.
LHVATW	HVATW	0	Variable not used.
LICMSH	ICMSH	0	Variable not used.
LIDRGS	IDRGS	0	Variable not used.
LIHSN	IHSN	0	Variable not used.
LISRN	ISRN	0	Variable not used.
LMATHS	MATHS	0	Variable not used.
LMFRL	MFRL	NCLX*IMFR	Graphics identifier for liquid mass flow.
LMFRV	MFRV	NCLX*IMFR	Variable not used.
LP	P	0	Variable not used.
LPA	PA	0	Variable not used.
LPAN	PAN	NCLX	Graphics identifier for new air partial pressure.
LPN	PN	NCLX	Graphics identifier for new pressure.
LQRD	QRD	0	Variable not used.
LQSL	QSL	NCLX	Graphics identifier for slab heat flux.
LQVD1	QVD1	0	Variable not used.
LQVD2	QVD2	0	Variable not used.
LRDZ	RDZ	0	Variable not used.
LRMEM	RMEM	0	Variable not used.
LROA	ROA	0	Variable not used.

LROAN	ROAN	NCLX	Graphics identifier for new air density.
LROHS	ROHS	0	Variable not used.
LROHSN	ROHSN	0	Variable not used.
LROL	ROL	0	Variable not used.
LROLN	ROLN	NCLX	Graphics identifier for new liquid density.
LROM	ROM	0	Variable not used.
LROV	ROV	0	Variable not used.
LROVN	ROVN	NCLX	Graphics identifier for new vapor density.
LS	S	0	Variable not used.
LS1	S1	0	Variable not used.
LS2	S2	0	Variable not used.
LSIG	SIG	0	Variable not used.
LSN	SN	NCLX*ISOLUT	Graphics identifier for new solid solute in cell (kg solid). ISOLUT = 0 or 1.
LST	ST	0	Variable not used.
LTCHFS	TCHF	0	Variable not used.
LTL	TL	0	Variable not used.
LTLN	TLN	NCLX	Graphics identifier for new liquid temperature.
LTSAT	TSAT	NCLX	Graphics identifier for saturation temperature.
LTSSN	TSSN	0	Variable not used.
LTV	TV	0	Variable not used.
LTVN	TVN	NCLX	Graphics identifier for new vapor temperature.
LVD1	VD1	0	Variable not used.
LVD1N	VD1N	0	Variable not used.
LVD2	VD2	0	Variable not used.
LVD2N	VD2N	0	Variable not used.
LVISL	VISL	0	Variable not used.
LVISV	VISV	0	Variable not used.
LVL	VL	0	Variable not used.

LVLC	VLC	0	Variable not used.
LVLNYT	VLNYT	3*NCLX	Graphics identifier for new liquid θ velocity.
LVLYT	VLYT	3*NCLX	Graphics identifier for temporary storage for mixture θ velocity.
LVM	VM	0	Variable not used.
LVOL	VOL	NCLX	Graphics identifier for cell fluid volumes.
LVOLG	VOLG	0	Variable not used
LVV	VV	0	Variable not used.
LVVC	VVC	0	Variable not used.
LVVN	VVN	0	Variable not used.
LVVNYT	VNYT	3*NCLX	Graphics identifier for new vapor θ velocity.
LVVYT	VVYT	3*NCLX	Graphics identifier for temporary storage for mixture θ velocity.
LWAT	WAT	0	Variable not used.
LXA	XA	0	Variable not used.

C.14.3. EQUIVALENCES–Defined for BLANKCOM

Array	Location	Description
HLA	C	Sum of all products of liquid HTC with heat-transfer area.
HVA	C	Sum of all products of vapor HTC with heat-transfer area.
WAT	C	Total heat-transfer area.
HLATW	C	Similar to HLA except that the product includes wall temperature.
HVATW	C	Similar to HVA except that the product includes wall temperature.
FINAN	C	Inverted annular regime factor.
RMEM	C	Mixture energy.
ROM	C	Mixture density.
QRD	-	Not presently used.
SIG	C	Surface tension.
AM	C	Air mass.
QSL	C	Wall heat flux.
ARC	C	Density of solute in cell, $c(1-\alpha)\rho_\ell$.

VOL	C	Cell flow volume.
VOLG	C	Cell geometric volume.
VMFRL	C	Liquid mass flux in the axial direction.
VMFRV	C	Vapor mass flux in the axial direction.
CPL	C	Liquid specific heat at constant pressure.
CPV	C	Vapor specific heat at constant pressure.
TSN	C	Saturation temperature for total pressure.
TSSN	C	Saturation temperature for steam pressure.
CL	C	Liquid conductivity.
CV	C	Vapor conductivity.
VISL	C	Liquid viscosity.
VISV	C	Vapor viscosity.
HFG	C	Latent heat of vaporization.
HGAM	C	Contribution to phase change from subcooled boiling.
LCCFL	F	CCFL flag.
FAYT	F	Actual flow area for theta (or y) face.
FAZ	F	Actual flow area for axial face.
FAXR	F	Actual flow area for radial (or x) face.
FAGYT	F	Geometric flow area for theta (or y) face.
FAGZ	F	Geometric flow area for axial face.
FAGXR	F	Geometric flow area for radial (or x) face.
VMYT	F	Mixture velocity for theta (or y) face.
VMZ	F	Mixture velocity for axial face.
VMXR	F	Mixture velocity for radial (or x) face.
HDYT	F	Interface hydraulic diameter for theta (or y) face.
HDZ	F	Interface hydraulic diameter for axial face.
HDXR	F	Interface hydraulic diameter for radial (or x) face.
WFLYT	F	Wall friction factor for liquid for theta (or y) face.
WFLZ	F	Wall friction factor for liquid for axial face.
WFLXR	F	Wall friction factor for liquid for radial (or x) face.

WFVYT	F	Wall friction factor for vapor for theta (or y) face.
WFVZ	F	Wall friction factor for vapor for axial face.
WFVXR	F	Wall friction factor for vapor for radial (or x) face.
DVVYT	F	Derivative of vapor velocity with respect to pressure for theta (or y) face.
DVVZ	F	Derivative of vapor velocity with respect to pressure for axial face.
DVVXR	F	Derivative of vapor velocity with respect to pressure for radial (or x) face.
DVLYT	F	Derivative of liquid velocity with respect to pressure for theta (or y) face.
DVLZ	F	Derivative of liquid velocity with respect to pressure for axial face.
DVLXR	F	Derivative of liquid velocity with respect to pressure for tradial (or x) face.
CFZLYT	F	Liquid forward-flow-direction additive friction-loss coefficient for theta (or y) face.
CFZLZ	F	Liquid forward-flow-direction additive friction-loss coefficient for axial face.
CFZLXR	F	Liquid forward-flow-direction additive friction-loss coefficient for radial (or x) face.
CFRLYT	F	Liquid reverse-flow-direction additive friction-loss coefficient for theta (or y) face.
CFRLZ	F	Liquid reverse-flow-direction additive friction-loss coefficient for axial face.
CFRLXR	F	Liquid reverse-flow-direction additive friction-loss coefficient for radial (or x) face.
CFZVYT	F	Vapor forward-flow-direction additive friction-loss coefficient for theta (or y) face.
CFZVZ	F	Vapor forward-flow-direction additive friction-loss coefficient for axial face.
CFZVXR	F	Vapor forward-flow-direction additive friction-loss coefficient for radial (or x) face.
CFRVYT	F	Vapor reverse-flow-direction additive friction-loss coefficient for theta (or y) face.

CFRVZ	F	Vapor reverse-flow-direction additive friction-loss coefficient for axial face.
CFRVXR	F	Vapor reverse-flow-direction additive friction-loss coefficient for radial (or x) face.
DTSDP	C	Derivative of TSAT with respect to pressure.
DELDP	C	Derivative of the liquid internal energy with respect to pressure at constant temperature.
DEGDP	C	Derivative of the steam internal energy with respect to pressure at constant temperature.
DELDT	C	Derivative of the liquid internal energy with respect to temperature at constant pressure.
DEGDT	C	Derivative of the steam internal energy with respect to temperature at constant pressure.
DRLDP	C	Derivative of the liquid density with respect to pressure at constant temperature.
DRGDP	C	Derivative of the steam density with respect to pressure at constant temperature.
DRLDT	C	Derivative of the liquid density with respect to temperature at constant pressure.
DRGDT	C	Derivative of the steam density with respect to temperature at constant pressure.
HVS		Enthalpy of the steam at TSAT.
HLS	C	Enthalpy of the liquid at TSAT.
DHVS	C	Derivative of the enthalpy of the vapor at TSAT with respect to pressure.
DHLS	C	Derivative of the enthalpy of the liquid at TSAT with respect to pressure.
DTSSDP	C	Derivative of the saturation temperature corresponding to the steam pressure with respect to pressure.
DEADT	C	Derivative of the non-condensible gas internal energy with respect to temperature at constant pressure.
DEADP	C	Derivative of the non-condensible gas internal energy with respect to pressure at constant temperature.
DRADP	C	Derivative of the non-condensible gas density with respect to pressure at constant temperature.

DRADT	C	Derivative of the non-condensible gas density with respect to temperature at constant pressure.
DRLAST	-	Unused variable.
ORYT	F	Scale factor used to reduce cross-flow at theta (or y) face to simulate the presence of an orifice (currently set to 1).
ORZ	F	Scale factor used to reduce cross-flow at axial face to simulate the presence of an orifice (currently set to 1).
ORXR	F	Scale factor used to reduce cross-flow at radial (or x) face to simulate the presence of an orifice (currently set to 1).
WMYT	F	Fraction of momentum cell at theta (or y) face that is associated with upstream cell.
WMZ	F	Fraction of momentum cell at axial face that is associated with upstream cell.
WMXR	F	Fraction of momentum cell at radial (or x) face that is associated with upstream cell.
DYT	C	Cell length in y direction or theta sector angle in radians.
DZZ	C	Cell length in axial direction.
DXR	C	Cell length in radial (or x) direction.
RDYT	C	Reciprocal of DYT.
RDZ	C	Reciprocal of DZZ
RDXR	C	Reciprocal of DXR
RMEAN	C	Radius of cell center.
RDYTA	C	Reciprocal of momentum cell length in theta (or y) direction.
RDZA	C	Reciprocal of momentum cell length in axial direction.
RDXRA	C	Reciprocal of momentum cell length in radial (or x) direction.
RDDYT	C	The maximum of RDYTA and (VOL/FA) of the momentum cell in the theta (or y) direction.
RDDZ	C	The maximum of RDZA and (VOL/FA) of the momentum cell in the axial direction.
RDDXR	C	The maximum of RDXRA ans (VOL/FA) of the momentum cell in the radial (or x) direction.
ALPO	C	Void fraction at the start of the previous step (α^{n-1}).

DALVA	C	Unused variable.
DALP	C	Weighting factor for new-time level contribution to outflow in basic mass and energy equations.
FAVYT	F	Donor-cell averaged vapor volume fraction at theta or (y) face.
FAVZ	F	Donor-cell averaged vapor volume fraction at axial face.
FAVXR	F	Donor-cell averaged vapor volume fraction at radial or (x) face.
FALYT	F	Donor-cell averaged liquid volume fraction at theta or (y) face.
FALZ	F	Donor-cell averaged liquid volume fraction at axial face.
FALXR	F	Donor-cell averaged liquid volume fraction at radial or (x) face.
FRVYT	F	Product of donor-cell averaged vapor macroscopic density with flow area and time-step at theta or (y) face.
FRVZ	F	Product of donor-cell averaged vapor macroscopic density with flow area and time-step at axial face.
FRVXR	F	Product of donor-cell averaged vapor macroscopic density with flow area and time-step at radial or (x) face.
FEVYT	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at theta or (y) face.
FEVZ	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at axial face.
FEVXR	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at radial or (x) face.
FRAYT	F	Product of donor-cell averaged non-condensible macroscopic density with flow area and time-step at theta or (y) face.
FRAZ	F	Product of donor-cell averaged non-condensible macroscopic density with flow area and time-step at axial face.
FRAXR	F	Product of donor-cell averaged non-condensible macroscopic density with flow area and time-step at radial or (x) face.
FRLYT	F	Product of donor-cell averaged liquid macroscopic density with flow area and time-step at theta or (y) face.

FRLZ	F	Product of donor-cell averaged liquid macroscopic density with flow area and time-step at axial face.
FRLXR	F	Product of donor-cell averaged liquid macroscopic density with flow area and time-step at radial or (x) face.
FELYT	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at theta or (y) face.
FELZ	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at axial face.
FELXR	F	Product of donor-cell averaged vapor macroscopic internal energy with flow area and time-step at radial or (x) face.
CnPm	C	Variables used as temporaries in a number of routines. Also the coefficient of the change in pressure across the m-th cell face in the equation for the n-th primary dependent variable in the basic step. The variables in order from n = 1,5 are pressure, vapor temperature, liquid temperature, void fraction, and partial pressure of non-condensible. The faces in order from m = 1,6 are the lower-numbered radial (or x) face, the higher-numbered radial (or x) face, the lower-numbered theta (or y) face, the higher-numbered theta (or y) face, the lower-numbered axial face, and the higher-numbered axial face.
DPRHS	C	Iterate change in pressure during basic step before inclusion of effects due to the relative change in pressure across the cell faces.
DARHS	C	Iterate change in void fraction during basic step before inclusion of effects due to the relative change in pressure across the cell faces.
DTVRHS	C	Iterate change in vapor temperature during basic step before inclusion of effects due to the relative change in pressure across the cell faces.
DTLRHS	C	Iterate change in liquid temperature during basic step before inclusion of effects due to the relative change in pressure across the cell faces.
DPARHS	C	Iterate change in partial pressure of non-condensible during basic step before inclusion of effects due to the relative change in pressure across the cell faces.
FBIT	C/F	Time-independent bit-flags.

DVVS1	C	Scale-factor applied to derivative of vapor velocity at outer radial face with respect to cell pressure for water-packing model.
DVVS1M	C	Scale-factor applied to derivative of vapor velocity at inner radial face with respect to cell pressure for water-packing model.
DVLS1	C	Scale-factor applied to derivative of liquid velocity at outer radial face with respect to cell pressure for water-packing model.
DVLS1M	C	Scale-factor applied to derivative of liquid velocity at inner radial face with respect to cell pressure for water-packing model.
SC1	C	Area ratio scale factor applied to outer radial (or x) convecting velocities for cross-term contribution to theta (or y) and axial motion equations.
SC1M	C	Area ratio scale factor applied to inner radial (or x) convecting velocities for cross-term contribution to theta (or y) and axial motion equations.
DVVS3	C	Scale-factor applied to derivative of vapor velocity at upper axial face with respect to cell pressure for water-packing model.
DVVS3M	C	Scale-factor applied to derivative of vapor velocity at lower axial face with respect to cell pressure for water-packing model.
DVLS3	C	Scale-factor applied to derivative of liquid velocity at upper axial face with respect to cell pressure for water-packing model.
DVLS3M	C	Scale-factor applied to derivative of liquid velocity at lower axial face with respect to cell pressure for water-packing model.
SC3	C	Area ratio scale factor applied to upper axial convecting velocities for cross-term contribution to radial (or x) and theta (or y) motion equations.
SC3M	C	Area ratio scale factor applied to lower axial convecting velocities for cross-term contribution to radial (or x) and theta (or y) motion equations.
DVVS2	C	Scale-factor applied to derivative of vapor velocity at forward theta (or y) face with respect to cell pressure for water-packing model.

DVLS2	C	Scale-factor applied to derivative of liquid velocity at forward theta (or y) face with respect to cell pressure for water-packing model.
SC2	C	Area ratio scale factor applied to forward theta (or y) convecting velocities for cross-term contribution to radial (or x) and axial motion equations.
SCD1	C	Area ratio scale factor associated with outer face used in diagonal V del V term in radial (or x) motion equation.
SCD1M	C	Area ratio scale factor associated with inner face used in diagonal V del V term in radial (or x) motion equation.
SCD2	C	Area ratio scale factor associated with forward face used in diagonal V del V term in theta (or y) motion equation.
SCD2M	C	Area ratio scale factor associated with backward face used in diagonal V del V term in theta (or y) motion equation.
SCD3	C	Area ratio scale factor associated with upper face used in diagonal V del V term in axial motion equation.
SCD3M	C	Area ratio scale factor associated with lower face used in diagonal V del V term in axial motion equation.
BIT	C/F	Bit flags from previous time step.
FRCI1	-	Unused.
FRCI2	-	Unused.
FRCI3	-	Unused.
CIYT	F	Old interfacial drag coefficient at theta (or y) face.
CIZ	F	Old interfacial drag coefficient at axial face.
CIXR	F	Old interfacial drag coefficient at radial (or x) face.
CHTI	C	Old value of vapor-side interfacial HTC times interfacial area.
CHTIA	C	Old value of air interfacial HTC times interfacial area.
ALV	C	Old value of flashing interfacial HTC times interfacial area.
ALVE	C	Old value of liquid-side interfacial HTC times interfacial area.
ARV	C	Old stabilizer value for macroscopic vapor density, $\alpha\rho_v$.
CONCO	C	Old ratio of solute mass to liquid mass.
PA	C	Old air partial pressure.

ROA	C	Old air density.
EA	C	Old air internal energy.
ALP	C	Old vapor fraction.
ROV	C	Old vapor density.
ROL	C	Old liquid density.
S	C	Old solute mass plated out.
VVYT	F	Old basic vapor velocity at theta (or y) face.
VVZ	F	Old basic vapor velocity at axial face.
VVXR	F	Old basic vapor velocity at radial (or x) face.
VLYT	F	Old basic liquid velocity at theta (or y) face.
VLZ	F	Old basic liquid velocity at axial face.
VLXR	F	Old basic liquid velocity at radial (or x) face.
EV	C	Old vapor internal energy.
EL	C	Old liquid internal energy.
TV	C	Old vapor temperature.
TL	C	Old liquid temperature.
GAM	C	Old vapor generation rate per unit volume.
P	C	Old pressure.
AREV	C	Old stabilizer value for vapor macrosopic internal energy, $\alpha\rho_v e_v$.
VVTYT	F	Old stabilizer vapor velocity at theta (or y) face.
VVTZ	F	Old stabilizer vapor velocity at axial face.
VVTXR	F	Old stabilizer vapor velocity at radial (or x) face.
ARL	C	Old stabilizer value for $(1-\alpha)\rho_\ell$.
AREL	C	Old stabilizer value for $(1-\alpha)\rho_\ell e_\ell$.
VLTYT	F	Old stabilizer liquid velocity at theta (or y) face.
VLTZ	F	Old stabilizer liquid velocity at axial face.
VLTXR	F	Old stabilizer liquid velocity at radial (or x) face.
ARA	C	Old stabilizer value for $\alpha\rho_a$.
OWVYT	F	Old donor-cell factor at theta (or y) face for vapor.
OWVZ	F	Old donor-cell factor at axial face for vapor.

OWVXR	F	Old donor-cell factor at radial (or x) face for vapor.
OWLYT	F	Old donor-cell factor at theta (or y) face for liquid.
OWLZ	F	Old donor-cell factor at axial face for liquid.
OWLXR	F	Old donor-cell factor at radial (or x) face for liquid.
BITN	C/F	Bit flags for current time step.
FRCI1N	-	Unused.
FRCI2N	-	Unused.
FRCI3N	-	Unused.
CINYT	F	New interfacial drag coefficient at theta (or y) face.
CINZ	F	New interfacial drag coefficient at axial face.
CINXR	F	New interfacial drag coefficient at radial (or x) face.
CHTIN	C	New value of vapor-side interfacial HTC times interfacial area.
CHTAN	C	New value of air interfacial HTC times interfacial area.
ALVN	C	New value of flashing interfacial HTC times interfacial area.
ALVEN	C	New value of liquid-side interfacial HTC times interfacial area.
ARVN	C	New stabilizer value for $\alpha\rho_v$.
CONC	C	New solute mass to coolant mass ratio.
PAN	C	New air partial pressure.
ROAN	C	New air density.
EAN	C	New air internal energy.
ALPN	C	New vapor fraction.
ROVN	C	New vapor density.
ROLN	C	New liquid density.
SN	C	New solute mass plated on structure surface.
VVNYT	F	New basic vapor velocity at theta (or y) face.
VVNZ	F	New basic vapor velocity at axial face.
VVNXR	F	New basic vapor velocity at radial (or x) face.
VLNYT	F	New basic liquid velocity at theta (or y) face.

VLNZ	F	New basic liquid velocity at axial face.
VLNXR	F	New basic liquid velocity at radial (or x) face.
EVN	C	New vapor internal energy.
ELN	C	New liquid internal energy.
TVN	C	New vapor temperature.
TLN	C	New liquid temperature.
GAMN	C	New vapor generation rate per unit volume.
PN	C	New pressure.
AREVN	C	New stabilizer value for $\alpha\rho_v e_v$.
VVNTYT	F	New stabilizer vapor velocity at theta (or y) face
VVNTZ	F	New stabilizer vapor velocity at axial face
VVNTXR	F	New stabilizer vapor velocity at radial (or x) face
ARLN	C	New stabilizer value for $(1 - \alpha)\rho_\ell$.
ARELN	C	New stabilizer value for $(1-\alpha)\rho_\ell e_\ell$.
VLNTYT	F	New stabilizer liquid velocity at theta (or y) face
VLNTZ	F	New stabilizer liquid velocity at axial face
VLNTXR	F	New stabilizer liquid velocity at radial (or x) face
ARAN	C	New stabilizer value for $\alpha\rho_a$.
WVYT	F	New donor-cell factor at theta (or y) face for vapor.
WVZ	F	New donor-cell factor at axial face for vapor.
WVXR	F	New donor-cell factor at radial (or x) face for vapor.
WLYT	F	New donor-cell factor at theta (or y) face for liquid.
WLZ	F	New donor-cell factor at axial face for liquid.
WLXR	F	New donor-cell factor at radial (or x) face for liquid.
SPIFZ	C	Stratified flow weighting factor for interfacial heat transfer correlations.
DVVS2M	F	Scale-factor applied to derivative of vapor velocity at backward theta (or y) face with respect to cell pressure for water-packing model.
DVLS2M	F	Scale-factor applied to derivative of vapor velocity at backward theta (or y) face with respect to cell pressure for water-packing model.

SC2M	F	Area ratio scale factor applied to backward theta (or y) convecting velocities for cross-term contribution to tradial (or x) and axial motion equations.
SCD2M	F	Area ratio scale factor associated with ibackward face used in diagonal V del V term in theta (or y) motion equation.

C.14.4. VSSLDATA–VESSEL Data Table

This data table includes the following COMMON blocks: BLANKCOM and FIXEDLT, both defined in Appendix D; VSSELVLT, defined in Sec. C.14.1; and VSSLPT, defined in Sec. C.14.2.

APPENDIX D

DESCRIPTION OF COMMON-BLOCK VARIABLES

COMDECK BANDW

COMMON/BANDW/ MUX, MUY, MUZ

INTEGER VARIABLES:

MUX: The number of diagonal rows above and below the main diagonal lying within the MUX+1+MUX bandwidth of the VESSEL matrix for the x- or r-directional stabilizer motion equation.

MUY: The number of diagonal rows above and below the main diagonal lying within the MUY+1+MUY bandwidth of the VESSEL matrix for the y- or θ-direction stabilizer motion equation.

MUZ: The number of diagonal rows above and below the main diagonal lying within the MUZ+1+MUZ bandwidth of the VESSEL matrix for the z-direction stabilizer motion equation, pressure semi-implicit equation, and the stabilizer mass and energy equations.

COMDECK BKCNTRL

COMMON/BKCTRL/ IPREIT, LBCKV, LREIT, LREITV

INTEGER VARIABLE:

IPREIT: Flag to print messages on forced reiteration.

LOGICAL VARIABLES:

LBCKV: If .TRUE., then variable forces a time-step back-up.

LREIT: If .TRUE., then variable forces a reiteration.

LREITV: If .TRUE., then variable forces a reiteration.

COMMON/DONR/ ITDON, JDONP, NCOMDP

INTEGER VARIABLES:

ITDON: If flow reversals occur for OITNO > ITDON, the time step is backed up.

JDONP: Cell number in NCOMDP.

NCOMDP: Component number of flow reversal forcing back-up.

COMDECK BKPOST

COMMON/BKPOST/ BKPALL, BKPALU, BKPSTA, BKPSTP, BKPSTT

COMMON/BKPOST/ IBKPST, JBKPST, LBKPST

REAL VARIABLES:

BKPALL: Maximum lower limits on void fraction such that a back-up is forced if the void fraction lies within these limits.

BKPALU: Maximum upper limits on void fraction such that a back-up is forced if the void fraction lies within these limits.

BKPSTA: Void-fraction variation that is allowed in the POST stage. If the void-fraction change exceeds BKPSTA, back-up is forced.

BKPSTP: Maximum fractional pressure change that is allowed in the POST stage. If the fractional pressure change exceeds BKSTP, back-up is forced.

BKPSTT: Maximum variation in liquid and vapor temperatures that is allowed in the POST stage. If the temperature change exceeds BKPSTT, back-up is forced.

INTEGER VARIABLES:

IBKPST: Component forces back-up.

JBKPST: Cell number.

LOGICAL VARIABLE:

LBKPST: If .TRUE., then a time-step back-up is forced from POST.

COMDECK BLANKCOM

COMMON A(300)

A(300): Dynamic SCM storage area. This array is dimensioned to other sizes or dynamically dimensioned for certain conditional directives imposed during compilation.

COMDECK BOIL

COMMON/BOIL/ COND, CVFAL, DALVJ, DHSDP, DHSDT, EHG, EVAP, FLASH, GAMDP, GAMDPA, GAMMA, SCL

COMMON/BOIL/ ITLEQ

DIMENSION COND(NK), CVFAL(NK), DALVJ(NK), DHSDP(NK), DHSDT(NK), EHG(NK), EVAP(NK), FLASH(NK), GAMDP(NK), GAMDPA(NK), GAMMA(NK), SCL(NK)

DIMENSION ITLEQ(NK)

REAL VARIABLES:

COND: Vapor-side heat-transfer coefficient to the vapor/liquid interface.

CVFAL: Energy transfer between the vapor and liquid based on DALVJ scaling.

DALVJ: Derivative of ALV (FLASH coefficient) with respect to void fraction (currently set to zero).

DHSDP: Derivative of EHG with respect to total pressure.

DHSDT: Derivative of EHG with respect to saturation temperature.

EHG: Internal energy of saturation temperature vapor.

EVAP: Liquid-side heat-transfer coefficient to the vapor liquid interface based on evaporation when the liquid temperature is above the saturation temperature based on vapor pressure.

FLASH: Liquid-side heat-transfer coefficient to the vapor/liquid interface based on flashing when the liquid temperature is above the saturation temperature based on total pressure.

GAMDP: Derivative of Γ with respect to the total pressure.

GAMDPA: Derivative of Γ with respect to the noncondensable-gas pressure.

GAMMA: Energy transfer between the vapor and liquid based on SCL scaling.

SCL: Scale factor for the phase-change heat-transfer coefficients.

INTEGER VARIABLE:

ITLEQ: Flag to indicate that no evaporation or condensation is expected to occur to the single-phase fluid during the time step.
0 = evaporation or condensation is evaluated;
1 = no evaporation or condensation is evaluated.

COMDECK CCFLCM

COMMON/CCFL/	CBETA, CCFLC, CCFLM, CTRANS, DIAH
COMMON/CCFL/	NCCFL, NHOLES
DIMENSION	CBETA(10), CCFLC(10), CCFLM(10), CTRANS(10), DIAH(10)
DIMENSION	NHOLES(10)

REAL VARIABLES:

CBETA: Bankoff interpolation constant for interpolating between Wallis and Kutalatze characteristic length dimensions.

CCFLC: Constant of the CCFL correlation.

CCFLM: Slope of the CCFL correlation.

CTRANS: Bond number above which the CCFL constant is independent of the Bond number.

DIAH: Diameter of one hole in the perforated plate.

INTEGER VARIABLES:

NCCFL: Number of CCFL parameter sets.

NHOLES: Number of holes in the perforated plate.

COMDECK CDBLKS

COMMON/CODEBK/	CBNAM, ILEV, MAX1LV, MAXLEN, MAXLN3, MLNVMT
DIMENSION	CBNAM(5)

INTEGER VARIABLES:

CBNAM:	Array containing the names of the overlays currently in memory.
ILEV:	The number of overlays currently in core.
MAX1LV:	Maximum amount of SCM storage needed for three-dimensional components when only one level of data is required.
MAXLEN:	Maximum amount of SCM storage needed to process any one-dimensional component.
MAXLN3:	Maximum amount of SCM storage needed to process any three-dimensional component.
MLNVMT:	The amount of SCM space required to solve the VESSEL matrix.

COMDECK CFLOW

COMMON/CFLOW/	CHM1, CHM2, CHMLT1, CHMLT2
COMMON/CFLOW/	ICFLOW, IHOR
DIMENSION	CHM1(5), CHM2(5)

REAL VARIABLES:

CHM1:	Array of choked-flow multipliers on the subcooled flow.
CHM2:	Array of choked-flow multipliers on the two-phase flow.
CHMLT1:	Multiplier on the subcooled flow.
CHMLT2:	Multiplier on the two-phase flow.

INTEGER VARIABLES:

ICFLOW: Choked-flow mode controller.

- 0 = model turned off,
- 1 = model using default multipliers turned on only for components connected to a BREAK (default condition), or
- 2 = model using optional multipliers turned on at cell edges indicated in component input (note that this option requires additional array data for all one-dimensional hydrodynamic components).

IHOR: Drag controller.

- 0 = uses dispersed drag only,
- 1 = (default) uses stratified drag in one dimension if conditions are met;
- 2 = always uses stratified drag;
- 3 = turns off head gradient force.

COMDECK CHECKS

COMMON/CHECKS/ DTEND, HDUMP, HEDIT, HGRAF, HSEDIT

COMMON/CHECKS/ NALT, NDID

REAL VARIABLES:

DTEND: Time interval during which the special time-step data are used.

HDUMP: Saved value of the next restart/dump edit time from the regular time-step data when the special time-step data are used.

HEDIT: Saved value of the next long edit time from the regular time-step data when the special time-step data are used.

HGRAF: Saved value of the next graphics edit time from the regular time-step data when the special time-step data are used.

HSEDIT: Saved value of the next short edit time from the regular time-step data when the special time-step data are used.

INTEGER VARIABLES:

NALT: Constant used to determine if void-fraction adjustments are needed when the interfacial drag is calculated at a one-dimensional junction connected to a BREAK.

NDID: ID number of the special time-step data that are being used.

COMDECK CHFINT

COMMON/CHFINT/ ALPCHF

REAL VARIABLE:

ALPCHF: Void fraction at the critical heat flux (CHF) location.

COMDECK CHGALP

COMMON/CHGALP/ DAL, DAU, OAL, OAU, XDAL, XDAU, XOAL, XOAU

COMMON/CHGALP/ JDAL, JDAU, JOAL, JOAU, NDAL, NDAU, NOAL, NOAU

REAL VARIABLES:

DAL: Maximum decrease in void fraction.

DAU: Maximum increase in void fraction over the time step.

OAL: Maximum decrease in void fraction immediately following an increase.

OAU: Maximum increase in void fraction immediately following a decrease.

XDAL: Limit on DAL beyond which the time step is reduced.

XDAU: Limit on DAU beyond which the time step is reduced.

XOAL: Limit on OAL beyond which the time step is reduced.

XOAU: Limit on OAU beyond which the time step is reduced.

INTEGER VARIABLES:

JDAL: Cell where DAL occurred.

JDAU: Cell where DAU occurred.

JOAL: Cell where OAL occurred.

JOAU: Cell where OAU occurred.

NDAL: Component where DAL occurred.

NDAU: Component where DAU occurred.

NOAL: Component where OAL occurred.

NOAU: Component where OAU occurred.

COMDECK CIFLIM

COMMON/CIFLIM/ FIFI, FIFR

REAL VARIABLES:

FIFI: Maximum decrease factor for the time-constant contstraint of the interfacial-drag coefficient (0.4).

FIFR: Maximum increase factor for the time-constant constraint of the interfacial-drag coefficient (2.0).

COMDECK CNRSLV

COMMON/CNRSLV/ AA, BB, W

COMMON/CNRSLV/ KEY, M, M1, N, NRSLV

COMMON/CNRSLV/ ERR

DIMENSION AA(NRFMX1,NRZFMX), BB(NRZFMX), W(NRZFMX)

REAL VARIABLES:

AA: Coefficient matrix.

BB: RHS vector.

W: Working-area vector.

INTEGER VARIABLES:

KEY: Evaluation-flag option.

1 = solves the linear matrix equation by forward-elimination and backward-substitution.

2 = performs the forward-elimination only.

3 = performs the backward-substitution only.

M: Number of x- or r-direction nodes in the heat-transfer mesh that defines a matrix A bandwidth of M+1+M.

M1: M + 1.

N: Order of matrix A that is stored in matrix AA.

NRSLV: Namelist variable defining the axial-direction heat-transfer calculation numerics.
0 = treats axial direction explicitly (default);
1 = treats axial direction implicitly.

LOGICAL VARIABLE:

ERR: Error flag from subroutine BANSOL, which indicates a singular matrix when .TRUE.

COMDECK COMCOM

COMMON/CC/ IMAX, IMIN, JFLAG

INTEGER VARIABLES:

IMAX: Last component (TRAC-assigned component number) in a loop in the outer calculation for one-dimensional components.

IMIN: First component (TRAC-assigned component number) in a loop in the outer calculation for one-dimensional components.

JFLAG: Flag that indicates an error in the outer calculation.

COMDECK CONCCK

COMMON/CONCCK/ JFLAGC

INTEGER VARIABLE:

JFLAGC: Flag that indicates an error in specifying the one-dimensional component input-parameter values.

COMDECK CONDHT

COMMON/CONDHT/ YLL, YLV

REAL VARIABLES:

YLL: Axial distance above node row JL where the vapor-liquid interface is located.

YLV: Axial distance above node row JL where the vapor-liquid interface is located.

COMDECK CONSTANT

COMMON/CONST/ PI, GC, ZERO, ONE, EPSALP

REAL VARIABLES:

PI: Constant π (3.1415926535898).

GC:	Gravitational constant (9.80665 $m \cdot s^{-2}$).
ZERO:	Real constant zero.
ONE:	Real constant one.
EPSALP	Void-fraction cutoff for thermodynamic vapor properties.

COMDECK CONTRLLR

COMMON/CONTRL/ DAMMC, DAMX, DELT, DELTHT, DIFMIN, DPRMX, DTLMX, DTMAX, DTMIN, DTO, DTRAT, DTRMX, DTSMX, DTVMX, EPS1, EPS2, EPSO, EPSS, ETIME, HTLOSI, HTLOSO, ODELT, PSSMN, PSSMX, RFAT, RVMAX, TEND, TIMEC, TIMET, VARER, VCMN, VCMX, VMAXO, VMAXT, VMAXT3, VMCON, VMNEW, VMOLD, VMXT3O, XTABLE

COMMON/CONTRL/ DSTEP, IADDED, ICCMX, ICMP, ICP, IDIAG, IEOS, IFF3D, IFPREP, IGEOM3, IM100, IM100X, IMFR, INVAN, IOFFTK, IPAK, IPAK3D, IPAKON, IPKPMP, IRSTFL, ISOLUT, ISSFLG, ISTDY, ISTTC, ITHD, ITMIN, ITPAKO, JFAT, KCCMX, LCMPTR, LEVSTG, LLVFLG, NCMN, NCMX, NCONTR, NCONTS, NCONTT, NCRG, NDIA1, NEWRFD, NFRC1, NFRC3, NITAV, NITMN, NITMX, NLOOPP, NOSETS, NSEND, NSEO, NSMN, NSMX, NSPL, NSPU, NSSO, NSTAB, NSTP, NVGRAV, OITMAX, SITMAX, STDYST, TRANSI

REAL VARIABLES:

DAMMC:	Maximum void-fraction change during time step (not used).
DAMX:	Error caused by relative change in void fraction (not used).
DELT:	Current time increment for advancement of finite-difference equations.
DELTHT:	Heat-transfer time-step size.
DIFMIN:	Minimum diffusion number required for stability of the nod conduction solution.
DPRMX:	Maximum pressure change during the current time step.
DTLMX:	Maximum liquid-temperature change during time step.
DTMAX:	Maximum allowable time-step size for time interval.
DTMIN:	Minimum allowable time-step size for time interval.
DTO:	Previous time-step size.
DTRAT:	Ratio of the previous time-step size to the reduced time-step size that results in a trip (with special time-step data assigned) crossing its set point at the end of the time step.
DTRMX:	Maximum rod-temperature change during time step.
DTSMX:	Maximum metal-temperature change during time step.

DTVMX: Maximum vapor-temperature change during time step.

EPS1: The lower-bound criterion for increasing the Kaganove-method integration time step for solving the point-kinetics equation.

EPS2: The upper-bound criterion for decreasing the Kaganove-method integration time step for solving the point-kinetics equations.

EPSO: Convergence criterion for outer iteration.

EPSS: Convergence criterion for steady-state calculation.

ETIME: Current calculation time used for edits.

HTLOSI: Inside system heat loss for one-dimensional components only (total system heat loss to the inside walls for one-dimensional components only).

HTLOSO: Outside system heat loss for one-dimensional components only (total heat loss from the outside of the heat structures to the surroundings for one-dimensional components only).

ODELT: Time increment for previous time step.

PSSMN: Minimum steam-generator secondary-side pressure.

PSSMX: Maximum steam-generator secondary-side pressure.

RFAT: Maximum ratio of the interface flow-area to the adjacent mesh-cell average flow area.

RVMAX: Maximum ratio of the adjacent mesh-cell average flow areas when their interface does not have an additive loss coefficient specified.

TEND: End time for the time-step data domain.

TIMEC: Clock time in seconds.

TIMET: Current calculation time.

VARER: Variable error.

VCMN: Final convergence for component NCMN at step NSMN.

VCMX: Final convergence for component NCMX at step NSMX.

VMAXO: Maximum one-dimensional component ratio of the Courant number to the time-step size at the beginning of the previous time step.

VMAXT: Maximum one-dimensional component ratio of the Courant number to the time-step size at the beginning of the present time step.

VMAXT3: Maximum three-dimensional component ratio of the Courant number to the time-step size at the beginning of the present time step.

VMCON: Net water mass (liquid plus vapor) convected into VESSEL(s) during time interval $t^{n+1} - t^{n}$.

VMNEW: VESSEL water mass (liquid plus vapor) at t^{n+1}

VMOLD: VESSEL water mass (liquid plus vapor) at t^{n}.

VMXT3O: Maximum three-dimensional component ratio of the courant number to the time-step size at the beginning of the previous time step.

XTABLE: Abscissa coordinate value from the last axial power-shape table evaluation.

INTEGER VARIABLES:

DSTEP: Time-step number of dump to be used for restart.

IADDED: Time-step interval for printing calculation summary to the terminal. (Zero suppresses this print.)

ICCMX: Component number in the IORDER array with the most severe time-step limit for stability.

ICMP: Component indicator.

ICP: Temporary pointer to next free location in the dynamic storage area for component data.

IDIAG: Namelist variable that defines different levels of debugging information on appropriate parameter values.

IEOS: Air-water option flag.
0 = steam-air-water;
1 = air-water (no steam present).

IFF3D: Outer-iteration VESSEL evaluation flag.
0 = evaluate the VESSEL coefficient matrix equation;
1 = back-substitute the VESSEL matrix equation solution.

IFPREP: Flag that indicates sections of PREPER to be executed (nonzero only for one-dimensional cores).

IGEOM3: VESSEL geometry flag.
0 = (default) flow areas between the downcomer and inside of the VESSEL set to zero;
1 = flow areas between the downcomer and inside of the VESSEL maintained at the user input values.
Note: The vent-valve option overrides IGEOM3 = 1 option in cells that have vent-valve connections.

IM100: Flag that indicates if back-up occurred on previous time-step (used for mass check on logic).

IM100X: Flag that indicates whether previous time step that failed was obtained from a restart.

IMFR: Calculates the theta, axial, and radial mass flows (kg/s) for both liquid and vapor, and adds them to the graphics. This option is invoked by a new NAMELIST variable IMFR.
1 = (default) one-dimensional VESSEL mass flow;
3 = three-dimensional VESSEL mass flow.

INVAN: Flag to select either T_{CHF} or T_{sat} for control of the inverted annular flow regime.

IOFFTK: Flag to select offtake model.

0 = off;
1 = on.

IPAK: Flag that indicates one-dimensional water-packing option.
0 = off;
1 = on.

IPAK3D: Flag that indicates three-dimensional water-packing option.
0 = off;
1 = on.

IPAKON: Flag that indicates if water-packing logic is on during time step.

IPKPMP: Flag that indicates if water-packing corrections are made at a pump source.
0 = (default) water-packing corrections are not made at a pump source;
1 = water-packing corrections are made at a pump source.

IRSTFL: Flag to control dump generation in the interactive mode.
0 = normal operation;
1 = termination with a dump because the interactive mode is requesting a component modification.

ISOLUT: Flag that turns on solute tracking option.

ISSFLG: Flag that controls editing in steady state.

ISTDY: Flag that indicates type of calculation.
0 = transient;
1 = steady state.

ISTTC: Static check flag.
0 = normal mode;
1 = a static balance check was requested when STDYST = 5 was input.

ITHD: Namelist variable to use hydraulic diameters (0) or input thermal diameters (1) for the heat-structure component heat-transfer calculation.

ITMIN: Minimum stable film-boiling option flag.

ITPAKO: Iteration number for which water packing was detected.

JFAT: Flow-area ratio test flag.
0 = flow-area ratios are appropriate;
1 = one or more ratios of interface flow area to adjacent mesh-cell average flow-area ratios are invalid.
2 = one or more adjacent volume average flow-area ratios are invalid.
3 = one or more of both types of flow-area ratios are invalid.

KCCMX: Cell in above component that limits stability.

LCMPTR: Pointer to end of component data for last component read.

LEVSTG: Void-fraction averaging flag.

0 = default, no void-fraction averaging is performed in HTCOR in the steam-generator secondaries;

1 = special void-fraction averaging is performed in HTCOR for steam-generator secondaries.

LLVFLG: Switch that determines averaging procedure used in subroutine HTIF.

NCMN: Position in IORDER array for component that was last to converge at step NSMN.

NCMX: Position in IORDER array for component that was last to converge at step NSMX.

NCONTR: Number of constrained steady-state controllers.

NCONTS: Number of constrained steady-state controllers that adjust pumps or valves so that their coolant mass flow equals a monitored coolant mass flow elsewhere in the system.

NCONTT: Number of constrained steady-state controllers that adjust the flow resistance across the VESSEL.

NCRG: NAMELIST variable (not documented elsewhere and overwritten to zero) that could be used to force the input of ICRRG (see the VESSEL variable-length table, Appendix C). Logic is incomplete.

NDIA1: Heat-transfer diameter option for one-dimensional components.

1 = (default) no heat-transfer diameter input for one-dimensional components;

2 = heat-transfer diameter input for one-dimensional components.

NEWRFD: Namelist variable that activates the reflood-model calculation for heat-structure components coupled to VESSEL components when internal test criteria are safisfied.

NFRC1: Set to 2 if forward and reverse loss coefficients are to be input for one-dimensional components.

NFRC3: Set to 2 if forward and reverse loss coefficients are to be input in the VESSEL.

NITAV: Average number of outer iterations since the last edit.

NITMN: Minimum number of outer iterations since the last edit.

NITMX: Maximum number of outer iterations since the last edit.

NLOOPP: Flag to indicate inconsistent source connections of a one-dimensional component loop to different directional face of VESSEL component(s).

NOSETS: Namelist variable defining when the SETS3D equations are to be evaluated for all VESSEL components.

0 = evaluate the SETS3D equations when the time-step size exceeds 0.8 times the VESSEL courant limit time-step size;

1 = do not evaluate the SETS3D equations;

2 = evaluate the SETS3D equations every time step (default).

NSEND: End the calculation at this time-step number.

NSEO: Time-step number of last completed edit.

NSMN: Last time step at which NITMN outer iterations occurred.

NSMX: Last time step at which NITMX outer iterations occurred.

NSPL: Debug print if NSPL < NSTEP < NSPU.

NSPU: Debug print if NSPL < NSTEP < NSPU.

NSSO: Time-step number of last completed short edit.

NSTAB: SETS3D-equations evaluation flag for all VESSEL components.

NSTP: Number of time steps since the last edit.

NVGRAV: Namelist variable option to allow the orientation of each VESSEL component to be input specified.

OITMAX: Maximum number of outer iterations.

SITMAX: Maximum number of outer iterations for steady-state calculation.

STDYST: Steady-state calculation indicator.

TRANSI: Transient calculation indicator.

COMDECK COUPLE

COMMON/COUPLE/ CCF, CCF1, RS

COMMON/COUPLE/ ICUPLE, IEVEN, NT1, NT2

REAL VARIABLES:

CCF: Cylindrical-geometry factor (CCF = 0. when NTSX is an even number, and CCF = 1. when NTSX is an odd number).

CCF1: Cylindrical-geometry factor (CCF1 = 1. when NTSX is an even number and CCF1 = 0. when NTSX is an odd number).

RS: Factor applied to radical velocity across the $r = 0$ cylindrical-geometry axis.

INTEGER VARIABLES:

ICUPLE: Flag to indicate radial-direction convective coupling across the $r = 0$ cylindrical-geometry axis (not used).

IEVEN: Flag to indicate that the number of azimuthal sectors is an odd (0) or even (1) number.

NT1: Number of azimuthal sectors divided by 2 (NTSX/2).

NT2: NT1 + 1.

COMDECK CPVECT

COMMON/CPVECT/	CPVINT, RDIAM, RMASS, RSTMLT, TCPVPR, VCPVLP, VCPVPR
COMMON/CPVECT/	IHTRIG, INTFLG, IPRCPV, KFLOW, KLEVEL, KPRESS, KTEMP, LASOG, LCPVLP, LCPVPR, NCPVP, NORMDP, NORMRS
DIMENSION	LCPVLP(4,9), LCPVPR(9), VCPVLP(4,9), VCPVPR(6)

REAL VARIABLES:

CPVINT:	Print interval for control-panel vector.
RDIAM:	Refueling storage tank diameter.
RMASS:	Initial refueling storage tank water mass (kg).
RSTMLT:	Multiplier for converting refueling storage tank water mass to water level.
TCPVPR:	Time of the last control-panel vector printout.
VCPVLP:	Control-panel vector loop parameter values.
VCPVPR:	Control-panel vector primary parameter values.

INTEGER VARIABLES:

IHTRIG:	Terminal (TTY) heading print trigger.
INTFLG:	Flag that indicates an interrupt message has been received.
IPRCPV:	Control-panel vector processing flag. 0 = control-panel vector processing selected; 1 = control-panel vector processing not selected.
KFLOW:	Flow output units. 0 = kg/s; 1 = lb/s.
KLEVEL:	Level output units. 0 = m; 1 = ft.
KPRESS:	Pressure output units. 0 = MPa; 1 = psi.
KTEMP:	Temperature output units. 0 = K; 1 = °F .
LASOG:	Length of each interactive graphics edit.
LCPVLP:	LCM pointers to variables used in evaluating control-panel vector loop parameters.

LCPVPR: LCM pointers for variables used in evaluating control-panel vector primary parameters.

NCPVP: Number of interactive graphic dumps.

NORMDP: Flag that indicates a dump in the noninteractive mode.
0 = no dump occurs, default if code is interactive;
1 = dump occurs.

NORMRS: Flag that indicates if a restart was obtained from a normal noninteractive TRAC version.
0 = no restart, default if code is interactive;
1 = a restart was obtained.

COMDECK CPVINP

COMMON/CPVINP/ ICELLS, ICOMPS, JCELL, JCOMPS, JDISCH, LOOPCT, LOOPID, LOOPS

DIMENSION ICELLS(4,8), ICOMPS(4,9), JCELL(3), JCOMPS(4), JDISCH(4), LOOPID(4), LOOPS(4)

INTEGER VARIABLES:

ICELLS(L,I): Cell number in loop L where the control-panel vector parameter I is located.
I = 1, hot-leg temperature;
2, cold-leg temperature;
3, primary-liquid mass flow;
4, ECCS liquid mass flow;
5, steam-generator secondary-side pressure;
6, steam-generator secondary-side steam-mass flow;
7, steam-generator secondary-side main-feedwater mass flow; and
8, steam-generator secondary-side auxiliary feedwater mass flow.

ICOMPS(L,I): Component number in loop L where the control-panel vector parameter I is located.
I = 1 through 8 defined in ICELLS(L,I).
I = 9, steam-generator secondary-side water level.

JCELL(I): Cell number where the control-panel vector global parameter I is located.
I = 2, primary pressure; and
3, containment pressure and temperature.

JCOMPS(I): Component number where the control-panel vector global parameter I is located.
I = 2 and 3 defined in ICELL(I).
1, reactor power; and

4, pressurizer water level.

JDISCH(L): Component number for refueling storage tank discharge in loop L (should be a FILL).

LOOPCT: Number of loops in this model ($1 \leq$ LOOPCT ≤ 4).

LOOPID(L): Loop identification for loop L.

LOOPS(L): Number of physical loops in loop L.

COMDECK DAMPER

COMMON/DAMPER/ FIHT, IFRCR

REAL VARIABLES:

FIHT Wall drag coefficient adjustment factor (I.O, not used).

INTEGER VARIABLES:

IFRCR: Wall drag evaluation option.
0 = no;
1 = yes.

COMDECK DECAYC

COMMON/DECAYC/ FISPHI, FP235, FP238, FP239, QAVG, Q235, Q238, Q239, RANS, R239PF, TOPATE

COMMON/DECAYC/ IANS79

REAL VARIABLES:

FISPHI: Fissions per initial fissile atom.

FP235: Fraction of core power from U^{235} fissions.

FP238: Fraction of core power from U^{238} fissions.

FP239: Fraction of core power from Pu^{239} fissions.

QAVG: Average energy per fission.

Q235: Energy per fission from U^{235}.

Q238: Energy per fission from U^{238}.

Q239: Energy per fission from Pu^{239}.

RANS: Multiplier applied to the ANS79 decay heat.

R239PF: Atoms of U^{239} produced per fission.

TOPATE: Four years in seconds units.

INTEGER VARIABLE:

IANS79: ANS79 decay-heat standard evaluation flag.
0 = not evaluated;
1 = evaluated the 69-group ANS79 decay-heat standard;

2 = evaluated the ANS79 decay-heat standard plus the heavy-metal decay for U^{239} and Np^{239}.

COMDECK DEFVAL

COMMON/DEFVAL/ ALPQ, CFZ3Q, HD3Q, HSTNQ, PAQ, PQ, QPPPQ, TLQ, TVQ, TWQ, VLQ, VVQ

COMMON/DEFVAL/ ISTOPT

REAL VARIABLES:

ALPQ: Default value for initial void fractions input through NAMELIST and used to specify void fractions when ISTOPT = 1 or 2.

CFZ3Q: Default value for three-dimensional VESSEL component additive loss coefficients input through NAMELIST and used to specify VESSEL additive loss coefficients when ISTOPT = 1 or 2.

HD3Q: Default value three-dimensional VESSEL component hydraulic diameters input through NAMELIST and used to specify VESSEL hydraulic diameters when ISTOPT = 1 or 2.

HSTNQ: Default value for initial heat-structure temperatures input through NAMELIST and used to specify the heat-structure temperatures when ISTOPT = 1 or 2.

PAQ: Default value for initial air partial pressures input through NAMELIST and used to specify air partial pressures when ISTOPT = 1 or 2.

PQ: Default value for initial pressures input through NAMELIST and used to specify pressures when ISTOPT = 1 or 2.

QPPPQ: Default value for initial volumetric heat sources in flow channel walls input through NAMELIST and used to specify volumetric heat sources when ISTOPT = 1 or 2.

TLQ: Default value for initial liquid temperatures input through NAMELIST and used to specify liquid temperatures when ISTOPT = 1 or 2.

TVQ: Default value for initial vapor temperatures input through NAMELIST and used to specify vapor temperatures when ISTOPT = 1 or 2.

TWQ: Default value for initial wall temperatures input through NAMELIST and used to specify wall temperatures when ISTOPT = 1 or 2.

VLQ: Default value for initial liquid velocities input through NAMELIST and used to specify liquid velocities when ISTOPT = 1 or 2.

VVQ: Default value for initial vapor velocities input through NAMELIST and used to specify vapor velocities when ISTOPT = 1 or 2.

INTEGER VARIABLE:

ISTOPT: Input option for thermal-hydraulic parameter default values.

COMDECK DETC

COMMON/DETC/ NDETC

INTEGER VARIABLE:

NDETC: Flag for generating debug printout from the outer interation cell-wise matrix definition.

COMDECK DF1DC

COMMON/DF1DC/ A11111, ALPST, ARDMIN, ARN, ARY, C1A, C1AV, C2A, C2AV, CT, [illegible]VJP, FL1, FL2, FLJP, FLJS, FV1, FV2, HAVLV, QTP, SO1, SO[illegible], SAVT, SSAC, SSE, SSM[illegible], SSMOM, SSVC, SSVE, VJS, ZZZZZZ

COMMON/DF1DC/ IO1, IO2, IO3, IACC2, IBKS, ICLFLG, ICME, ICORL, ICORU, IIO1, IIO2, IIO3, IL, IPHSEP, ISFLG, ISLB, I[illegible]B, IVPVLV, JSTART, LPINDX, MSC, NC2, NJN, NSTG, NTEE

REAL VARIABLES:

ARDMIN: Minimum value of the difference between the flow-area ratios one mesh-cell distance from a junction interface with a PLENUM component and at the junction interface with a PLENUM component for flow from the PLENUM component.

ARN: No factor for applying flow-area ratios in the momentum-convection term.
0.0 = apply area ratios;
1.0 = do not apply area ratios.

ARY: Yes factor for applying flow-area ratios in the momentum-convection term.
1.0 = apply area ratios;
0.0 = do not apply area ratios.

A11111: Dummy variable that provides a known start to the COMMON block.

ALPST: The JCELL fluid void fraction to be convected into the TEE component side leg by the TEE offtake model.

C1A: Fraction of liquid velocity at the left face of the TEE junction cell that contributes to the momentum transfer into the TEE side leg.

C1AV: Vapor velocity fraction at the left face of the TEE junction cell that contributes to the momentum transfer into the TEE side leg.

C2A: Fraction of liquid velocity at the right face of the TEE junction cell that contributes to the momentum transfer into the TEE side leg.

C2AV: Vapor velocity fraction at the right face of the TEE junction cell that contributes to the momentum transfer into the TEE side leg.

CT: Momentum source coefficient.

DVJP: Pressure derivative of source velocity.

FL1: Temporary storage for liquid mass-flow corrections for mass-conservation checks at low-numbered cell face.

FL2: Temporary storage for liquid mass-flow corrections for mass-conservation checks at high-numbered cell face.

FLJP: K-factor turning plus abrupt flow-area change loss times the side-leg RHO*FA*VM**2 at a TEE internal junction that is to be assigned to the primary-side interfaces that flow into JCELL.

FLJS: FRIC turning plus abrupt flow-area change loss at a TEE internal junction that is to be assigned to the side-leg internal-junction interface.

FV1: Temporary storage for vapor mass-flow corrections for mass-conservation checks at low-numbered cell face.

FV2: Temporary storage for vapor mass-flow corrections for mass-conservation checks at high-numbered cell face.

HAVLV: Temporary storage for the hydraulic diameter when the valve is open.

QTP: Total direct power input.

S01: Sign of IOU(1,current component).

S02: Sign of IOU(2,current component).

SALT: Source term to liquid for compressible work.

SAVT: Source term to vapor for compressible work.

SSAC: Air source.

SSE: Energy source.

SSMC: Mass source.

SSMOM: Momentum source to left-hand cell boundary.

SSVC: Vapor mass source.

SSVE: Vapor energy source.

VJS: Source velocity.

ZZZZZZ: Dummy variable that provides a known end to the COMMON block.

INTEGER VARIABLES:

I01: ABS(IOU(1,current component)).

I02: ABS(IOU(2,current component)).

I03: IOU(3,current component) [always positive]

IACC2: Flag for PIPE used to model accumulator.

IBKS: Indicator for network solution.

ICLFLG: Flag used by the STGEN (steam-generator) component in the post-pass to instruct the numerical stabilizer whether the second junction of a secondary component is connected to an external component.

ICME: Component index for referencing IOU array.

ICORL: Core-region lower boundary.

ICORU: Core-region upper boundary.

II01: I01 plus a displacement for the current loop.

II02: I02 plus a loop displacement.

II03: I03 plus a loop displacement.

IL: Loop number index.

IPHSEP: Phase-separation evaluation flag of the TEE offtake model.

ISFLG: Flag that indicates if the calculations are being performed for a STGEN (steam-generator) component.

[illegible] Left-hand boundary switch.

[illegible] Right-hand boundary switch.

[illegible] Interface number of the adjustable-valve flow area.

[illegible] Cell number at left end of one-dimensional segment.

[illegible] Loop index that indicates the loop in the system.

[illegible] Cell number for source terms.

NC2: Cell number that begins a TEE and STGEN (steam-generator) TEE secondary.

NJN: Number of network matrix junctions.

NSTG: Counter for a STGEN (steam generator).

NTEE: Counter for a TEE.

COMDECK DIDDLE

COMMON/DIDDLE/ AFCT, ALPBCT, ALPCC, ALPLVL, ALPLVU, ALPSHL, ALPSHU, ALW1, ALW2, CALV2, CBMIN, ENCUT, ENFAC1, ENFAC2, ENMIN, FAREA1, FAREAH, FAREAV, FSE5, SCINAN, TGRAV, VDRPF, VDRPMX, VECLCT, VECVCT, VINTF, VLVCMX, VRBCUT, VRTCUT

COMMON/DIDDLE/ NIFSLB

REAL VARIABLES:

AFCT: Area scaling for waves on inverted annular interface.

ALPBCT: Lower bound on bubble void fraction used to compute interfacial heat-transfer rates (and resulting Γ) when boiling.

ALPCC: Void fraction that gives the minimum value for the bubble condensation rate.

ALPLVL: Lowest value of the maximum adjacent void fraction allowed for calculating a plug interfacial area.

ALPLVU:	Highest value of the minimum adjacent void fraction allowed for calculating a plug interfacial area.
ALPSHL:	Void below which the interface sharpener is off.
ALPSHU:	Void above which the interface sharpener is completely on.
ALW1:	Void fraction lower limit for transition from bubbly-slug (at ALW1 = 0.5) to annular-mist (at ALW2 = 0.75) flow regimes.
ALW2:	Void fraction upper limit for transition from bubbly-slug (at ALW1 = 0.5) to annular-mist (at ALW2 = 0.75) flow regimes.
CALV2:	The liquid-side HTC for superheated drops.
CBMIN:	Minimum allowed mean bubble diameter.
ENCUT:	Minimum droplet entrainment fraction.
ENFAC1:	Scaling factor for minimum entrainment velocity.
ENFAC2:	Scaling factor for entrainment correlation exponent.
ENMIN:	Variable not implemented.
FAREA1:	Scale factor for one-dimensional plug flow condensation area.
FAREAH:	Scale factor for three-dimensional separated plug flow horizontal condensation area.
FAREAV:	Scale factor for three-dimensional separated plug flow vertical condensation area.
FSE5:	Scale factor for pool entrainment.
SCINAN:	Scale factor for inverted annular drag.
TGRAV:	Absolute value of GRAV above which horizontal stratified flow cannot exist (0.75).
VDRPF:	Scale factor in the expression for the limiting circulation velocity in a drop.
VDRPMX:	Maximum allowed internal circulation velocity in a drop.
VECLCT:	Lowest allowed liquid speed when computing interfacial coefficients.
VECVCT:	Lowest allowed vapor speed when computing interfacial coefficients.
VINTF:	Factor in expression for mean circulation speed in a moving drop
VLVCMX:	Maximum liquid velocity used for the condensation ALV correlation.
VRBCUT:	Minimum allowed relative velocity for computing ALV during boiling.
VRTCUT:	Minimum allowed relative speed for computing interfacial coefficients (except during boiling).

INTEGER VARIABLE:

NIFSLB: If nonzero, then slabs should be used to test for inverted annular flow.

COMDECK DIDDLH

COMMON/DIDDLH/ AFLML, AFLMU, ALP2, ALP3, ALPAG, ALPBR, ALPCUT, ALPDF, ALOW, AUP, FBER, FBEX, FDALVA, FDFHL, FLILER, FLILES, FREQ1, FREQ2, FUDGE1, FUDGE2, HGF, HGVMN, LIMFLG

COMMON/DIDDLH/ IHTAV, IHTCN, NSHTCN

REAL VARIABLES:

AFLML: Void fraction below which Bromley film boiling contributes fully to the liquid.

AFLMU: Void fraction above which no Bromley coefficient is added to the liquid.

ALP2: Void fraction above which vapor is in forced convection.

ALP3: Void fraction above which there is no liquid heat transfer.

ALPAG: Void fraction at the agitated-to-post-agitated inverted-annular flow transition boundary.

ALPBR: Void fraction above which liquid convection is linearly faired off and vapor connection is faired on.

ALPCUT: Void fraction above which nucleate boiling is not permitted (if other criteria are met).

ALPDF: Void fraction describing the beginning of the highly dispersed inverted-annular flow.

ALOW: Lowest value of void fraction in adjacent cells.

AUP: Highest value of void fraction in adjacent cells.

FBER: Variable not used.

FBEX: Power of $(1 - \alpha)$ weighting of Bromley correlation.

FDALVA: Multiplier of DALVA(J) which is rate of change of ALW with respect to void fraction and is currently set to zero.

FDFHL: A scaling factor for the wall-to-droplet heat-transfer correlation.

FLILER: Constant used to adjust the wall-to-liquid HTC obtained by modified Bromley correlation in reflood.

FLILES: Same as FLILER for non-reflood cases.

FREQ1: Time-constant constraint frequency for the maximum increase in interfacial heat-transfer and drag coefficients.

FREQ2: Time-constant constraint frequency for the maximum decrease in interfacial heat-transfer and drag coefficients.

FUDGE1: Time-constant constraint factor of maximum increase when the time-step size is 1.0/FREQ1.

FUDGE2: Time-constant constraint factor of maximum decrease when the time-step size is 1.0/FREQ2.

HGF: Function of nucleate-boiling heat transfer, which contributed to subcooled boiling.

HGVMN: Cutoff velocity for condensation used to suppress subcooled nucleate boiling.

LIMFLG: Flag for evaluating time-constant constraint of the evaporation and condensation rate coefficients.
0 = no;
1 = yes.

INTEGER VARIABLES:

IHTAV: Variable is normally 1. If IHTAV is 0, then there is no time averaging of HTCs.

IHTCN: Variable is normally 0. If IHTCN is 1, then HTCs are forced to remain constant.

NSHTCN: Variable is normally 10 000 000. If NSTEP > NSHTCN, then IHTCH is set to 1 (for debugging only).

COMDECK DIDDLI

COMMON/DIDDLI/ SMIVX

COMMON/DIDDLI/ IIABK, NSCOOL

REAL VARIABLE:

SMIVX: Constant 1.5 (not used).

INTEGER VARIABLES:

IIABK: Constant 1 (not used).

NSCOOL: Flag (when having its default value of 1) that constrains the subcooled boiling heat flux to not exceed the wall heat flux to the liquid.

COMDECK DIMNSION

COMMON/DIMEN/ IFREE, JNVSSL, KVEL1T, KVEL2T, KVEL3T, LAST, LDIM, LENBD, LENDIM, LENTBL, LFREE, LLAST, LNLDPV, LNRDPT, LOCRDP, LSTART, LSTRDP, LVER, MDIM, MEMFLG, MOFF, NCOMP, NCOMPT, NHTSTR, NJNMX, NJNT, NJUN, NLOOPS, NMVSSL, NPX, NSTGJ, NTHM, NTHM1D, NTHM3D, NUMTCR, NVCON, NVELX, NVELY, NVELZ, NWRDA

INTEGER VARIABLES:

IFREE:	First free location in the dynamic storage area.
JNVSSL:	Maximum number of VESSEL junctions in a loop.
KVEL1T:	Order of the x- or r-direction stabilizer motion-equation VESSEL matrix.
KVEL2T:	Order of the y- or θ-direction stabilizer motion-equation VESSEL matrix.
KVEL3T:	Order of the z-direction stabilizer motion-equation VESSEL matrix.
LAST:	Last location in the dynamic storage area.
LDIM:	Maximum storage size order of the capacitance matrix.
LENBD:	Length of boundary data array for each junction.
LENDIM:	Variable that dimensions the component variable-length tables.
LENTBL:	Length of fixed-length table.
LFREE:	First free location in LCM.
LLAST:	Last location in LCM.
LNLDPV:	Pointer variable for the network matrix equation right-hand side vector.
LNRDPT:	Total number of ROD-data pointer variables.
LOCRDP:	Number 1 (the initial value of the do-loop index over rod-data pointer variables).
LSTART:	First free location in LCM.
LSTRDP:	Number of general ROD-data pointer variables.
LVER:	Location in LCM of version information data.
MDIM:	Maximum storage order of the banded VESSEL matrix.
MEMFLG:	Flag for monitoring dynamic memory expansion.
MOFF:	Array row number of the main diagonal elements from the banded VESSEL matrix.
NCOMP:	Number of components (each STGEN component counts as a single component).
NCOMPT:	Total number of components, including the secondary components defined as parts of the STGEN components.
NHTSTR:	Namelist variable defining the total number of heat-structure components.
NJNMX:	Maximum number of network junctions.
NJNT:	Total number of network junctions for all loops.
NJUN:	Number of junctions.
NLOOPS:	Number of one-dimensional loops in the system.

NMVSSL: Number of VESSELs.

NPX: Number of pointers in the PTRS COMMON block.

NSTGJ: Number of internal junctions in a STGEN (steam generator).

NTHM: Number of elements per cell in the DRIV array.

NTHM1D: Length of the data stored per cell in the DRIV array (mostly thermodynamic derivatives) in one-dimensional components.

NTHM3D: Length of the data stored per cell in the DRIV array (mostly thermodynamic derivatives) in three-dimensional VESSEL components.

NUMTCR: Number of title cards.

NVCON: Total number of VESSEL connections.

NVELX: Order of the x- or r-direction stabilizer motion equation VESSEL matrix.

NVELY: Order of the y- or θ-direction stabilizer motion equation VESSEL matrix.

NVELZ: Order of the z-direction stabilizer motion equation VESSEL matrix.

NWRDA: Size of the A array under *IF DEF, ASIZE.

COMDECK DLIMIT

COMMON/DLIM/ DELAMX, DELCMX, DELDMX, DELEMX, DELPMX, DELRMX, DELVMX, DELXMX, DTBKUP, FPMAX, FXMAX, GXMAX

COMMON/DLIM/ NLIM, NLIM2

DIMENSION NLIM(8), NLIM2(6)

REAL VARIABLES:

DELAMX: Time-step limit caused by void-fraction change.

DELCMX: Time-step limit caused by maximum changes in pressures and temperatures.

DELDMX: Time-step limit caused by numerical considerations in the ROD and SLAB heat transfer.

DELEMX: Time-step limit caused by VESSEL mass errors.

DELPMX: Time-step limit that results in a maximum 10% change in reactor-core power.

DELRMX: Time-step limit caused by final value of the percentage variation in pressure from iteration to iteration.

DELVMX: Material Courant stability limit (computed only in VESSELs).

DELXMX: Time-step limit that results in the maximum allowed adjustment of VALVE components.

DTBKUP: Time-step limit defined by DELPMX or DELXMX when a back-up calculation is required after the prep-stage calculation.

FPMAX: Maximum fractional change (0.1) in reactor-core power per time step.

FXMAX: VALVE-adjustment algorithm parameter (0.4).

GXMAX: Minimum fractional change (0.05) in the VALVE maximum flow-area fraction change over a time step.

INTEGER VARIABLES:

NLIM: Array that stores the number of time steps that were constrained by each of the time-step limits since the last short or large edit.

NLIM2: Array that stores the number of time steps that were constrained by each of six different time-step limits defining DELCMX since the last short or large edit. [The sum of all six NLIM2(I) equals NLIM(5), which is the number of times DELCMX controls the time-step size.]

COMDECK DMPCK

COMMON/DMPCK/ LVCK

INTEGER VARIABLE:

LVCK: Summed number of values over the VESSEL component that have been written to the dump file (summed by subroutine DLEVEL but not used).

COMDECK DMPCTRL

COMMON/CTRLDP/ DMPINT, LTDUMP, TDUMP

COMMON/CTRLDP/ DMPFLG, ICTRLD, NSDO

DIMENSION ICTRLD(8)

REAL VARIABLES:

DMPINT: Dump interval for time domain.

LTDUMP: CPU time when last dump was taken.

TDUMP: Calculation time when next dump will be taken.

INTEGER VARIABLES:

DMPFLG: Flag that signals whether the dump output file has been initialized.
0 = uninitialized;
1 = initialized.

ICTRLD: Array that contains buffering information about the dump output file.

NSDO: Time-step number of last completed dump.

COMDECK DSKPTP

COMMON/DSKPTP/ NL, NR, NW

INTEGER VARIABLES:

NL:	Number of words of data in the process-to-process (PTP) message.
NR:	First word address on the I/O unit 9 disk where the PTP message is to be read from.
NW:	First word address on the I/O unit 9 disk where the PTP message is to be written to.

COMDECK EDIFF

COMMON/EDIFF/ IDIAG2, JPRTST, JTLTST, JTMTST, JTVTST, KDAMX, LDAMX, LPRTST, LTLTST, LTMTST, LTVTST, NDAMX, NPRTST, NTLTST, NTMTST, NTVTST

INTEGER VARIABLES:

IDIAG2:	Flag that allows skipping of certain diagnostics generated in NEWDLT by IDIAG option. (Hardwired on.)
JPRTST:	Cell number of component that has controlled time step due to pressure change limits.
JTLTST:	Cell number of component that has controlled time step due to liquid temperature change limits.
JTMTST:	Structure node of component that has controlled time step due to "metal" temperature change limits.
JTVTST:	Cell number of component that has controlled time step due to vapor temperature change limits.
KDAMX:	Variable not used.
LDAMX:	Variable not used.
LPRTST:	Z-elevation number of component that has controlled time step due to pressure change limits.
LTLTST:	Z-elevation number of component that has controlled time step due to liquid temperature change limits.
LTMTST:	Z-elevation number of component that has controlled time step due to "metal" temperature change limits.
LTVTST:	Z-elevation number of component that has controlled time step due to vapor temperature change limits.
NDAMX:	Variable not used.
NPRTST:	Component number that has controlled time step due to pressure change limits.

NTLTST: Component number that has controlled time step due to liquid temperature change limits.

NTMTST: Component number that has controlled time step due to "metal" temperature change limits.

NTVTST: Component number that has controlled time step due to vapor temperature change limits.

COMDECK ELVKF

COMMON/ELVKF/ IELV, IINL, IKFAC

INTEGER VARIABLES:

IELV: Input option switch that allows user to input cell-centered elevations for gravity term.

IINL: Index for the two passes through INIT.

IKFAC: Input option switch that allows user to input K-factors for additive form-loss coefficients.

COMDECK EMOT

COMMON/EMOT/ CSF1D, CSF3D, FNCIF

COMMON/EMOT/ IVMN, IVMX, JIV, NOLDV

REAL VARIABLES:

CSF1D: Maximum material courant number for the one-dimensional hydro components.

CSF3D: Maximum material courant number for the three-dimensional hydro components.

FNCIF: Constant 0.7 (not used).

INTEGER VARIABLES:

IVMN: Minimum time-step number for debug printing interface JIV velocities.

IVMX: Maximum time-step number for debug printing interface JIV velocities.

JIV: Mesh-cell interface number for debug printing vapor and liquid, tilde, and solution velocities in subroutine TF1DSI.

NOLDV Flag for setting the beta factor in the momentum-convection term to zero.
0 = no;
1 = yes.

COMDECK ERRCON

COMMON/ERRCON/ ANTEST, ATEST1, DARA, DARL, DARV, DDVL, DDVV, DTLL, DTLLM, DTLU, DTLUM, DTVL, DTVLM, DTVU, DTVUM, TIMDL, TIMDU

COMMON/ERRCON/ IATEST, ICHGA, ILREIT, IPTEST, IVTEST, JATEST, JDARA, JDARL, JDARV, JDDVL, JDDVV, JDTLL, JDTLU, JDTVL, JDTVU, JPTEST, JVTEST, KPTEST, NDARA, NDARL, NDARV, NDDVL, NDDVV, NDTLL, NDTLU, NDTVL, NDTVU, NPTEST, NSDL, NSDU

REAL VARIABLES:

ANTEST: End-of-time-step void fraction that is outside its 0. to 1. value range in mesh cell JATEST of component IATEST.

ATEST1: Beginning-of-time-step void fraction in mesh cell JATEST of component IATEST

DARA: Maximum change in $\alpha\rho_a$.

DARL: Measure of the maximum difference in $(1-\alpha)\rho_\ell$ between the basic and stabilizer steps.

DARV: Measure of the maximum difference in $\alpha\rho_g$ between the basic and stabilizer steps.

DDVL: Measure of the maximum difference in V_ℓ between the basic and stabilizer steps.

DDVV: Measure of the maximum difference in V_g between the basic and stabilizer steps.

DTLL: Largest decrease in T_ℓ for current iteration.

DTLLM: DTVLM and DTLLM are limits on DTVL and DTLL beyond which another iteration must be performed.

DTLU: Largest increase in T_ℓ for current iteration.

DTLUM: DTVLM and DTLLM are limits on DTVL and DTLL beyond which another iteration must be performed.

DTVL: Largest decrease in vapor temperature in a given iteration.

DTVLM: DTVLM and DTLLM are limits on DTVL and DTLL beyond which another iteration must be performed.

DTVU: Largest increase in T_g for current iteration.

DTVUM: DTVLM and DTLLM are limits on DTVL and DTLL beyond which another iteration must be performed.

TIMDL: If TIMDL $\leq$ TIMET $\leq$ TIMDU, details of DARV, etc., should be printed.

TIMDU: If TIMDL $\leq$ TIMET $\leq$ TIMDU, details of DARV, etc., should be printed.

INTEGER VARIABLES:

IATEST:	Component number with an out-of-range void fraction value.
ICHGA:	Flag to print maximum void fraction changes to the message file.
ILREIT:	Flag that allows reiteration messages when equation set changes.
IPTEST:	VESSEL x- or r-direction mesh-cell number having maximum $\lvert\delta p/p\rvert$.
IVTEST:	Component number having a velocity that changed its numerical sign during the last outer iteration.
JATEST:	Mesh-cell number in component IATEST where the void fraction has an out-of-range value.
JDARA:	Cell where DARA occurred.
JDARL:	Cell where DARL occurred.
JDARV:	Cell where DARV occurred.
JDDVL:	Cell where DDVL occurred.
JDDVV:	Cell where DDVV occurred.
JDTLL:	Cell where DTLL occurred.
JDTLU:	Cell where DTLU occurred.
JDTVL:	Cell where DTVL occurred.
JDTVU:	Cell where DTVU occurred.
JPTEST:	VESSEL y- or θ-direction mesh cell or one-dimensional component mesh cell with maximum $\lvert\delta p/p\rvert$.
JVTEST:	Mesh-cell interface number in component IVTEST with a velocity that changed numerical sign during the last outer iteration.
KPTEST:	VESSEL z-direction mesh cell with maximum $\lvert\delta p/p\rvert$.
NDARA:	Component where DARA occurred.
NDARL:	Component where DARL occurred.
NDARV:	Component where DARV occurred.
NDDVL:	Component where DDVL occurred.
NDDVV:	Component where DDVV occurred.
NDTLL:	Component where DTLL occurred.
NDTLU:	Component where DTLU occurred.
NDTVL:	Component where DTVL occurred.
NDTVU:	Component where DTVU occurred.
NPTEST:	Component number with maximum $\lvert\delta p/p\rvert$.
NSDL:	If NSDL $\leq$ NSTEP $\leq$ NSDU, a detailed diagnostic of DARV, etc., should be printed to TRCMSG.
NSDU:	If NSDL $\leq$ NSTEP $\leq$ NSDU, a detailed diagnostic of DARV, etc., should be printed to TRCMSG.

COMDECK FILM

COMMON/FILM/ CONFLM, FDMAX, FFUNH, FILML, FILMU, XFDCON

REAL VARIABLES:

- CONFLM: Constant used in film thickness calculation.
- FDMAX: Factor indicating how much bigger film drag may be than the wall drag.
- FFUNH: Factor indicating cross-channel cold-wall effect.
- FILML: Lower bound on film thickness.
- FILMU: Upper bound on film thickness.
- XFDCON: Multiplier on wet-wall film drag.

FIXED-LENGTH TABLES

COMDECK FIXEDLT

COMMON/FLTAB/ COILD, HTLSCI, HTLSCO

COMMON/FLTAB/ CTITLE, CTYPE, ICFLG, ID, IREST, LENARR, LENFV, LENFV2, LENPTR, LENVLT, LEXTRA, LFV, LFVN, NCELLT, NODES, NRVLT, NUM, NUMBM1, NUMBM2, NUMBM3, NUMBN1, NUMBN2, NUMBN3

DIMENSION CTITLE(4)

REAL VARIABLES:

- COILD: Constant 0.0 (not used).
- HTLSCI: Component inside surface heat-transfer coefficient.
- HTLSCO: Component outside surface heat-transfer coefficient.

INTEGER VARIABLES:

- CTITLE: Component description.
- CTYPE: Component type.
- ICFLG: Cell-edge choked-flow model options.
- ID: Component identification.
- IREST: Component restart indicator.
- LENARR: Length of array block.
- LENFV: Length of fundamental variables.
- LENFV2: Length of fundamental variables for which old-time and new-time values are the same at the start of the OUTER code block.
- LENPTR: Length of pointer table.
- LENVLT: Length of variable-length table.

LEXTRA: Length of nonstandard dump for components.

LFV: Relative position of old fundamental variables.

LFVN: Relative position of new fundamental variables.

NCELLT: Total number of cells.

NODES: Number of heat-transfer nodes.

NRVLT: Number of real variables in each component VLT COMMON block.

NUM: Component number.

NUMBM1: Indices to access large numerals for printing component NUM and IORDER.

NUMBM2: Indices to access large numerals for printing component NUM and IORDER.

NUMBM3: Indices to access large numerals for printing component NUM and IORDER.

NUMBN1: Indices to access large numerals for printing component NUM and IORDER.

NUMBN2: Indices to access large numerals for printing component NUM and IORDER.

NUMBN3: Indices to access large numerals for printing component NUM and IORDER.

COMDECK FIXUM

COMMON/FIXUM/ NOAIR, NSMEC, NTHRMC, NVTC

INTEGER VARIABLES:

NOAIR: Variable that turns off noncondensable (air) field calculations.

NSMEC: Variable that turns off stabilizer mass and energy equations.

NTHRMC: Variable that turns off (debugs) basic equation set.

NVTC: Variable that turns off stabilizer motion equations.

COMDECK GOBCOM

COMMON/GOBCOM/ IDUM, IGOB

INTEGER VARIABLES:

IDUM: Variable not used.

IGOB: Variable whose location stores the field length of available memory in SCM.

COMDECK GRAPHICS

COMMON/GRAPH/ EDINT, GFINT, SEDINT, TEDIT, TGRAF, TSEDIT

COMMON/GRAPH/ IBUFF, ICTRLG, IPKG, KP, LCAT, LCMGCT, LENCAT, NCTX, NSGO, NWTX

[Nuclear Plant Analyzer (NPA) variables listed below currently are intended only for in-house Los Alamos use.]

COMMON/GRAPH/ EDTBLK, IGROUT, IBLK, NBLKOUT

COMMON/GRAPH/ RDYFRM, SENDFR

DIMENSION ICTRLG(8)

REAL VARIABLES:

EDINT:	Print edit interval for time domain.
GFINT:	Graphics edit interval for time domain.
SEDINT:	Interval for short edits.
TEDIT:	Time of next print edit.
TGRAF:	Time of next graphics edit.
TSEDIT:	Time of next short edit.

INTEGER VARIABLES:

IBLK:	Counter for number of data-edit blocks.
IBUFF:	Length of graphics buffer.
ICTRLG:	Array that contains buffering information about the graphics output file.
IGROUT:	Controller that maintains the address for NPA random disk writes.
IPKG:	Graphics file packing density.
KP:	Pointer in graphics catalog block.
LCAT:	Address of graphics catalog in SCM.
LCMGC	Address of graphics catalog in LCM.
LENCAT:	Number of words in each catalog entry.
NBLKOUT:	Counter for the number of words written to buffer in current graphics data edit.
NCTX:	Number of graphics catalog entries.
NSGO:	Time-step number of last completed graphics edit.
NWTX:	Number of words written to disk per graphics edit.

LOGICAL VARIABLES:

EDTBLK:	Flag that is set to TRUE when graphics file is written to start of the first data edit.
RDYFRM:	Flag for sending TRAC NPA data to the HUNI file for plotting.
SENDFR:	Flag for sending TRAC NPA data to the HUNI file for plotting.

COMDECK H2FDBK

COMMON/H2FDBK/ IH2SRC

INTEGER VARIABLE:

IH2SRC: Namelist variable when nonzero forces namelist variables IGAS = 2 and NOAIR = 0.

COMDECK HOLERITH

COMMON/HOLL/ ACCUMH, BREAKH, COREH, CTAINH, FILLH, PIPEH, PLENH, PRIZRH, PUMPH, RODH, SEPDH, SLABH, STGENH, TEEH, TURBH, VALVEH, VSSLH

INTEGER VARIABLES:

ACCUMH: Hollerith representation of word "ACCUM."

BREAKH: Hollerith representation of word "BREAK."

COREH: Hollerith representation of word "CORE."

CTAINH: Hollerith representation of word "CTAIN."

FILLH: Hollerith representation of word "FILL."

PIPEH: Hollerith representation of word "PIPE."

PLENH: Hollerith representation of word "PLENUM."

PRIZRH: Hollerith representation of word "PRIZER."

PUMPH: Hollerith representation of word "PUMP."

RODH: Hollerith representation of word "ROD."

SEPDH: Hollerith representation of word "SEPD."

SLABH: Hollerith representation of word "SLAB."

STGENH: Hollerith representation of word "STGEN."

TEEH: Hollerith representation of word "TEE."

TURBH: Hollerith representation of word "TURB."

VALVEH: Hollerith representation of word "VALVE."

VSSLH: Hollerith representation of word "VESSEL."

COMDECK HOLLR

COMMON/HOLLR/ HBREAK, HPLEN, HPRIZR, VSS

REAL VARIABLES:

HBREAK: Real Hollerith BREAK component name.

HPLEN: Real Hollerith PLENUM component name.

HPRIZR: Real Hollerith PRIZER component name.

VSS: Real Hollerith VESSEL component name.

COMDECK HTCAV

COMMON/HTCAV/ FHTCU, FHTCL, OWHTD

REAL VARIABLES:

FHTCU: Maximum factor of increase of the liquid and vapor heat-transfer coefficients (2.0).

FHTCL: Minimum factor of decrease of the liquid and vapor heat-transfer coefficient (0.0).

OWHTD: Fraction of the previous time-averaged liquid or vapor heat-transfer coefficient that is averaged together with a (1.0 - OWHTD) fraction of the present coefficient to define the present time-averaged value.

COMDECK HTCREF1

COMMON/HTCREF1/ ALPAG2, ALPCF2, ALPRW, ALPSM, ALPTB, FUNH, QCHF, ZAGS, ZCHFL, ZDFS, ZRWS, ZSLAB, ZSMS, ZTB

COMMON/HTCREF1/ IJ, NHSCA, NNODES

DIMENSION ALPAG2(NXRYT), ALPCF2(NXRYT), ALPRW(NXRYT), ALPSM(NXRYT), ALPTB(NXRYT), FUNH(NXRYT), ZAGS(NXRYT), ZCHFL(NXRYT), ZDFS(NXRYT), ZRWS(NXRYT), ZSMS(NXRYT), ZTB(NXRYT)

DIMENSION NHSCA(NXRYT)

REAL VARIABLES:

ALPG2: Array of void fractions at top of the agitated section for a given (r, θ).

ALPCF2: Array of void fractions at CHF location for a given (r, θ).

ALPRW: Array of void fractions at top of the rough wavy section for a given (r, θ).

ALPSM: Array of void fractions at top of the smooth section for a given (r, θ).

ALPTB: Array of void fractions at transition boiling location for a given (r, θ).

FUNH: Array of fractions of the heat-structure surface that is unheated.

QCHF: Critical heat flux (CHF).

ZAGS: Array of elevation where agitated inverted annular flow ends for a given (r, θ).

ZCHFL: Array of elevations of CHF point for a given (r, θ).

ZDFS: Array of elevation where highly dispersed flow begins for a given (r, θ).

ZRWS: Array of elevations where rough-wavy inverted annular flow ends for a given (r, θ).

ZSLAB: Elevation of heat-transfer node being considered.

ZSMS: Array of elevations where smooth inverted annular flow ends for a given (r, θ).

ZTB: Array of elevations of transition boiling point for a given (r, θ).

INTEGER VARIABLES:

IJ: (r, θ) hydro-cell number.

NHSCA: Array of component numbers of the heat structure that defines the principal powered RODs or SLABs.

NNODES: Number of nodes for a given ROD or SLAB.

COMDECK HTCREF2

COMMON/HTCREF2/ TVZ, TWZ, ZNODES

DIMENSION TVZ(NZFMX), TWZ(NZFMX), ZNODES(NZFMX)

REAL VARIABLES:

TVZ: Array of vapor temperatures for a given ROD or SLAB.

TWZ: Array of wall temperatures for a given ROD or SLAB.

ZNODES: Array of all node centers.

COMDECK HTCREF3

COMMON/HTCREF3/ IFREZ, NREFLD

DIMENSION NREFLD(NXRYT)

INTEGER VARIABLES:

IFREZ: Flag used to turn interfacial vapor heat transfer off; i.e., freeze the drop size.

NREFLD: Flag indicating the reflood model is on; set in subroutine CORE1.

COMDECK HTCS

COMMON/HTCS/ HLIQ, HTCWL, HTCWV, HVAP, QSTEAM, SLIP

COMMON/HTCS/ ICONHT

REAL VARIABLES:

HLIQ: The enthalpy of liquid.

HTCWL: Namelist input for constant wall-to-liquid HTC used when ICONHT = 1.

HTCWV: Namelist input for constant wall-to-vapor HTC used when ICONHT = 1.

HVAP: The enthalpy of vapor.

QSTEAM: Wall-to-wall heat flux.

SLIP: Slip ratio between phasic velocities.

INTEGER VARIABLE:

ICONHT: Namelist input, ICONHT = 0 normal heat-transfer calculation; ICONHT = 1. Constant heat-transfer coefficients.

COMDECK IFCRS

COMMON/IFCRS/ AL01, ALMAX, ALMIN, ALPBCD, ALPBCH, ALPBCW, ALPDCH, ALPGS, ALPMCT, ALPTM, ALPTP, ALPTS1, ALPTS2, ALVCN, ALVCN1, ALVCN2, ALVEFX, ALVEV, ALVEV1, ALVEV2, ALVFAX, ALPVS, AUPCT, AUPDRG, CCFLL, CCFUL, CCFVLM, CHTABH, CHTACC, CHTAFX, CHTANV, CHTCN1, CHTCN2, CHTEV1, CHTEV2, CHTFAX, CHTICN, CHTIEV, CHTINV, CNDBS, CNDFL, CNDPL, CNDRO, CNDST, D1X, D2X, DTVHT, EPMAX, EPMIN, EVFAX, F2MX, FCDROP, FCSUB, FDIS, FDIS1, FDIS2, FDISV1, FDISV2, FFD, FFS, FIFAM, FIFBL, FIFBS, FIFCR, FIFEP, FIFST, FIFWL, FISHI, FLMIN, FLSH1, FLSH2, FLSHF, FMDIS, FRI1, FRI2, FRW

COMMON/IFCRS/ FSB, FSM, FUI1, FUI2, H0, HAMIN, HARMX, HCAMIN, HCMIN, HDMAX, HFVL, HFVU, HIMFAC, PC24, PCRIT, RDMAX, RDMIN, REGMN, SLP1, STFRL, STFRU, STSTRT, TLGTS, TVLTL, TVLTS, TWDFAC, TWDFAK, VLACC, VLMAX, VOIDD1, VOIDD2, VOIDS1, VOIDS2, VOIDS3, VR2MIN, VRCMIN, VRFMIN, XHVDIS, XMDIS, XNB

COMMON/IRCRS/ IBLAUS, IEPRI, IHOTP, IWILS

REAL VARIABLES:

AL01: Constant in subcooled boiling model.

ALMAX: 0.9999, maximum void fraction (α) to use in calculation of interfacial drag.

ALMIN: 0.00001, minimum void fraction (α) to use in calculation of interfacial drag.

ALPBCD: 0.00001, minimum void fraction (α) to use in calculation of bubbly interfacial drag.

ALPBCH: 0.00001, minimum void fraction (α) to use in calculation of bubbly interfacial heat transfer.

ALPBCW: 0.00001, minimum void fraction (α) to use in Wilson model (upper plenum) calculation of interfacial drag.

ALPDCH: 0.9995, maximum void fraction (α) for calculation of droplet diameter in the annular-mist regime.

ALPGS: Variable not used.

ALPMCT: Variable not used.

ALPTM: 0.1, maximum void fraction (α) in cell below for vertical stratified flow in the VESSEL.

ALPTP: 0.9, minimum void fraction (α) in cell above for vertical stratified flow in the VESSEL.

ALPTS1: Variable not used.

ALPTS2: Variable not used.

ALVCN: Time constant in rate model for change in condensing ALVE.

ALVCN1: Constant used in determining the upper bound at the liquid-side HTC for subcooled liquids.

ALVCN2: Constant used in determining the lower bound of the liquid-side HTC for subcooled liquids.

ALVEFX: Constant used in determining the limit of the liquid-side HTC between time steps.

ALVEV: Constant used in determining the limit of the liquid-side HTC between time steps.

ALVEV1: Constant used in determining the upper bound of the liquid-side HTC for saturated or superheated liquids.

ALVEV2: Constant used in determining the lower bound of the liquid-side HTC for saturated or superheated liquids.

ALVFAX: Constant used in determining the limit of flashing HTC between time steps.

ALPVS: ALPVS = 0.3 constant in model for bubbly flow below a stratified level.

AUPCT: Constant in stratified flow model for ACCUMs (accumulators).

AUPDRG: Constant in stratified flow model for ACCUMs (accumulators).

CCFLL: Variable not used.

CCFUL: Variable not used.

CCFVLM: Variable not used.

CHTABH: Vapor-side HTC for noncondensable gas in bubbly-slug flow.

CHTACC: Vapor-side HTC for ACCUMS (accumulators).

CHTAFX: Constant used in determining the limit of vapor-side HTC for noncondensable gas.

CHTANV: Liquid-side HTC for noncondensable gas for smooth, rough-wavy, and agitated inverted-annular flow.

CHTCN1: Constant used in determining the upper bound of vapor-side HTC for subcooled vapor.

CHTCN2: Constant used in determining the lower bound of vapor-side HTC for subcooled vapor.

CHTEV1: Constant used in determining the upper bound of vapor-side HTC for saturated or superheated vapor.

CHTEV2: Constant used in determining the lower bound of vapor-side HTC for saturated or superheated vapor.

CHTFAX: Constant used in determining the limit of vapor-side HTC between time steps.

CHTICN: Constant used in determining the limits of vapor-side HTC.

CHTIEV: Constant used in determining the limits of vapor-side HTC.

CHTINV: Liquid-side HTC for smooth, rough-wavy, and agitated inverted-annular flows.

CNDBS: Constant to adjust the interfacial area for condensing bubble.

CNDFL: Constant to adjust the liquid-side HTC in annular-mist flow.

CNDPL: Constant to adjust the liquid-side HTC for condensation in plug flows.

CNDRO: Constant to adjust the liquid-side HTC in annular-mist flows.

CNDST: Multiplier for stratified-flow condensation interfacial heat transfer.

D1X: Constant in EPRI model.

D2X: Constant in EPRI model.

DTVHT: Variable not used.

EPMAX: Maximum drag on EPRI model for CORE-component interfacial drag (not used).

EPMIN: Minimum drag on EPRI model for CORE-component interfacial drag (not used).

EVFAX: Constant in the evaporation model.

F2MX: Factor in the droplet vapor to interface heat-transfer model.

FCDROP: Constant to adjust the droplet interfacial-drag coefficient for lightly dispersed inverted-annular flow.

FCSUB: Multiplication constant in the subcooled-boiling condensation model.

FDIS: Constant to adjust the interfacial-drag coefficient for highly dispersed inverted-annular flow.

FDIS1: Constant in the dispersed-droplet interfacial-drag model.

FDIS2: Constant in the dispersed-droplet interfacial-drag model.

FDISV1: Constant in the dispersed-droplet interfacial-drag model.

FDISV2: Constant in the dispersed-droplet interfacial-drag model.

FFD:	Constant to adjust the interfacial-drag coefficient of the liquid flow in highly dispersed inverted-annular flow.
FFS:	Constant to adjust the interfacial-drag coefficient for the free-stream contribution in subcooled nucleate-boiling regime.
FIFAM:	Factor applied to annular-mist interfacial drag (1.0).
FIFBL:	Multiplier in downcomer interfacial-drag model.
FIFBS:	Factor applied to bubbly-slug interfacial drag (1.0).
FIFCR:	Variable not used.
FIFEP:	Multiplier in EPRI interfacial-drag model (1.0); not used.
FIFST:	Factor applied to stratified-flow interfacial drag (1.0).
FIFWL:	Multiplier for Wilson-model interfacial drag in the upper plenum of the VESSEL (1.0).
FISHI:	Variable not used.
FLMIN:	Minimum film thickness for annular flow.
FLSH1:	Maximum flash multiplier.
FLSH2:	Minimum flash multiplier.
FLSHF:	Multiplier on liquid superheat for flashing.
FMDIS:	Constant to adjust the interfacial-drag coefficient for the post-agitated inverted-annular flow.
FRI1:	Time constant for rate of decrease in C_i.
FRI2:	Time constant for rate of increase in C_i.
FRW:	Constant to adjust the interfacial-drag coefficient for the rough-wavy inverted-annular flow.
FSB:	Constant to adjust the interfacial-drag coefficient for the subcooled nucleate-boiling regime.
FSM:	Constant to adjust the interfacial-drag coefficient for the smooth inverted-annular flow.
FUI1:	Minimum allowed change in C_i.
FUI2:	Maximum allowed change in C_i.
H0:	Constant in subcooled-boiling condensation model.
HAMIN:	Product of the heat-transfer coefficient times the interfacial area.
HARMX:	Variable not used.
HCAMIN:	Variable not used.
HCMIN:	Variable not used.
HDMAX:	Hydraulic diameter used in VESSEL component if user-input hydraulic diameter is less than 10^{-5}.
HFVL:	Constant used in dispersed-droplet interfacial-drag model.

HFVU:	Constant used in dispersed-droplet interfacial-drag model.
HIMFAC:	Multiplication constant used in the calculation of the minimum vapor-interface heat-transfer rate.
PC24:	Pressure constant (1.95187E+15 Pa^2)
PCRIT:	Critical-point pressure (2.209E+07 Pa).
RDMAX:	Maximum droplet radius in annuler-mist flow.
RDMIN:	Minimum droplet radius in annular-mist flow.
REGMN:	Minimum Reynold's number in stratified flow.
SLP1:	Constant in subcooled-boiling model.
STFRL:	Stratified-flow lower-velocity limit multiplier.
STFRU:	Stratified-flow upper-velocity limit multiplier.
STSTRT:	Multiplier on stratified-flow interfacial heat transfer (1.0).
TLGTS:	Maximum liquid superheat used to calculate limit on interfacial heat transfer.
TVLTL:	Maximum vapor temperature less than liquid temperature used to calculate limit on interfacial heat transfer.
TVLTS:	Maximum vapor subcooling used to calculate limit on interfacial heat transfer.
TWDFAC:	Constant in subcooled-boiling model.
TWDFAK:	Constant in subcooled-boiling model.
VLACC:	Maximum liquid velocity in ACCUM (accumulator) for calculation of interfacial heat transfer.
VLMAX:	Maximum liquid velocity in annular film for calculation of interfacial heat transfer.
VOIDD1:	Variable not used.
VOIDD2:	Void fraction limit in the rough-wavy reflood flow regime.
VOIDS1:	Constant 0.05, the lower limit of the void fraction for smooth inverted-annular flow.
VOIDS2:	The upper limit on the void fraction for rough-wavy inverted-annular flow.
VOIDS3:	Constant 0.3, the upper limit on the void fraction for smooth inverted-annular flow.
VR2MIN:	Variable not used.
VRCMIN:	Constant 0.1 minimum relative velocity used to calculate a run.
VRFMIN:	Minimum relative velocity to be used in the bubbly-slug C_i calculation.

XHVDIS: Constant to adjust the weighting for rough-wavy and smooth inverted-annular flow interfacial-drag coefficient in the intermediate void-fraction region.

XMDIS: Constant to adjust the weighting for post-agitated inverted-annular flow interfacial-drag coefficient.

XNB: Constant to adjust the weighting for the bubbly flow in the intermediate void-fraction region.

INTEGER VARIABLES:

IBLAUS: Blasius friction-factor flag used in downcomer for interfacial drag if set = 1.

IEPRI: EPRI interfacial-drag model flag used for rod bundle in core region if set = 1.

IHOTP: Flag for hot-patch modeling, 1 = on, 0 = off.

IWILS: Wilson interfacial-drag model flag for use in upper plenum when set to 1.

COMDECK IFDPTR

COMMON/IFDPTR/ IWRTPT, LASTP1, NTMPV, TMPVL

COMMON/IFDPTR/ LVT1, LVT2, LVT3, LVT4, LVT5, LVT6, LVT7, LVT8, LVT9, LVT10, LVT11, LVT12, LVT13, LVT14, LVT15, LVT16, LVT17, LVT18, LVT19, LVT20, LVT21, LVT22, LVT23, LVT24, LVT25, LVT26, LVT27, LVT28, LVT29, LVT30, LVT31, LVT32, LVT33, LVT34, LVT35, LVT36, LVT37, LVT38, LVT39, LVT40, LVT41, LVT42, LVT43, LVT44, LVT45, LVT46, LVT47, LVT48, LVT49, LVT50, LVT51, LVT52, LVT53, LVT54, LVT55, LVT56, LVT57, LVT58, LVT59, LVT60, LVT61, LVT62, LVT63, LVT64, LVT65, LVT66, LVT67, LVT68, LVT69, LVT70, LVT71, LVT72, LVT73, LVT74, LVT75, LVT76, LVT77, LVT78, LVT79, LVT80, LVT81, LVT82, LVT83, LVT84, LVT85, LVT86, LVT87, LVT88, LVT89, LVT90, LVT91, LVT92, LVT93, LVT94, LVT95, LVT96, LVT97, LVT98, LVT99, LVT100, LVT101, LVT102, LVT103, LVT104, LVT105, LVT106, LVT107, LVT108, LVT109, LVT110, LVT111, LVT112, LVT113, LVT114, LVT115, LVT116, LVT117, LVT118, LVT119, LVT120, LVT121, LVT122, LVT123, LVT124

INTEGER VARIABLES:

IWRTPT: Flag to set up temporary pointers for subroutines PREFWD and PREIFD.

LASTP1: LAST+1, pointer for the first free location in memory for the temporary storage arrays set up to vectorize the three-dimensional wall shear and interfacial-drag coefficient evaluations.

NTMPV: Constant 124, the number of temporary storage arrays in subroutines PREFWD and PREIFD set up to vectorize the three-dimensional wall shear and interfacial-drag coefficient evaluations.

TMPVL: Number of calculative mesh cells in the three-dimensional VESSEL component.

LVT#: Pointer variable for the #th temporary storage array set up to vectorize the three-dimensional wall shear and interfacial drag coefficient evaluation.

COMDECK INFOHL

COMMON/INFOHL/ DROPD, FHLF, QDEN, QFR, QTOTAL, QWEBB, VR2

REAL VARIABLES:

DROPD: Calculated drop diameter used in Forsland-Rohsenow correlation.

FHLF: Factor carried along to separate Denham and Forsland-Rohsenow regions.

QDEN: Heat flux calculated using Denham correlation.

QFR: Heat flux calculated using Forsland-Rohsenow correlation.

QTOTAL: Total heat flux calculated, including radiation.

QWEBB: Heat flux calculated using Webb-Chen correlation.

VR2: Local relative velocity minus quench-front relative velocity.

COMDECK IOUNITS

COMMON/UNITS/ IBFADD, IBFADG, IBFADR, IBFLND, IBFLNG, IBFLNR, IDOUT, IGOUT, IMOUT, IN, INLAB, INPROC, IODONE, IOERR, IOSKIP, IOUT, IRSTRT, ITTY, LCMCPD, NITTAB, NPWTAB

COMMON/CUNITS/ CARD

INTEGER VARIABLES:

CARD: Variable that contains the current input card in character format.

IBFADD: Pointer to beginning of dump LCM buffer.

IBFADG: Pointer to beginning of graphics LCM buffer.

IBFADR: Pointer to beginning of restart LCM buffer.

IBFLND: Length of dump buffer.

IBFLNG: Length of graphics buffer.

IBFLNR: Length of restart buffer.

IDOUT: I/O unit number for dump output file (currently set to unit 12).

IGOUT: I/O unit number for graphics output file (currently set to unit 11).

IMOUT: I/O unit number for warning messages (currently set to unit 7).

IN: I/O unit number for input to TRAC (initially set to unit 5 to point to file TRCINP; if the input does not invoke free format, IN is changed to 1 to point to file TRACIN).

INLAB: I/O unit number for TRAC to generate a labeled input-data file.

INPROC: Flag used during input that indicates whether component data are being processed.

IODONE: Flag that indicates if the current input card has been read.

IOERR: Input error flag.

IOSKIP: Flag that turns input processing off and on.

IOUT: I/O unit number for printed output file (currently set to unit 6).

IRSTRT: I/O unit number for restart input file (currently set to unit 13).

ITTY: I/O unit number for terminal output (currently set to unit 59).

LCMCPD: Storage for the beginning address for reading from or writing to LCM with calls to subroutines RDLCM and WRLCM.

NITTAB: Flag for printing the time-step data table heading label to the terminal (-1) or message file (-2) because a warning message(s) has been printed since the last table values were printed.

NPWTAB: Flag for printing the power/reactivity feedback table heading label to the message file (-1) because a warning message(s) has been printed since the last table values were printed.

COMDECK ITERSTAT

COMMON/ISTAT/ VARERM, VERR

COMMON/ISTAT/ IOTT, NSTEP, OITNO

REAL VARIABLES:

VARERM: Maximum variable error.

VERR: Velocity error at component junction.

INTEGER VARIABLES:

IOTT: Temporary storage for IITNO.

NSTEP: Number of time steps taken.

OITNO: Outer-iteration number.

COMDECK JUNCTION

COMMON/JUNCT/ JMATCH, JPTR

INTEGER VARIABLES:

JMATCH: Counts the number of bad junction numbers detected during the network trace in SRTLP.

JPTR: Number of junction-component pairs.

COMDECK LCMSPACE

COMMON/LCMSP/ ALCM

ALCM(1): Dynamic LCM storage area.

COMDECK MASK

COMMON/MASK/ MSK1, MSK2, MSK3, MSK4, MSK5, MSK6, MSK7, MSK8, MSK9, MSK11, MSK12, MSK13, MSK14, MSK15, MSK16, MSK17, MSK18, MSK19, MSK21, MSK22, MSK23, MSK24, MSK25, MSK26, MSK27, MSK28, MSK29, MSK31, MSK32, MSK33, MSK34, MSK35, MSK36, MSK37, MSK38, MSK39, MSK41, MSK42, MSK43

REAL VARIABLES:

MSK#: Variable value having a 1 in bit # and 0 in all other bits of the word.

COMDECK MASSCK

COMMON/MASSCK/ NSTABO

INTEGER VARIABLE:

NSTABO: Old value of NSTAB from the previous time step (NSTAB is a flag for evaluating the SETS3D equations).

COMDECK MDFCOM

COMMON/MDFCOM/ ICLIST, INPT, INRST

DIMENSION ICLIST(100)

INTEGER VARIABLES:

ICLIST: Component number list that is used during interactive deck modifications.

INPT: Unit number for the input-data file that is to be interactively modified.

INRST: Unit number for the restart input-data file, which contains interactively modified components.

COMDECK MDTBL

COMMON/MDTBL/ IDXENT, NIDXNT, VARENT

DIMENSION IDXENT(20), VARENT(600)

INTEGER VARIABLES:

IDXENT: An array of 16 character entries that holds the component type index for the NPA master-dictionary table. Each entry contains the following:

CNAME	A8	component type
NENT	I4	number of entries for this component
DSPTR	I4	pointer to the first entry for this component

NIDXNT: An integer containing the number of entries in the master-dictionary table.

VARENT: An array of 160 character entries that holds the master-dictionary table. Each entry contains the following:

VNAME	A8	variable name
UTYPE	A1	use flag
VTYPE	A1	variable type
VSIZE	I2	variable size (characters/words)
NDIM	I4	dimensionality
DVAL	4I6	maximum size of each dimension
DNAM	4A12	variable controlling size of each dimension
SVAL	4I6	stride of each dimension
SNAM	4A12	variable controlling stride of each dimension

COMDECK MELFLG

COMMON/MELFLG/ MELTRC

INTEGER VARIABLE:

MELTRC: Flag to indicate whether subroutine THERMO is called from TRAC components or MELVSL. Necessary due to differing convention on mixture properties.
0 = call is from MELVSL;
1 = call is from TRAC.

COMDECK MEMORY

COMMON/TIMER/ ADATE, ATIME, CPUT, TIMCPU, TIMEI, TIMIOM, TIMSYS, TIMTOT

COMMON/TIMER/ NSTEPT

REAL VARIABLES:

ADATE: Date obtained from a call to the system routine DATE.

ATIME: Time obtained from a call to the system routine DATE.

CPUT: Cumulativ CPU time from previous jobs in a linked series of calculations; CPUT is set to 0.0 at time 0.0.

TIMCPU: CPU time obtained from a call to the system routine TIMING.

TIMEI: Time limit of the current job obtained from a call to the system routine GETJTL.

TIMIOM: I/O time obtained from a call to the system routine TIMING.

TIMSYS: System time obtained from a call to the system routine TIMING.

TIMTOT: Total of CPU, I/O, and system times obtained from a call to the system routine TIMING.

INTEGER VARIABLE:

NSTEPT: Storage for the cumulative number of time steps from previous jobs in a linked series of calculations; NSTEPT is set to 0 at time 0.0.

COMDECK NAVGN

COMMON/NAVGN/ NAVG1

INTEGER VARIABLE:

NAVG1: Value defined to IDALPI in subroutine TF1DS when the interface is a junction connected to a BREAK component with flow into the BREAK.

COMDECK NMFAIL

COMMON/NMFAIL/ IFTP, ITFL1, NFL1, NFL3

INTEGER VARIABLES:

IFTP: Flag that prevents thermal failure messages if a message has come from TF1SD3 or FF3D.

ITFL1: Iteration number of the last TF1DS3 failure.

NFL1: Total number of TF1DS3 failures in the current time step.

NFL3: Total number of FF3D failures in the current time step.

COMDECK NPA

[Nuclear Plant Analyzer (NPA) variables listed below currently are intended only for in-house Los Alamos use.]

COMMON/NPA/ CONNPA, DTDUMP, DTEDIT, DTNPA, SRATIO, TGEDIT, TIMNPA, TPAUSE, TPDUMP, TRCNPA, TSTOP, VALNPA, ZNAME

COMMON/NPA/ IACT, IFD, NACT, NFNPA, NPACOM, NTSNPA

DIMENSION NAPCOM(100), TIMNPA(100), VALNPA(100), ZNAME(6)

REAL VARIABLES:

CONNPA: Hollerith data name for the NPA executive "master" program connected to the process-to-process (PTP) data path.

DTDUMP: Time edit, defined interactively by the the NPA user, between dump (restart) edits to file TRCDMP.

DTEDIT: Time interval, defined interactively by the NPA user, between large edits to file TRCOUT.

DTNPA: Time error (0.1 s) allowed to implement an NPA user command before the user is prompted by the system to decide if a back-up procedure should be performed to implement the command action at the correct problem time.

SRATIO: Maximum speed ratio of the problem time-step size to the computer time required to evaluate the time step.

TGEDIT: Problem time after which the next NPA user-defined graphics edit to file TRCGRF will occur.

TIMNPA: Array that defines the problem time when a pending NPA user-defined action will be implemented.

TPAUSE: Problem time when the next NPA user-defined pause in the TRAC calculation will occur.

TPDUMP: Problem time after which the next NPA user-defined dump (restart) edit to file TRCDMP will occur.

TRCNPA: Hollerith data name for the TRAC "slave" program connected to the PTP data path.

TSTOP: Problem time specified by the NPA user after which the TRAC calculation will terminate.

VALNPA: Array that defines the desired value of an NPA user-controlled action that is pending at time TIMNPA.

ZNAME: Array containing a Hollerith data message that communicates NPA user commands to TRAC or TRAC warning messages to the NPA executive program.

INTEGER VARIABLES:

IACT: Flag that is changed from 0 to 1 when an additional graphics edit and dump (restart) edit will be performed before an NPA user-defined component-action adjustment is performed.

IFD: Number of PTP data paths.

NACT: Number of pending NPA user-defined commands stored in arrays TIMNPA, VALNPA, and NPACOM.

NFNPA: Flag that is changed from 0 to 1 when file PTPDSK will not be destroyed at the end of the TRAC run.

NPACOM: Array that defines the component number to which a pending NPA user-defined action will be applied at time TIMNPA.

NTSNPA: Number of TRAC time steps (2) between TRAC status messages that are being sent to the NPA executive program.

COMDECK NRCMP

COMMON/NRCMP/ NCMPMX, NHTSMN, NRCOMP

INTEGER VARIABLES:

NCMPMX: Maximum hydro component number.

NHTSMN: Minimum heat-structure component number.

NRCOMP: Number of components defined from the TRCRST restart-data file.

COMDECK OVLI

COMMON/OVLI/ ISTORE, JFLAG

INTEGER VARIABLES:

ISTORE Pointer variable for the A-array where unused memory storage starts.

JFLAG Flag which is set to 1 when an input-data error is encountered and TRAC is to abort the calculation after all input data has been processed.

COMDECK PMPSTB

COMMON/PMPSTB/ FWPA

COMMON/PMPSTB/ IPMPCN

REAL VARIABLE:

FWPA: Fraction 0.1 of the present donor-celled void fraction across the pump-impeller interface that is averaged with the fraction (1.0-FWPA = 0.9) of its previous void fraction average to define the void fraction for evaluating the PUMP HMD table.

INTEGER VARIABLE:

IPMPCN: Flag for not defining the donor-celled mixture density and void fraction across the pump-impeller interface.

COMDECK POINTERS

——General Pointers——

COMMON/PTRS/ I11111, LBD, LCNTL, LCOMPT, LCONTP, LCONTR, LDRA, LDRC, LICVS, LIITNO, LIJVS, LILCMP, LIOU, LISVF, LIVCON, LIVLJN, LJOUT, LJSEQ, LJUN, LLCMHS, LLCON, LLOOPN, LMATB, LMCMSH, LMSCT, LNBR, LNJN, LNSIG, LNSIGP, LNVCNL, LORDER, LPRPTB, LPTBLN, LTITLE, LVSI, LWP

——Network Solution Pointers——

COMMON/PTRS/ JAOL, JAOV, JDRA, JDRC, JDREL, JDREV, JDRL, JDRV, JNJUN, JOD, LAOL, LAOU, LAOV, LDPVC, LDPVCV, LDREL, LDREV, LDRL, LDRV, LDVB, LIDPCV, LILPRB, LIVLFC, LIVLTO, LIVVTO, LOD, LVRH

——Combination of Unshifted Pointers and Array Lengths——

COMMON/PTRS/ LBVEC, LBW, LDMAT, LEMAT, LENFXD, LFXD, LRMAT, LVMAT, LVSSC, LVSSIP, NCLEAR, NMAT, NVCELL, NZZZZZ

DIMENSION IPT(32)

GENERAL POINTERS:

I11111:	Dummy variable that provides a known start to the COMMON block.
LBD:	Boundary-data array pointer.
LCNTL:	A-array pointer for the signal-variable, control-block, and trip parameter data.
LCOMPT:	Component LCM pointers stored in the order used for iteration.
LCONTP:	Number of constrained steady-state controllers that adjust a VALVE to achieve a desired upstream pressure.
LCONTR:	Pointer to the location where the first parameter of constrained steady-state parameter data is stored in the A array.
LDRA:	Storage for right-hand side of the noncondensable (air) stabilizer mass equation.
LDRC:	Pointers for network variables for the solute-tracking option.
LICVS:	Pointer for a temporary array that contains a list of all VESSEL composite-cell numbers that have a source connection to one of their cell faces.
LIITNO:	Number of inner iterations during the last outer iteration for each component (in the order used for iteration).
LIJVS:	Pointer for a temporary array that contains a list of all junction numbers that link to a VESSEL.

LILCMP: Component LCM pointers stored in the order in which components were read.

LIOU: Network junction numbers for the junctions of all components excluding BREAKs and FILLs.

LISVF: Pointer to an array of flags indicating whether or not a particular component is used to evaluate one or more signal variables (−1, no signal variable; +1, signal variable). This array uses the same order in which the component data are processed.

LIVCON: Pointer to network junction numbers that connect to a VESSEL.

LIVLJN: IVLJN(I) is the VESSEL junction number that corresponds to the network junction number given by IVCON(I).

LJOUT: Storage area for pointers that locate the beginning of each system loop within data for IOU.

LJSEQ: Junction numbers in the order in which junctions occur in the junction-component array.

LJUN: Junction-component pair array pointer.

LLCMHS: Pointer to define the starting address for the fixed-length table of each heat-structure component.

LLCON: Number of times each component was the last to converge since last edit.

LLOOPN: IA(LLOOPN+IL−1) gives the element of the IORDER array that begins the ILth loop pass.

LMATB: Pointer for additional material-property ID number.

LMCMSH: Storage for number of coarse-mesh VESSEL source cells or absolute cell index if direct VESSEL solution is used.

LMSCT: Temporary storage for VESSEL pressure changes adjacent to sources.

LNBR: Component numbers stored in the order in which components were read.

LNJN: NJN(IL) is the number of network junctions in loop IL.

LNSIG: NSIG(IL) is the total number of components excluding BREAKs and FILLs in a loop.

LNSIGP: NSIGP(IL) is NSIG(IL) plus the number of STGENs (steam generators) in loop IL.

LNVCNL: IA(LNVCNL+IL−1) points to the elements of IVCON and IVLJN that begin the ILth loop.

LORDER: Component numbers stored in the order used for iteration.

LPRPTB: Pointer to user-defined material-property tables.

LPTBLN: Pointer for the number of entry groups in the user-defined material-property table.

LTITLE: Problem title and version information (stored using only the first four bytes of each word).

LVSI: Junction flow reversal indicators in the order in which junctions occur in the junction-component array.

LWP: Pointer for the composite location numbers of hydro cells coupled to a heat-structure component surface.

NETWORK SOLUTION POINTERS:

LAOL: Variable to rework solution of ARL, AREL, and VLT (contains rework matrix).

LAOU: Network junction coefficient matrix.

LAOV: Variable to rework solution of ARV, AREV, and VVT (contains rework matrix).

LDPVC: Locator that shows the beginning of coefficients to evaluate the derivatives of junction velocities with respect to VESSEL pressures.

LDPVCV: Pointer for reordered coupling coefficients between the VESSEL and the one-dimensional network solution.

LDREL: Storage for right-hand side of the liquid stabilizer equation.

LDREV: Storage for right-hand side of the vapor stabilizer equation.

LDPL: Variable to rework solution of ARL and VLT (contains right-hand side of linear equations).

LDRV: Variable to rework solution of ARV and VVT (contains right-hand side of linear equations).

LDVB: Storage for the right-hand side of the network junction equations or the changes in junction velocities.

LIDPCV: Pointers to coefficients stored in DPCV.

LILPRB: Pointer for the A array which defines if each hydro loop has VESSEL predictor velocities coupled in different directions.

LIVLFC: Pointer for the A array which defines the face-connect number for all junction connections to VESSELs for a given hydro loop.

LIVLTO: Pointer for the A array which defines the liquid tilde velocity at a source-connection junction to a VESSEL for a hydro loop.

LIVVTO: Pointer for the A array which defines the vapor tilde velocity at a source-connection junction to a VESSEL for a hydro loop.

LOD: Temporary storage for intercomponent coupling information.

LVRH: Storage for explicit information to evaluate equations of motion at network junctions.

JAOL: Pointer for STGEN (steam-generator) internal-network solution matrix.

JAOV: Pointer for STGEN (steam-generator) internal-network solution matrix.

JDRA: Pointer for STGEN (steam-generator) internal-network solution vector.

JDRC: Pointer for STGEN (steam-generator) internal-network solution vector.

JDREL: Pointer for STGEN (steam-generator) internal-network solution vector.

JDREV: Network vector internal to the STGEN (steam generator).

JDRL: Pointer for STGEN (steam-generator) internal-network solution vector.

JDRV: Pointer for STGEN (steam-generator) internal-network solution vector.

JNJUN: Temporary storage location used to define the number of junctions in the current network solution procedure.

JOD: Pointer for STGEN (steam-generator) internal-network solution matrix.

COMBINATION OF UNSHIFTED POINTERS AND ARRAY LENGTHS:

LBVEC: Pointer for storing in the A array the capacitance-matrix equation right-hand-side vector.

LBW: Number of element rows in the array that stores the VESSEL banded coefficient matrix.

LDMAT: Pointer for storing in the A array the capacitance coefficient matrix.

LEMAT: Pointer for storing in the A array the E matrix of the capacitance-matrix method.

LENFXD: Length of data that always remains in the SCM array A.

LFXD: First word address in the A array of the data defined by LENFXD.

LRMAT: Pointer for storing in the A array the R matrix of the capacitance-matrix method.

LVMAT: VESSEL matrix storage for coarse-mesh rebalance or direct inversion.

LVSSC: Right-hand side of equation associated with LVMAT.

LVSSIP: Pivoting information for LVMAT.

NCLEAR Number of values in the A (LVMAT) array storing the VESSEL banded coefficient matrix.

NMAT: Number of additional material-property tables provided by the user.

NVCELL: Total number of cells in all VESSELs.

NZZZZZ. Dummy integer that provides a known end to the COMMON block.

COMDECK PSE

COMMON/PSE/ NPICMP, NPSE, NPSE1, NPSE3, NPSHTI, NPSIZ, NPSJ, NPSK, NPSV1

INTEGER VARIABLES:

NPICMP: Component number in TF1DS if NSTEP = NPSE1 and in HTIF if NSTEP = NPSHTI that causes a pause.

NPSE: Pause in TRANS if NSTEP = NPSE.

NPSE1: Pause in TF1DS if NSTEP = NPSE1. The cell number is NPSJ, and the component number is NPICMP.

NPSE3: Pause in TF3DS if NSTEP = NPSE3. The cell index K is NPSK, and the second level is NPSIZ.

NPSHTI: Pause in HTIF if NSTEP = NPSHTI.

NPSIZ: Pause in TF3DS for each level if NSTEP = NPSE3.

NPSJ: Pause in TF1DS for each cell if NSTEP = NPSE1.

NPSK: Pause in TF3DS for each cell if NSTEP = NPSE3.

NPSV1: Pause in TF1DS1 if NSTEP = NPSE1. The cell number is NPSJ, and the component number is NPICMP.

COMDECK Q8LDBK

COMMON/Q8LDBK/ IBLK

DIMENSION IBLK(3,16)

INTEGER VARIABLE:

IBLK: Array that stores code block information in a packed format [IBLK(1,*) is the code block label).

COMDECK QEDMP

COMMON/QEDMP/ ATYPE, EXCHP

DIMENSION EXCHP(16)

REAL VARIABLES:

ATYPE: Constant 0 defined by subroutine ERRTRP.

EXCHP: Array containing system execution information at the point where an execution error was encountered.

COMDECK REFHTI

COMMON/REFHTI/ AGALP, AGSZ, CAFJ, CHFALP, CHFHV, CHFZ, DFALP, DFSZ, RWALP, RWSZ, SMALP, SMSZ, TBALP, TBZ, UNHF

REAL VARIABLES:

AGALP:	Void fraction at the agitated section of inverted-annular flow.
AGSZ:	Elevation of the agitated section of inverted-annular flow.
CAFJ:	Capillary number.
CHFALP:	Void fraction at the CHF point.
CHFHV:	Vapor heat transfer at CHF.
CHFZ:	Elevation of CHF.
DFALP:	Void fraction at the highly dispersed section elevation.
DFSZ:	Elevation of highly dispersed section of inverted-annular flow.
RWALP:	Void fraction of rough-wavy section elevation.
RWSZ:	Elevation of rough-wavy section of inverted-annular flow.
SMALP:	Void fraction at the smooth section elevation.
SMSZ:	Elevation of smooth section of inverted-annular flow.
TBALP:	Void fraction at transition-boiling point.
TBZ:	Elevation of transition boiling.
UNHF:	Fraction of heated surface that is unheated.

COMDECK REFHTI2

COMMON/REFHTI2/ ALPTAL, ALPTAU, ALPTRL, ALPTRU, ALPTSL, ALPTSU

REAL VARIABLES:

ALPTAL:	Minimum void fraction allowed for end of agitated-inverted flow regime.
ALPTAU:	Maximum void fraction allowed for end of agitated-inverted flow regime.
ALPTRL:	Minimum void fraction allowed for end of rough-wavy-inverted flow regime.
ALPTRU:	Maximum void fraction allowed for end of rough-wavy-inverted flow regime.
ALPTSL:	Minimum void fraction allowed for end of smooth-inverted flow regime.
ALPTSU:	Maximum void fraction allowed for end of smooth-inverted flow regime.

COMDECK RESTART

COMMON/RSTART/ DDATE, DDTIME

COMMON/RSTART/ DLNFLT, DNCOMP, ICTRLR

DIMENSION ICTRLR(8)

REAL VARIABLES:

DDATE: Date restart file was created.

DDTIME: Time restart file was created.

INTEGER VARIABLES:

DLNFLT: Length of fixed-length tables read from restart file.

DNCOMP: Number of components in the restart file.

ICTRLR(8): Array that contains buffering information about the restart file.

COMDECK ROWS

COMMON/ROWS/ ISCL

INTEGER VARIABLE:

ISCL Flag (when not 0) that has TRAC divide by the largest matrix element in each matrix row all 4 or 5 matrix elements and 3 right-hand-side elements in each row of the 4 x 4 or 5 x 5 outer-iteration mesh-cell matrix equation.

COMDECK RSPARM

COMMON/RSPARM/ DTSTRT

COMMON/RSPARM/ ICDELT

REAL VARIABLE:

DTSTRT: Time step that can be forced as the initial time-step size at restart (default is −1.0).

INTEGER VARIABLE:

ICDELT: Variable that allows the selection of DELT at the beginning of a transient. ICDELT forces DELT to be the value of the dump regardless of whether the previous run was a steady state. When DTSTRT is nonzero, its value is used for the initial DELT. The default is zero.

COMDECK SEPCB

COMMON/SEPCB/ ALPDRC, ALPSPC, DPSEPC

COMMON/SEPCB/ IDRYCB, ISEPCB, ISTAGC, NCSEPC, NDRYRC, NSEPSC

REAL VARIABLES:

ALPDRC: Void fraction to be convected from dryer.

ALPSPC: Separator void fraction.

DPSEPC: Separator pressure drop.

INTEGER VARIABLES:

IDRYCB:	Dryer flag.
ISEPCB:	Separator flag.
ISTAGC:	Separator option type.
NCSEPC:	Cell number for separator.
NDRYRC:	Cell number for dryer.
NSEPSC:	Number of separators modeled.

COMDECK SIGNAL

COMMON/SIGNAL/ CPV, DSV

DIMENSION CPV(42), DSV(2)

REAL VARIABLES:

CPV:	Control-panel vector for storing the values of signal-variable parameter numbers 1 through 6 for the global parameters and 7 through 15 for up to four coolant loops.
DSV:	Dummy signal-variable vector for storing the values of signal-variable parameter numbers 16 and 17.

COMDECK SOLCON

COMMON/SOLCON/ CNC, CNMAX, CNMIN, CNT, CNTLMN, CNTLMX

REAL VARIABLES:

CNC:	Constant term (kg solute/kg liquid) in linear fit to solubility.
CNMAX:	Solubility (kg solute/kg liquid) when liquid temperature is at or above CNTLMX.
CNMIN:	Solubility (kg solute/kg liquid) when liquid temperature is at or below CNTLMN.
CNT:	Coefficient of liquid temperature (kg solute/ kg liquid K) in linear fit.
CNTLMN:	Minimum liquid temperature (K) to use linear fit.
CNTLMX:	Maximum liquid temperature (K) to use linear fit.

COMDECK STDYERR

COMMON/SSCON/ CF, EPS, EPSPOW, FFLW, FMAX, MAXFLN, RPCF, RTWFP, STIME,TPOWR

COMMON/SSCON/ IPOVEL, IPOWR, LOK, NCORES, NEF, NET, NOPOW

DIMENSION FMAX(7), LOK(7,2)

REAL VARIABLES:

CF:	Coolant mass flow through the reactor-core region.
EPS:	Tolerance on calculation time for editing and terminating the problem.
EPSPOW:	Convergence criterion on the fractional change in liquid velocity per second for setting on the steady-state power when all reactor-core inlet interfaces satisfy this criterion.
FFLW:	Fraction of the steady-state power level that the coolant mass flow through the core times RPCF defines.
FMAX:	Array of maximum normalized errors.
MAXFLN:	Maximum one-dimensional mass flow at this steady-state convergence test.
RPCF:	Ratio of reactor-core power to coolant mass flow based on the difference in internal energies from the core inlet and outlet temperatures input.
RTWFP:	Ratio of heat-transfer to fluid-dynamics time-step sizes.
STIME:	Steady-state calculation time.
TPOWR:	Steady-state calculation time (s) when the reactor-core power is set on.

INTEGER VARIABLES:

IPOVEL:	Number of reactor-core inlet interfaces that satisfy the EPSPOW criterion based on date-of-change of liquid velocity.
IPOWR:	Flag that turns on the steady-state power.
LOK:	Array of locations of maximum normalized errors.
NCORES:	Total number of reactor core region inlet interfaces.
NEF:	Number of time steps (100) between steady-state convergence check printouts to the terminal and message files.
NET:	Number of time steps (5) between steady-state convergence checks.
NOPOW:	Steady-state power flag. 0 = on; 1 = off.

COMDECK STNCOM

COMMON/STNCOM/ STNMAX, TMSTNU, TLDMIN, TMTLD

COMMON/STNCOM/ ISTNU, JSTNU, KSTNU, NSTNU, ITLDM, JTLDM, KTLDM, NTLDM

REAL VARIABLES:

STNMAX:	Largest Stanton number calculated in this calculation.

TLDMIN: The minimum liquid temperature (for any heat structure) when subcooled boiling begins based on the Saha-Zuber correlation.

TMTLD: Time when TLDMIN was found.

TMSTNU: Time at which STNMAX was calculated.

INTEGER VARIABLES:

ISTNU: Three-dimensional r-cell number for which STNMAX was found.

ITLDM: Unused variable.

JSTNU: Thee dimensional θ-cell number for which STNMAX was found.

JTLDM: Axial node number where TLDMIN was found.

KSTNU: Three-dimensional z-level number for which STNMAX was found.

KTLDM: Unused variable.

NSTNU: Component number where STNMAX was calculated.

NTLDM: Component number where TLDMIN was found.

COMDECK STRTNT

COMMON/STRTNT/ FSTRL, FSTRV, SDTINT, STFLL, STFLU, STFVL, STFVU

INTEGER VARIABLES:

SDTINT: Variable not used.

FSTRL: Multiplier on the liquid velocity check for stratified flow in CELLA3.

FSTRU: Variable not used.

STFLL: Constants used to determine stratified-flow weighting factors.

STFLU: Constants used to determine stratified-flow weighting factors.

STFVL: Variable not used.

STFVU: Variable not used.

COMDECK SUPRES

COMMON/SUPRES/ S

REAL VARIABLE:

S: Factor in nucleate-boiling heat-transfer coefficient evaluation in CHEN.

COMDECK SYSSUM

COMMON/SYSSUM/ ALQCOR, ALQPRZ, ALQUP, CORWM, PMX, TLMX, TLNCOR, TSHCOR, TSNCOR, TVMX, VOLCOR, XLQCOR, XTSHCR

COMMON/SYSSUM/ JPMX, JTLMX, JTVMX, NPMX, NTLMX, NTVMX

REAL VARIABLES:

ALQCOR:	Core-region mean liquid fraction.
ALQPRZ:	PRIZER (pressurizer) mean liquid fraction.
ALQUP:	Upper-plenum mean liquid fraction. (Calculated only for three-dimensional VESSELs.)
CORWM:	Core-region water mass.
PMX:	Maximum pressure.
TLMX:	Maximum liquid temperature.
TLNCOR:	Core-region mean liquid temperature.
TSHCOR:	Core region mean super heat.
TSNCOR:	Core-region mean saturation temperature.
TVMX:	Maximum vapor temperature.
VOLCOR:	Core-region volume.
XLQCOR:	Minimum core-region liquid fraction.
XTSHCR:	Maximum core-region super heat.

INTEGER VARIABLES:

JPMX:	Cell number for the maximum pressure.
JTLMX:	Cell number for the maximum liquid temperature.
JTVMX:	Cell number for the maximum vapor temperature.
NPMX:	Component number for the maximum pressure.
NTLMX:	Component number for the maximum liquid temperature.
NTVMX:	Component number for the maximum vapor temperature.

COMDECK TF3DC

COMMON/TF3DC/ INSCT, IZ, KABSO, KCMSH, KL, KLEV, KU, KVEL1, KVEL2, KVEL3, ORG

INTEGER VARIABLES:

INSCT:	Variable used to obtain a displacement into network arrays involving VESSEL junctions when there is more than one VESSEL.
IZ:	VESSEL level number currently being used.
KABSO:	Storage offset to obtain an absolute cell number when multiple VESSELs are used.
KCMSH:	Offset for coarse-mesh indexing with multiple VESSELs.
KL:	Displacement of level (IZ−1) from level (IZ) in A-array storage for the VESSEL three-dimensional data array.
KLEV:	VESSEL component axial-direction K index [the axial-level number IZ plus NZBCM (two lower pseudo-cell levels)].

KU: Displacement of level (IZ+1) from level (IZ) in A-array storage for the VESSEL three-dimensional data array.

KVEL1: Order of the x- or r-direction stabilizer motion-equation matrix for the present VESSEL component.

KVEL2: Order of the y- or θ-direction stabilizer motion-equation maxtix for the present VESSEL component.

KVEL3: Order of the z-direction stabilizer motion-equation matrix for the present VESSEL component.

ORG: Starting location of the three-dimensional VESSEL component IZ level data in the A array.

COMDECK THERM

COMMON/THERM/ ATC, ATW, AW, CKW, DIATC, NTC, VTC

COMMON/THERM/ ITTC

REAL VARIABLES:

ATC: Area per unit length of thermocouple.

ATW: Thickness of ROD or SLAB element to thermocouple weld.

AW: Area of ROD or SLAB element to thermocouple weld.

CKW: ROD or SLAB element to thermocouple weld thermal conductivity.

DIATC: Diameter of thermocouple.

NTC: Number of thermocouples per ROD or SLAB element.

VTC: Volume per unit length of thermocouple.

INTEGER VARIABLE:

ITTC: Thermocouple flag.
0 = no thermocouple on heat-structure ROD or SLAB element;
1 = thermocouple present on heat-structure ROD or SLAB element.

COMDECK THERMV

COMMON/THERMV/ IEND3, ISTRT3, NDIMV1, NIXNJ NVTHM

INTEGER VARIABLES:

IEND3: Last calculation cell number (ICX) in the VESSEL component x- or r-direction.

ISTRT3: First calculation cell number (ICO) in the VESSEL component x- or r-direction.

NDIMV1: NVTHM times the total number of x- or r-direction calculation plus pseudo cells dimensioned for.

NIXNJ: NDIMV1 times the total number of y- or θ-direction calculation plus pseudo cells dimensioned for.

NVTHM: Number of different array parameters in the EQUIV common block for a VESSEL component.

COMDECK TMP

COMMON/TMP/ AFLUX, ARLCK, ARVCK, S2A, S2B, S2C, S2D, S3A, S3B, S3C, S3D, S5A, STDER, STPRS, XVOLL, XVOLV

COMMON/TMP/ LIFEQ

DIMENSION AFLUX(NK), ARLCK(NK), ARVCK(NK), S2A(NK), S2B(NK), S2C(NK), S2D(NK), S3A(NK), S3B(NK), S3C(NK), S3D(NK), S5A(NK), STDER(NK), STPRS(NK), XVOLL(NK), XVOLV (NK)

DIMENSION LIFEQ(NK)

REAL VARIABLES:

AFLUX: Net air mass flow into the NK-NZBCM level mesh cell.

ARLCK: Net liquid mass flow into the NK-NZBCM level mesh cell.

ARVCK: Net vapor mass flow into the NK-NZBCM level mesh cell.

S2A: Vectorization mask factor for defining the vapor mass equation.

S2B: Vectorization mask factor for defining void fraction equal to 1.0.

S2C: Vectorization mask factor for defining void fraction equal to 0.0.

S2D: Vectorization mask factor for defining the vapor pressure equal to the saturation pressure based on the vapor temperature.

S3A: Vectorization mask factor for defining the vapor energy equation.

S3B: Vectorization mask factor for defining the liquid temperature equal to the vapor temperature.

S3C: Vectorization mask factor for defining the liquid temperature equal to the saturation temperature based on the vapor pressure.

S3D: Vectorization mask factor for defining the vapor temperature equal to the saturation temperature based on the vapor pressure.

S5A: Vectorization mask factor for defining the noncondensable-gas mass equation.

STDER: Derivative of the saturation temperature with respect to the total pressure based on the saturation temperature and saturation pressure.

STPRS: Saturation pressure based on the liquid temperature.

XVOLL: Fluid volume (NSTAB=0) or fluid volume minus liquid volume outflow during the time step (NSTAB=1) in the NK-NZBCM level mesh cell.

XVOLV: Fluid volume (NSTAB=0) or fluid volume minus vapor volume outflow during the time step (NSTAB=1) in the NK-NZBCM level mesh cell.

LOGICAL VARIABLE:

LIFEQ: Fluid-phase flag which is false when two-phase fluid may become single phase. If this flag is false on the second pass through the linearization, the cell will be relinearized.

COMDECK TOTALS

COMMON/TOTALS/ TLEN, TVOL

REAL VARIABLES:

TLEN: Total length of a component section.

TVOL: Total volume of a component section.

COMDECK TSATCN

COMMON/TSATCN/ AEOS14, CEOS1, CEOS2, CEOS3, CEOSLP

COMMON/TSATCN/ IGAS, ILIQ

DIMENSION CEOSLP(40)

REAL VARIABLES:

AEOS14: Constant in expression for saturation temperature calculation at intermediate pressures; defined in subroutine THERMO.

CEOS1: Constant in expression for saturation temperature calculation at intermediate pressures; defined in subroutine THERMO.

CEOS2: Constant in expression for saturation temperature calculation at intermediate pressures; defined in subroutine THERMO.

CEOS3: Constant in expression for saturation temperature calculation at intermediate pressures; defined in subroutine THERMO.

CEOSLP: Equation-of-state array for low pressures; defined in subroutine SETEOS.

INTEGER VARIABLES:

IGAS: Noncondensable-gas type.
1 = air;
2 = hydrogen;
3 = helium.

ILIQ: Condensable-fluid type (variable not used).

COMDECK TST3D

COMMON/TST3D/ CCIF, I1D, NIFHT, NIFSH, NOBOIL, NOIMP, NWSH

INTEGER VARIABLES:

CCIF: Namelist variable defining the constant value for the interfacial-drag coefficient when NIFSH = 1.

I1D: Flag to convert mean mass and vapor mass equations to vapor mass and liquid mass equations for evaluation by subroutine TF3DS.

NIFHT: Flag for defining a constant 10.0 value to the ALVE, CHTI, ALV, and CHTIA evaporation and condensation coefficients.

NIFSH: Interfacial-drag (shear) option flag and namelist variable.

NOBOIL: Flag for not evaluating evaporation and condensation when IEOS=0.

NOIMP: Flag for not evaluating the $\frac{\partial \alpha \rho}{\partial t}$ term in the motion equation.

NWSH: Flag for defining the vapor-gas FRIC by its vapor-gas-field value rather than the liquid-field value.

COMDECK TWOSTEP

COMMON/TWOSTP/ NPSFE, NPSME, NTSPRN

INTEGER VARIABLES:

NPSFE: Pause in FEMOM and CIF3 if NSTEP = NPSFE. The cell number is NPSJ or the level number is NPSIZ, and the component number is NPICMP.

NPSME: Pause in STBME and STBMPL if NSTEP = NPSME. The cell number is NPSJ and the component number is NPICMP.

NTSPRN: Flag for printing extra thermal-hydraulic parameter information to TRCOUT.

COMDECK VCKDAT

COMMON/VCKDAT/ DONTOL

COMMON/VCKDAT/ IPRVCK, ISKIP, ITVKMX

REAL VARIABLE:

DONTOL: Tolerance for density difference requiring re-donor-celling in the VESSEL.

INTEGER VARIABLES:

IPRVCK: Flag to print information about re-donor-celling in the VESSEL (normally set to 0 for no print).

ISKIP: Flag to skip re-donor-cell logic in VESSEL component (normally set to 0 for no skip).

ITVKMX: Maximum iteration count to check for need to re-donor-cell in VESSEL.

COMDECK VDVMOD

COMMON/VDVMOD/ IVDVS1, IVDVS2

INTEGER VARIABLES:

IVDVS1: Flag for scaling $V\Delta V$ terms.
0 = no scaling;
1 = scaling occurs.

IVDVS2: Flag for scaling $\beta V\Delta V$ terms.
0 = no scaling;
1 = scaling occurs.

COMDECK VELLIM

COMMON/VELLIM/ DFLLB, DFLUB, DFVLB, DFVUB, VLLB, VLUB, VVLB, VVUB

COMMON/VELLIM/ JVLIM

REAL VARIABLES:

DFLLB: Derivative of the pump-impeller interface liquid velocity (at its lower limit) with respect to total pressure.

DFLUB: Derivative of the pump-impeller interface liquid velocity (at its upper limit) with respect to total pressure.

DFVLB: Derivative of the pump-impeller interface vapor velocity (at its lower limit) with respect to total pressure.

DFVUB: Derivative of the pump-impeller interface vapor velocity (at its upper limit) with respect to total pressure.

VLLB: Pump-impeller interface liquid velocity lower-limit value.

VLUB: Pump-impeller interface liquid velocity upper-limit value.

VVLB: Pump-impeller interface vapor velocity lower-limit value.

VVUB: Pump-impeller interface vapor velocity upper-limit value.

INTEGER VARIABLE:

JVLIM: For PUMP type IPMPTY=0, the pump-impeller interface number (JVLIM=2) when the PUMP component-action table defines the fluid velocity.

COMDECK WEBNUM

COMMON/WEBNUM/ ALVFCP, ALVFCS, BMIN, CHTFCP, CHTFCS, CHTIBC, CHTIBH, CNDFC, DMIN, PENTL, PENTU, VLSPR, VVLOW, VVUP, WEB, WED, WEDU

COMMON/WEBNUM/ ICHVOL

REAL VARIABLES:

ALVFCP: Multiplier on ALV for low-velocity vertical components.

ALVFCS: Multiplier on ALV under spray conditions.

BMIN: Minimum allowed bubble size.

CHTFCP: Multiplier on CHTI for low-velocity vertical components.

CHTFCS: Multiplier on CHTI under spray conditions.

CHTIBC: Vapor-bubble interfacial HTC when TV > TSAT.

CHTIBH: Vapor-bubble interfacial HTC when TV < TSAT.

CNDFC: Condensation-rate scaling factor.

DMIN: Minimum allowed drop size.

PENTL: Lower bound on entrained void fraction α.

PENTU: Upper bound on entrained void fraction α.

VLSPR: Lower limit on the quantity $(1 - \alpha)V_\ell$ at the top of the cell above which spray condition is assumed to exist.

VVLOW: Lower limit on vapor velocity for special condensation model for low-velocity vertical components.

VVUP: Upper limit on vapor velocity for special condensation model for low-velocity vertical components. Note: For liquid velocity greater than VLUP, the regular condensation model is used. For liquid velocity less than VLLOW, the special condensation model is used. For liquid velocity between VLLOW and VLUP, a linear interpolation between the two models is used.

WEB: Bubble Weber number.

WED: Droplet Weber number.

WEDU: Droplet Weber number during core-region upflow (not implemented).

INTEGER VARIABLE:

ICHVOL: Flag that invokes a minimum value on the interface HTC.
0 = has no effect, normal;
1 = sets the minimum to the cell volume times 1.0×10^7.

COMDECK XVOL

COMMON/XVOL/ BGSS, DAWL, DAXVL, DAXVU, DGSS, FREV

COMMON/XVOL/ IFVT, IFVTU, LDAX

REAL VARIABLES:

BGSS: Limits on special void-fraction prediction logic.

DAWL: Weighting factors in special TF1DS flux logic.

DAXVL: Lower-velocity limit on special TF1DS flux logic.

DAXVU: Upper-velocity limit on special TF1DS flux logic.

DGSS: Limits on special void-fraction prediction logic.

FREV: Sensitivity level for reiteration on flow reversal.

INTEGER VARIABLES:

IFVT: Flag for setting velocities passed to TF1DS for special flux logic.

IFVTU: Time-of-velocity controller.
0 = the XVSET logic uses the old-time velocity;
1 = the XVSET logic uses the the new-time velocity.

LDAX: Bypass switches on special TF1DS flux logic.

APPENDIX E

EXAMPLE UPDATE

```
*ident upldptr
*/ This is an example update showing how to add a pointer common
*/ to all 1-D components.  The new pointers added in this update
*/ are
*/      LDNEW - new old-time dualpt pointer for the new old-time
*/              variable DNEW.
*/      LDNEWN - new new-time dualpt pointer for the new new-time
*/               variable DNEWN.
*/      LHYNEW - new hydropt pointer for the new hydrodynamic variable
*/               HYNEW.
*/      LHTNEW - new heatpt pointer for the new heat transfer variable
*/               HTNEW.
*/      LINEW - new intpt pointer for the new integer variable INEW.
*/
*/ This update also includes the necessary coding to add a generalized
*/ heat transfer variable to the steam generator (which does not use
*/ the heat transfer pointers in HEATPT).
*/      LHTNWG - new generalized heat transfer pointer for the new heat
*/               transfer variable HTNWG used by the steam generator
*/               instead of the variable HTNEW.
*/
*/ Wherever possible, changed lines of coding are commented out, rather
*/ than simply deleted in this example update.  This is done to allow
*/ the user a clearer picture of what is being changed.  This update
*/ was generated from version 5.3.
*/
*/ ---------------------------------------------------------------------
*/
*/ Add new old-time, new-time variable pointers to DUALPT comdeck.
*/
*delete dualpt.9                                                  dualpt
c     * ld    ,ldn   ,lea   ,lean  ,lel   ,
      * ld    ,ldn   ,ldnew ,ldnewn,lea   ,lean  ,lel   ,
*/
*/ Add new heat calculation variable pointers to HEATPT comdeck.
*/
*delete heatpt.3                                                  heatpt
c     * lemis ,lhol  ,lhov  ,lrn   ,lrn2  ,
      * lemis ,lhol  ,lhov  ,lhtnew,lrn   ,lrn2  ,
*/
*/ Add new hydrodynamic calculation variable pointers to HYDRO comdeck.
```

```
*/
*delete hydropt.9                                                hydropt
c     * lhla  ,lhlatw,lhva  ,lhvatw,lqp3f ,
      * lhla  ,lhlatw,lhva  ,lhvatw,lhynew,lqp3f ,
*/
*/ Add new integer variable pointers to INTPT comdeck.
*/
*delete intpt.2                                                  intpt
c      common/ptab/   lidr  ,lmatid,lnff  ,llccfl
       common/ptab/   lidr  ,linew ,lmatid,lnff  ,llccfl
*/
*/ Initialize newly added pointers in subroutine SlDPTR.  Increment
*/ LENPTR by one for each pointer added in the appropriate section
*/ of SlDPTR.  Adjust the length of the pointer initialized directly
*/ after each of the new pointers added to reflect correct lengths.
*/
*delete sldptr.37                                                sldptr
c      lea    = ld(3)  + 0
       ldnew  = ld(3)  + 0
       lea    = ldnew  + nfaces
*delete sldptr.87                                                sldptr
c      lean   = ldn(3) + 0
       ldnewn = ldr(3) + 0
       lean   = ldnewn + nfaces
*delete sldptr.120                                               sldptr
c      lenptr = 80
       lenptr = 82
*delete sldptr.192,sldptr.193                                    sldptr
c      lnxt   = lregnm + nfaces
c      lenptr = lenptr + 63
       lhynew = lregnm + nfaces
       lnxt   = lhynew + nfaces
       lenptr = lenptr + 64
*delete sldptr.213,sldptr.214                                    sldptr
c      lnxt   = llccfl  + nfaces
c      lenptr = lenptr + 4
       linew  = llccfl  + nfaces
       lnxt   = linew   + ncells
       lenptr = lenptr + 5
*delete sldptr.233,sldptr.235                                    sldptr
c      lnxt   = ltov   + ncells
       lhtnew = ltov   + ncells
       lnxt   = lhtnew + ncells
  100 continue
```

```
c     lenptr = lenptr + 12
      lenptr = lenptr + 13
*/
*/ Set up graphics catalogs for variables to be graphed.
*/
*insert igcomp.20                                                   igcomp
*call holerith
*insert igcomp.85                                                   igcomp
      call grfput(icomp,2,0,ldnewn,ncells+1,1,
     1            'new dualpt pointer','dnew')
      call grfput(icomp,2,0,lhynew,ncells+1,1,
     1            'new hydropt pointer','hynew')
      if (type .ne. stgenh) then
        call grfput(icomp,2,0,lhtnew,ncells,1,
     1              'new heatpt pointer','htnew')
      end if
*/
*/ Write the variables to be dumped to the dump/restart file.
*/ Increment LEDGE and LCNTR by the number of cell-edge and
*/ cell-center variables being dumped, respectively.
*/
*delete dcomp.31,dcomp.32                                            dcomp
c     lvcntr=25
c     lvedge=13
      lvcntr=26
      lvedge=15
      if (type .ne. stgenh) lvcntr=lvcntr+1
*insert dcomp.130                                                    dcomp
      call bfout(a(ldnewn),ncellt+1,ictrld)
      call bfout(a(lhynew),ncellt+1,ictrld)
      if (type .ne. stgenh) then
        call bfout(a(lhtnew),ncellt,ictrld)
      endif
      call bfout(a(linew),ncellt,ictrld)
*/
*/ Read in new variables from the dump/restart file in the same
*/ order that they were written.
*/
*insert recomp.64                                                    recomp
      call bfin(a(bump+ldnewn),ncells+1,ictrlr)
      call bfin(a(bump+lhynew),ncells+1,ictrlr)
      if (type .ne. stgenh) then
        call bfin(a(bump+lhtnew),ncells,ictrlr)
      endif
```

```
      call bfin(a(bump+linew),ncells,ictrlr)
*/
*/ Assuming that dnew, dnewn, and hynew are all calculated in FEMOM,
*/ add them to the argument list of FEMOM, add dimension statements
*/ in FEMOM, and perform their calculation.
*/
*delete femom.6                                                  femom
c     4       tssn,sigm,gam,rarl,rarv,nff,tchf,lccfl)
      4       tssn,sigm,gam,rarl,rarv,nff,tchf,lccfl,
      5       dnew,dnewn,hynew)
*delete femom.130                                                femom
c     6 tssn(1),sigm(1),gam(1),rarl(1),rarv(1),nff(1),tchf(1),lccfl(1)
      6 tssn(1),sigm(1),gam(1),rarl(1),rarv(1),nff(1),tchf(1),lccfl(1),
      7 dnew(1),dnewn(1),hynew(1)
*insert femom.168                                                femom
c stick in some values for dnew, dnewn, and hynew
c
      do 1 j = jstart,ncp
        dnew(j) = 1.0
        dnewn(j) = 2.0
        hynew(j) = 3.0
    1 continue
c
*/
*/ Also change all call statements to FEMOM to include dnew, dnewn
*/ and hynew in the argument list.
*/
*delete preper.209                                               preper
c     7 a(lrarl),a(lrarv),a(lnff),tchf,a(llccfl))
      7 a(lrarl),a(lrarv),a(lnff),tchf,a(llccfl),
      8 a(ldnew),a(ldnewn),a(lhynew))
*/
*/ Similarly, assuming that htnew and inew are calculated in subroutine
*/ CYLHT, add them to the argument list of CYLHT, add dimension
*/ statements in CYLHT, and perform their calculation.
*/
*delete cylht.4                                                  cylht
c     2dt,istdy,qp3f)
      2dt,istdy,qp3f,htnew,inew)
*delete cylht.18                                                 cylht
c     4qppp(nodes,ncells),qp3f(ncells)
      4qppp(nodes,ncells),qp3f(ncells),htnew(ncells),inew(ncells)
*insert cylht.20                                                 cylht
c perform the calculation of htnew and inew.
```

```
c
      do 1 j=1,ncells
        htnew(j) = 4.0
        inew(j)  = 5
    1 continue
c
*/
*/ Also change all call statements to CYLHT to include htnew and inew
*/ in the argument list.
*/
*delete poster.115                                                    poster
c    6 ncells,deltht,istdy,a(lqp3f+istml))
     6 ncells,deltht,istdy,a(lqp3f+istml),
     7 a(lhtnew+istml),a(linew+istml))
*delete stgn3x.41                                                     stgn3x
c     *  a(ldum2),nds,ndml,1,deltht,istdy,a(lqp3f+ii) )
      *  a(ldum2),nds,ndml,1,deltht,istdy,a(lqp3f+ii),
      *  a(lhtnwg+iml),a(linew+iml))
*/
*/ Add the special generalized heat calculation pointer for the
*/ steam generator component to its own pointer table. (Since
*/ the steam generator pointer table doesn't include comdeck HEATPT.)
*/
*delete stgenpt.12                                                   stgenpt
c     * lcpwg ,lcwg  ,ldrg  ,lemsg ,lidgi ,
      * lhtnwg,lcpwg ,lcwg  ,ldrg  ,lemsg ,lidgi ,
*/
*/ Initialize the special generalized heat calculation pointer for
*/ the steam generator component in it's own read and restart routines.
*/
*delete rstgen.166                                                    rstgen
c      lcpwg  = lnxt
       lhtnwg = lnxt
       lcpwg  = lhtnwg + nght
*delete rstgen.201                                                    rstgen
c      lenptr = lenptr + 34
       lenptr = lenptr + 35
*delete restgn.90                                                     restgn
c        lcpwg  = lnxt
         lhtnwg = lnxt
         lcpwg  = lhtnwg + nght
*delete restgn.125                                                    restgn
c      lenptr   = lenptr + 34
       lenptr   = lenptr + 35
```

```
*/
*/ Set up the graphics catalog for the steam generator's special
*/ generalized heat calculation pointer.
*/
*insert igstgn.50                                                     igstgn
          call grfput(icomp,2,0,lhtnwg,nght,1,
     *    'new stgen gen. heatpt pointer','htnwg')
*/
*/ Increase LEXTRA by the length of the steam generator's new
*/ generalized heat calculation pointer.
*/
*delete istgen.71                                                     istgen
      lextra = nght*(14+3*nodmx+ndml) + 10*nscmp
      lextra = nght*(15+3*nodmx+ndml) + 10*nscmp
*/
*/ Write the steam generator's new heat calculation
*/ pointer to the dump/restart file.
*/
*insert dstgen.50                                                     dstgen
      call bfout(a(lhtnwg),nght,ictrld)
*/
*/ Read in the steam generator's new heat calculation pointer
*/ from the restart file in the same order that it was dumped.
*/
*insert restgn.294                                                    restgn
        call bfin(a(lhtnwg),nght,ictrlr)
        call warray('htnwg',a(lhtnwg),nght)
```

APPENDIX F

GRAPHICS VARIABLES

This appendix lists the variables that are written to the graphics (TRCGRF) file. Subroutine IGRAF controls the writing of the graphics catalog and writes the first graphics edit; subroutine GRAF reads the graphics catalog and writes the subsequent graphics edits for each graphics time-step edit. Those variables that contain the parenthetical "first edit only" do not vary with time and appear in only the first graphics edit.

The variables are listed by subroutine rather than component to prevent multiple listings of the variables in subroutine IGCOMP. The format of the appendix makes it easy to determine all possible variables for a given component while still making it clear which variables apply to particular components. Because the exact variables available from a given calculation are dependent on options and input parameters, we have not maintained the sequence of the variables, but we have alphabetized the variables for ease of reference. We have provided definitions, and as appropriate, the corresponding units. This listing is generated for TRAC-PF1/MOD2 (version 5.4).

F.1. GENERAL VARIABLES

The general variables apply to the overall calculation as opposed to specific components or cells within a component; subroutine IGRAF creates the graphics catalog for these variables.

Variable	Dimension	Description
CPUTOT	1	Total CPU time (s) since time 0.0 s in the calculation.
DELT	1	Time-step size (s).
DPRMAX	1	Maximum fractional pressure change over the current time step, a parameter used in the time-step-control logic.
DTLMAX	1	Maximum liquid-temperature change (K) over the current time step, a parameter used in the time-step-control logic.
DTVMAX	1	Maximum vapor-temperature change (K) over the current time step, a parameter used in the time-step-control logic.
TIMET	1	Transient time (s) in the calculation.
TNSTEP	1	Total number of time steps since time 0.0 s in the calculation.

F.2. SIGNAL-VARIABLE AND CONTROL-BLOCK OUTPUTS

Subroutine IGSVCB creates the graphics catalog for all of the signal variables and control blocks specified in the input (including those from the restart dump). Subroutine IGSVCB first loops over all of the signal variables in the order of increasing magnitude of their ID numbers and similarly loops over all of the control blocks. The quantity ultimately written to the graphics file is the value of each signal variable and the output value from each control block at the current time step; as such, the quantities in the graphics file are user-specified and the units depend on that specification.

Variable	Dimension	Description
SV	1	Signal-variable data; although the dimension of each is 1, there are NTSV of them.
CB	1	Control-block output; although the dimension of each is 1, there are NTCB of them.

F.3. GENERAL ONE-DIMENSIONAL COMPONENT GRAPHICS

Subroutine IGCOMP writes the graphics catalog for variables that are common to all of the one-dimensional components (ACCUM, PIPE, PRIZER, PUMP, STGEN, TEE, TURB, and VALVE). For STGEN and TEE, the dimension of [illegible] includes necessary space for phantom cells, which are required to account for the [illegible] there are more interfaces than cells. In some cases, whether a variable [illegible] edited depends on user-specified options in the TRAC input file (TRACIN). Also, the STGEN component does not use IGCOMP to edit heat-transfer-related data.

Variable	Dimension	Description
ALPHA	NCELLT	Cell vapor fractions.
ALV	NCELLT	Cell-flashing interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
ALVE	NCELLT	Cell liquid-side interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
AM	NCELLT	Cell noncondensable-gas masses (kg).
CHTI	NCELLT	Cell vapor-side interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
CHTIA	NCELLT	Cell noncondensable-gas interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
CIF	NCELLT+1	Cell-interface interfacial-drag coefficients ($kg \cdot m^{-4}$).
CONC	NCELLT	Cell dissolved-solute concentrations [$kg \cdot (kg\text{--}liquid)^{-1}$].
DX	NCELLT	Cell lengths (m) [first edit only].
FA	NCELLT+1	Cell-interface flow areas (m^2) [first edit only].
FF	NCELLS+1	Cell-interface friction factors.
HL	NCELLT	Cell-wall liquid heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
HV	NCELLT	Cell-wall vapor heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
ID	1	User-specified component ID number (first edit only).

IDR	NCELLT	Cell-wall heat-transfer regimes.
MFLOW	NCELLT+1	Cell-interface mass flows ($kg \cdot s^{-1}$).
NCELLT	1	Total number of cells, including phantom cells (first edit only).
NUM	1	Component number (first edit only).
P	NCELLT	Cell pressures (Pa).
PA	NCELLT	Cell noncondensable-gas partial pressures (Pa).
REGNM	NCELLT+1	Cell-interface flow regime numbers.
RHOL	NCELLT	Cell liquid densities ($kg \cdot m^{-3}$).
RHOM	NCELLT	Cell mixture densities ($kg \cdot m^{-3}$).
RHOV	NCELLT	Cell vapor densities ($kg \cdot m^{-3}$).
ROAN	NCELLT	Cell noncondensable-gas densities ($kg \cdot m^{-3}$).
SOLID	NCELLT	Cell plated-solute mass/cell fluid volume ($kg \cdot m^{-3}$).
TL	NCELLT	Cell liquid temperatures (K).
TSAT	NCELLT	Cell saturation temperatures (K) based on pressures.
TSSN	NCELLT	Cell saturation temperatures (K) based on steam partial pressures.
TV	NCELLT	Cell vapor temperatures (K).
TW	NODES*NCELLT	Cell-wall node temperatures (K) in the order from node 1 to NODES for cell 1, node 1 to NODES for cell 2, etc.
TYPE	1	Component type (first edit only).
VL	NCELLT+1	Cell-interface liquid velocities ($m \cdot s^{-1}$).
VMFR	NCELLT+1	Cell-interface vapor mass flows ($kg \cdot s^{-1}$).
VOL	NCELLT	Cell volumes (m^3) [first edit only].
VV	NCELLT+1	Cell-interface vapor velocities ($m \cdot s^{-1}$).

F.3.1. ACCUM Component Graphics

In addition to a call to IGCOMP, subroutine IGACUM writes to the graphics catalog variables specific to the ACCUM component.

Variable	Dimension	Description
HEIGHT	1	Water level (m) in the ACCUM component (assumes the component is vertically oriented with cell 1 at the top).
HTLSCI	1	Inside heat loss (W) for the ACCUM slabs.

HTLSCO	1	Outside heat loss (W) for the ACCUM slabs.
VFLOW	1	Volumetric flow ($m^3 \cdot s^{-1}$) at the exit (interface NCELLS+1).
VLOSS	1	Liquid volume discharged (m^3) at the exit (interface NCELLS+1).

F.3.2. BREAK Component Graphics

Subroutine IGBRAK writes the entire graphics catalog for the BREAK component.

Variable	Dimension	Description
ALPHA	1	BREAK vapor fraction.
BSA	1	Integrated noncondensable-gas (air) mass flow (kg).
BXA	1	Noncondensable-gas mass flow ($kg \cdot s^{-1}$).
CONC	1	BREAK dissolved-solute concentration [$kg \cdot (kg-liquid)^{-1}$].
DX	1	BREAK length (m) [first edit only].
ENTH	1	Enthalpy ($J \cdot kg^{-1}$) at BREAK fluid-state conditions.
FA	2	BREAK interface flow areas (m^2) [first edit only].
ID	1	User-specified component ID number (first edit only).
IMFLOW	1	Integrated mass flow (kg) into the BREAK.
MFLOW	1	Mass flow ($kg \cdot s^{-1}$) into the BREAK.
NCELLT	1	Total number of cells (should be 1) [first edit only].
NUM	1	Component number (first edit only).
P	1	BREAK pressure (Pa).
PA	1	BREAK noncondensable-gas partial pressure (Pa).
TL	1	BREAK liquid temperature (K).
TV	1	BREAK vapor temperature (K).
TYPE	1	Component type (first edit only).
VOL	1	BREAK volume (m^3) (first edit only).

F.3.3. FILL Component Graphics

Subroutine IGFILL writes the entire graphics catalog for the FILL component.

Variable	Dimension	Description
ALPHA	1	FILL vapor fraction.
CONC	1	FILL dissolved-solute concentration [$kg \cdot (kg-liquid)^{-1}$].
DX	1	FILL length (m) [first edit only].

ENTH	1	Enthalpy ($J \cdot kg^{-1}$) at FILL fluid-state conditions.
FLOWAREA	2	FILL-interface flow areas (m^2) [first edit only].
ID	1	Use.-specified component ID number (first edit only).
MFLOW	1	Mass flow ($kg \cdot s^{-1}$) out of the FILL.
NCELLT	1	Total number of cells (should be 1) [first edit only].
NUM	1	Component number (first edit only).
P	1	FILL pressure (Pa).
PA	1	FILL noncondensable-gas partial pressure (Pa).
TL	1	FILL liquid temperature (K).
TV	1	FILL vapor temperature (K).
TYPE	1	Component type (first edit only).
VL	1	FILL liquid velocity ($m \cdot s^{-1}$).
VOL	1	FILL volume (m^3) [first edit only].
VV	1	FILL vapor velocity ($m \cdot s^{-1}$).

F.3.4. Heat-Structure (ROD or SLAB) Component Graphics

Subroutine IGHSTR writes the entire graphics catalog for the heat-structure (ROD or SLAB) component.

Variable	Dimension	Description
ALREAC	1	Void-fraction reactivity.
DBREAC	1	Boron (dissolved and plated solute) reactivity.
ID	1	User-specified component ID number (first edit only).
IDBCI	1	Inner-surface boundary condition of the heat-structure ROD or SLAB.
IDBCO	1	Outer-surface boundary condition of the heat-structure ROD or SLAB.
IDRGRI	NZMAX	Heat-transfer regimes for the inner surface of the heat-structure ROD or SLAB.
IDRGRO	NZMAX	Heat-transfer regimes for the outer surface of the heat-structure ROD or SLAB.
NODES	1	Number of ROD-radial or SLAB-thickness heat-transfer nodes in the heat structure (first level only).
NRODS	1	Total number of calculational RODs or SLABs defined by the heat structure.

NUM	1	Component number (first edit only).
NZMAX	1	Maximum number of rows of nodes in the axial direction (first edit only).
PGREAC	1	Programmed reactivity.
RMCKN	1	Reactor multiplication constant K_{eff}.
RPOWER	1	Reactor power (W).
STNUI	NZMAX	Inner-surface Stanton number of the heat-structure ROD or SLAB.
STNUO	NZMAX	Outer-surface Stanton number of the heat-structure ROD or SLAB.
STRTMP	NODES*NZMAX	Heat-structure's ROD or SLAB element temperatures (K), ordered node 1 to node NODES for row 1, followed by node 1 to node NODES for row 2, etc.
TCREAC	1	Coolant-temperature reactivity.
TFREAC	1	Fuel-temperature reactivity.
TLDI	NZMAXZ	Inner-surface liquid temperatures (K) at bubble departure.
TLDO	NZMAXZ	Outer-surface liquid temperatures (K) at bubble departure.
TRHMAX	1	Maximum additional ROD or SLAB temperature.
TRAMAX	1	Maximum average ROD or SLAB temperature.
TYPE	1	Component type (first edit only).
ZHT	NZMAX	Axial positions (m) of the rows of nodes in the heat-structure component.

F.3.5. PIPE Component Graphics

In addition to a call to IGCOMP, subroutine IGPIPE writes to the graphics catalog variables specific to the PIPE component.

Variable	Dimension	Description
CPOW	1	Heater power (W) to the PIPE fluid.
HEIGHT	1	Water level (m) in the PIPE component (assumes the component is vertically oriented with cell 1 at the top) when the accumulator flag is set.
HTLSCI	1	Inside heat loss (W) for the PIPE slabs.
HTLSCO	1	Outside heat loss (W) for the PIPE slabs.
VFLOW	1	Volumetric flow ($m^3 \cdot s^{-1}$) at the exit (interface NCELLS+1) when the accumulator flag is set.

VLOSS	1	Liquid volume discharged (m^3) at the exit (interface NCELLS+1) when the accumulator flag is set.

F.3.6. PLENUM Component Graphics

Subroutine IGPLEN writes the entire graphics catalog for the PLENUM component. Although subroutine IGPLEN allows the option of writing variables relating to wall heat transfer, the heat-transfer option for the PLENUM has not been developed; therefore, the heat-transfer variables are not listed below.

Variable	Dimension	Description
ALPHA	1	Cell vapor fraction.
AM	1	Cell noncondensable-gas mass (kg).
CONC	1	Cell dissolved-solute concentration [$kg \cdot (kg{-}liquid)^{-1}$].
DX	NPLJN	Cell lengths (m) associated with each PLENUM junction (first edit only).
ID	1	User-specified component ID number (first edit only).
NPLJN	1	Number of PLENUM junctions (first edit only).
NUM	1	Component number (first edit only).
NCELLT	1	Total number of cells (should be 1) [first edit only].
P	1	Cell pressure (Pa).
PA	1	Cell noncondensable-gas partial pressure (Pa).
RHOL	1	Cell liquid density ($kg \cdot m^{-3}$).
RHOM	1	Cell mixture density ($kg \cdot m^{-3}$).
RHOV	1	Cell vapor density ($kg \cdot m^{-3}$).
ROAN	1	Cell noncondensable-gas density ($kg \cdot m^{-3}$).
SOLID	1	Cell plated-solute mass/cell fluid volume ($kg \cdot m^{-3}$).
TL	1	Cell liquid temperature (K).
TSAT	1	Cell saturation temperature (K) based on pressure.
TV	1	Cell vapor temperature (K).
TYPE	1	Component type (first edit only).
VOL	1	Cell volume (m^3) [first edit only].

F.3.7. PRIZER Component Graphics

In addition to a call to IGCOMP, subroutine IGPRZR writes to the graphics catalog variables specific to the PRIZER component.

Variable	Dimension	Description
HEIGHT	1	Water level (m) in the PRIZER component (assumes the component is vertically oriented with cell 1 at the top).
HTLSCI	1	Inside heat loss (W) for the PRIZER slabs.
HTLSCO	1	Outside heat loss (W) for the PRIZER slabs.
POWER	1	Heater/sprayer power (W).
VFLOW	1	Volumetric flow ($m^3 \cdot s^{-1}$) at the exit (interface NCELLS+1) of the PRIZER.
VLOSS	1	Liquid volume discharged (m^3) at the exit (interface NCELLS+1) of the PRIZER.

F.3.8. PUMP Component Graphics

In addition to a call to IGCOMP, subroutine IGPUMP writes to the graphics catalog variables specific to the PUMP component.

Variable	Dimension	Description
ALPHAP	1	PUMP void fraction as donor-celled to the second (pump-impeller) interface (weighted 10% new, 90% old).
DELTAP	1	PUMP ΔP (Pa) [cell 2 −cell 1].
HEAD	1	PUMP head ($m^2 \cdot s^{-2}$) from the homologous curves and two-phase degradation multiplier.
HTLSCI	1	Inside heat loss (W) for the PUMP slabs.
HTLSCO	1	Outside heat loss (W) for the PUMP slabs.
OMEGA	1	Pump-impeller speed ($rad \cdot s^{-1}$).
PFLOW	1	PUMP mass flow ($kg \cdot s^{-1}$) at the second (pump) interface.
RHOP	1	PUMP mixture density ($kg \cdot m^{-3}$) as donor-celled to the second (pump-impeller) interface.
SMOM	1	PUMP momentum source ($m \cdot s^{-1}$) applied at the second (pump-impeller) interface based on the PUMP head.
TORQUE	1	PUMP hydraulic torque ($kg \cdot m^2 \cdot s^{-2}$) from the homologous curves and two-phase degradation multiplier.
VFLOWP	1	PUMP volumetric flow ($m^3 \cdot s^{-1}$) at the second (pump-impeller) interface.

F.3.9. STGEN Component Graphics

In addition to a call to IGCOMP, subroutine IGSTGN writes to the graphics catalog variables specific to the STGEN component. Subroutine IGSTGN does not utilize the call to IGCOMP to write the wall heat-transfer variables but writes that part of the graphics catalog directly.

Variable	Dimension	Description
CHTI	NCELLT	Vapor-side interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
HILG	NTUBE+NGHT	Heat-structure inside liquid heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
HIVG	NTUBE+NGHT	Heat-structure inside vapor heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
HOLG	NTUBE+NGHT	Heat-structure outside liquid heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
HOVG	NTUBE+NGHT	Heat-structure outside vapor heat-transfer coefficients ($W \cdot m^{-2} \cdot K^{-1}$).
HTLSCI	1	Inside heat loss (W) for the first NTUBE heat structures.
HTLSCO	1	Outside heat loss (W) for the first NTUBE heat structures.
HTLSGI	1	Inside heat loss (W) for the last NGHT heat structures.
HTLSGO	1	Outside heat loss (W) for the last NGHT heat structures.
IDGHI	NTUBE+NGHT	Heat-structure inside heat-transfer regimes.
IDGHO	NTUBE+NGHT	Heat-structure outside heat-transfer regimes.
NCELL1	1	Number of cells in the primary component (does not include side leg, if it exists) [first edit only].
NCELL2	1	Total number of cells in all secondary components (includes accounting of phantom cells to allow for the fact that there are more interfaces than cells) [first edit only].
NCLP	1	Number of cells in the primary-component side tube (first edit only).
NCLS	10	Number of cells in the secondary-component main tube (first edit only).
NCLT	10	Number of cells in the secondary-component side tube (first edit only).
NODMX	1	Number of radial nodes in each heat structure (first edit only).

NSCMP	1	Number of secondary components (first edit only).
STYPE	10	Secondary-component types (first edit only).
TWGI	NODMX* (NTUBE+NGHT)	Heat-structure node temperatures (K) in the order from node 1 to NODMX for structure 1, node 1 to NODMX for structure 2, etc., continuing through the NTUBE structures for the tube walls and followed by the NGHT generalized heat structures.

F.3.10. TEE Component Graphics

In addition to a call to IGCOMP, subroutine IGTEE writes to the graphics catalog variables specific to the TEE component.

Variable	Dimension	Description
HTLSCI	1	Inside heat loss (W) for the TEE slabs.
HTLSCO	1	Outside heat loss (W) for the TEE slabs.
NCELL1	1	Number of cells in the main tube (first edit only).
NCELL2	1	Number of cells in the side tube (first edit only).
POWR1	1	Heater power (W) to the TEE main-tube fluid.
POWR2	1	Heater power (W) to the TEE side-tube fluid.

F.3.11. TURB Component Graphics

In addition to a call to IGCOMP, subroutine IGTURB writes to the graphics catalog variables specific to the TURB component.

Variable	Dimension	Description
CPOW	1	Heater power (W) to the TURB fluid.
EFFSTG	1	Turbine-stage efficiency.
OMEGA	1	TURB (turbine) speed (rad · s^{-1}).
POWER	1	TURB (turbine) power (W).
POWSTG	1	Turbine-stage power output (W).
TRBSIG	1	TURB (turbine) governing signal.

F.3.12. VALVE Component Graphics

In addition to a call to IGCOMP, subroutine IGVLVE writes to the graphics catalog variables specific to the VALVE component.

Variable	Dimension	Description
AREA	1	Adjustable-valve interface flow area (m^2).
HTLSCI	1	Inside heat loss (W) for the VALVE slabs.

HTLSCO	1	Outside heat loss (W) for the VALVE slabs.

F.4. THREE-DIMENSIONAL VESSEL COMPONENT GRAPHICS

Subroutine IGVSSL writes to the graphics catalog all of the variables for the VESSEL component. The cell and interface data are written on a level basis, with a do-loop over all levels. The rod-related data are written on a rod basis, with a loop over all rods. The variables written to the VESSEL graphics are very much dependent on the options selected and parameters set in the VESSEL input, in NAMELIST, and in other general options.

Variable	Dimension	Description
ALPHA	NCLX	Cell vapor fractions.
ALV	NCLX	Cell flashing interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
ALVE	NCLX	Cell liquid-side interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
AM	NCLX	Cell noncondensable-gas masses (kg).
CEMFR	1	Core-outlet mass flow ($kg \cdot s^{-1}$).
CHTI	NCLX	Cell vapor-side interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
CHTIA	NCLX	Cell noncondensable-gas interfacial heat-transfer coefficients ($W \cdot K^{-1}$) [area folded in].
CIF-R	NCLX	Radial or x-direction interfacial-drag coefficients ($kg \cdot m^{-4}$).
CIF-T	NCLX	Azimuthal or y-direction interfacial-drag coefficients ($kg \cdot m^{-4}$).
CIF-Z	NCLX	Axial interfacial-drag coefficients ($kg \cdot m^{-4}$).
CIMFRL	1	Core-inlet liquid mass flow ($kg \cdot s^{-1}$).
CIMFRV	1	Core-inlet vapor mass flow ($kg \cdot s^{-1}$).
CMASS	1	Core-region liquid mass (kg).
CMFLOW	1	Core-inlet mass flow ($kg \cdot s^{-1}$).
COMFRL	1	Core-outlet liquid mass flow ($kg \cdot s^{-1}$).
COMFRV	1	Core-outlet vapor mass flow ($kg \cdot s^{-1}$).
CONC	NCLX	Cell dissolved-solute concentrations [$kg \cdot (kg\text{-liquid})^{-1}$].
CRLIQFR	1	Core-region liquid volume fraction.
CRPRESS	1	Core-region average pressure (Pa) [volume averaged].

DCFLOW	1	Downcomer mass flow (kg · s^{-1}) [sums the axial flows out of the downcomer at level IDCL].
DCLQVOL	1	Downcomer liquid volume fraction.
DMASS	1	Downcomer liquid mass (kg).
DR	NRSX	Δr or Δx (m) for each radial ring or x-direction cell (first edit only).
DTHETA	NTSX	$\Delta\theta$ (rad) or Δy (m) for each azimuthal segment or y-direction cell (first edit only).
DZ	NASX	Δz (m) for each axial level [first edit only].
FLOWAREA	NCLX*3	Cell-interface fluid flow areas (m^2) [first edit only].
ICJ	NCSR	Components adjacent to sources (first edit only).
ID	1	User-specified component ID number (first edit only).
ISRC	NCSR	Cell numbers to which sources are connected (first edit only).
ISRF	NCSR	Face numbers to which sources are connected (first edit only).
ISRL	NCSR	Level numbers to which sources are connected (first edit only).
MFRL	NCLX	Liquid axial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 1].
MFRLR	NCLX	Liquid radial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
MFRLT	NCLX	Liquid azimuthal mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
MFRLZ	NCLX	Liquid axial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
MFRV	NCLX	Vapor axial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 1].
MFRVR	NCLX	Vapor radial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
MFRVT	NCLX	Vapor azimuthal mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
MFRVZ	NCLX	Vapor axial mass flows (kg · s^{-1}) [NAMELIST option IMFR = 3].
NASX	1	Number of axial levels [first edit only].

NCELLT	1	Total number of cells (NASX*NRSX*NTSX) [first edit only].
NCLX	1	Number of cells on each level (NRSX*NTSX) [first edit only].
NCSR	1	Number of VESSEL source connections (first edit only).
NODES	1	Number of radial heat-transfer nodes in each rod (not defined; first edit only).
NRSX	1	Number of radial rings or x-direction cells (first edit only).
NSRL	NASX	Number of sources on each level (first edit only).
NTSX	1	Number of azimuthal segments or y-direction cells (first edit only).
NUM	1	Component number (first edit only).
NZMAX	1	Maximum number of rows of nodes in each rod (not defined; first edit only).
P	NCLX	Cell pressures (Pa).
PA	NCLX	Cell noncondensable-gas partial pressures (Pa).
PDC	1	Downcomer average pressure (Pa) [volume averaged].
PLP	1	Lower-plenum average pressure (Pa) [volume averaged].
PMASS	1	Liquid mass below downcomer (kg).
PUP	1	Upper-plenum average pressure (Pa) [volume averaged].
QHSTR	NCLX	Heat-structure heat transfer (W) to fluid in cell.
RHOL	NCLX	Cell liquid densities ($kg \cdot m^{-3}$).
RHOV	NCLX	Cell vapor densities ($kg \cdot m^{-3}$).
ROAN	NCLX	Cell noncondensable-gas densities ($kg \cdot m^{-3}$).
SOLID	NCLX	Cell plated-solute mass/cell fluid volume ($kg \cdot m^{-3}$).
TCILMF	1	Integrated core-inlet liquid mass flow (kg).
TCIVMF	1	Integrated core-inlet vapor mass flow (kg).
TCOLMF	1	Integrated core-outlet liquid mass flow (kg).
TCORE	1	Core-region average liquid temperature (K) (liquid-mass averaged).
TCOVMF	1	Integrated core-outlet vapor mass flow (kg).
TDC	1	Downcomer average liquid temperature (K) [liquid-mass averaged].

TL	NCLX	Cell liquid temperatures (K).
TLP	1	Lower-plenum average liquid temperature (K) [liquid-mass averaged].
TSAT	NCLX	Cell saturation temperatures (K) based on pressures.
TSCORE	1	Core-region average saturation temperature (K) [based on the core-region average pressure].
TSDC	1	Downcomer average saturation temperature (K) [based on downcomer average pressure].
TSLP	1	Lower-plenum average saturation temperature (K) [based on the lower-plenum average pressure].
TSUP	1	Upper-plenum average saturation temperature (K) [based on the upper-plenum average pressure].
TUP	1	Upper-plenum average liquid temperature (K) [liquid-mass averaged].
TV	NCLX	Cell vapor temperatures (K).
TYPE	1	Component type (first edit only).
VLN-R	NCLX	Liquid radial or x-direction velocities ($m \cdot s^{-1}$).
VLN-T	NCLX	Liquid azimuthal or y-direction velocities ($m \cdot s^{-1}$).
VLN-Z	NCLX	Liquid axial velocities ($m \cdot s^{-1}$).
VLPLIQ	1	Lower-plenum liquid volume fraction.
VLPLM	1	Lower-plenum liquid mass (kg).
VMASS	1	VESSEL liquid mass (kg).
VOL	NCLX	Cell fluid volumes (m^3) [first edit only].
VSFLOW	1	VESSEL mass flow ($kg \cdot s^{-1}$) [sums over all VESSEL source connections].
VUPLIQ	1	Upper-plenum liquid volume fraction.
VUPLM	1	Upper-plenum liquid mass (kg).
VVN-R	NCLX	Vapor radial or x-direction velocities ($m \cdot s^{-1}$).
VVN-T	NCLX	Vapor azimuthal or y-direction velocities ($m \cdot s^{-1}$).
VVN-Z	NCLX	Vapor axial velocities ($m \cdot s^{-1}$).

APPENDIX G

TRAC ERROR MESSAGES

Subroutine ERROR handles errors diagnosed by TRAC. The subroutine uses the level number associated with each error listed below to determine its course of action.

Level	Actions
1, 3	Fatal error, stop problem.
2	Nonfatal error, continue problem.
4	Fatal error, add dump to the TRCDMP file, then stop problem.
−2	Steady-state nonconvergence warning.
−4	Problem stopped by user.

The error messages are written to the TRCOUT and TRCMSG files and to the terminal. The message begins with the name of the subroutine, bounded by asterisks (* · · · *), which detected the error. Because of this format and because implementation of TRAC on various computers differs, we have used the subroutine name to alphabetize the following list of error messages. If an error message occurs that is not found in the following list, we suggest that you inspect the coding in the subroutine listed in the message for more detail.

Subroutine	Level	Message	Explanation
BFIN	1	DATA SET EOF ERROR	An illegal end-of-file was found when the data were read.
BFIN	1	DATA SET TYPE ERROR	An error occurred when the data were read in the binary format.
BFOUT	1	DATA SET TYPE ERROR	An error occurred when the data were written in a binary format.
BITS	1	ILLEGAL BIT SPECIFIED	An attempt was made to set bit beyond the word length.
BITS	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	Variable ITYPE was not equal to 1, 2, or 3. This will only occur if there is a coding error.
BREAKX	1	BK TABLE LOOKUP ERROR	An error exists in interpolating a break table.
CBSET	1	C-BLOCK ID NOT FOUND TO SET NFLG	The first input parameter ID number for the control block could not be found in the list on control blocks so that it could be flagged with this control block's new flag.

CBSET	1	C-BLOCK ID NOT FOUND TO SET OFLG	The first input parameter ID number for this control block could not be found in the list of control blocks so that it could be flagged with this control block's old flag.
CBSET	1	CNTL.BLK. ID NOT FOUND	One of the control-block input parameters has a negative ID number that could not be found in the list of control blocks.
CBSET	1	ERROR IN TABLE LOOKUP	An error was detected by subroutine LININT while it was linearly interpolating in the control-block FNG1 table.
CBSET	1	SIG. VAR. ID NOT FOUND	One of the control-block input parameters has a positive ID number that could not be found in the list of signal variables.
CHBD	2	BOUNDARY ERROR DETECTED	Adjacent components have mismatched geometry.
CHF	1	TCHF FAILED TO CONVERGE	The calculation failed to converge on a unique critical heat-flux (CHF) wall temperature.
CHKSR	2	VESSEL SOURCE LOCATION ERROR	A vessel to one-dimensional source connection was either specified on a cell that does not exist or on a face that does not exist.
CHOKE	1	CHARACTERISTIC SOLUTION DID NOT CONVERGE	The two-phase characteristic solution using a quick-solution search was bounded, but complete convergence could not be obtained within allowed iterations.
CHOKE	1	CONVERGENCE FAILED IN GREV	The system's routine GREV has trouble calculating all the eigenvalues of the two-phase characteristic solution.
CHOKE	2	LARGEST CHARACTERISTIC ROOT WAS COMPLEX	An informative message is printed under debug mode only.
CHOKE	2	NEGATIVE DFLDP CALCULATED, ASSUMED ZERO	The calculated derivative $\partial V_t/\partial p$ was negative because the round-off errors should always be > 0.0. Therefore, the derivative was set to 0.0.

CHOKE	2	NEGATIVE DFVDP CALCULATED, ASSUMED ZERO	The calculated derivative $\partial V_g/\partial \rho$ was negative because the round-off errors should be > 0.0. Therefore, the derivative was set to 0.0.
CHOKE	2	ONLY APPROXIMATE SOLUTION OBTAINED	The normal two-phase choking solution maintains constant phasic slip. However, because of convergence problems, this condition could not be satisfied, but rather the relative velocity between the phases was approximately maintained.
CHOKE	2	QUICK SOLUTION SEARCH FAILED	An informative message is printed under debug mode only.
CIVSSL	1	CONNECTIONS COMPUTED AFTER VESSEL	The component calculational sequence must compute the connections before the vessel.
CIVSSL	1	IORDER PROBLEM	The calculational sequence must compute the component connected to the vessel before it calculates the vessel.
CIVSSL	1	JUNCTION PROBLEM	A component adjacent to the VESSEL cannot be found.
CIVSSL	1	VESSEL CONNECTED TO A FILL	A VESSEL cannot be connected to a FILL.
CIVSSL	1	VESSEL CONNECTED TO BREAK	A VESSEL cannot be connected to a BREAK.
CONBLK	1	BAD CNTL-BLOCK OPERATION NUMBER	A control-block operation number does not lie between 1 and 61.
CONBLK	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	Variable ICBN was incorrectly defined. This will only occur if there is a coding error.
CONBLK	1	IMPROPER LLAG BLOCK CONSTANTS	The lead-lag transfer function control block 30 has a first constant that is negative or a second constant that is zero or negative.
CONBLK	1	IMPROPER SOTF BLOCK CONSTANTS	The second-order transfer function control block 51 has a first constant that is negative or a second constant that is zero or negative.
CONBLK	1	INVALID CNTL-BLOCK INPUT VALUES	A control block is defined with invalid input parameter values.

CONBLK	1	INVALID DEAD-FUNCTION CONSTANTS	The dead control block 11 has a second constant that is less than the first constant.
CONBLK	1	NONPOSITIVE LAG TIME	The first-order LAG transfer function control block 26 has a first constant that is zero or negative.
CONVRT	1	ARRAY DIMENSIONS EXCEEDED	The subroutine, which extracts a vessel deck for modification and re-input, assumes that there are no more than 25 axial, radial, or theta zones.
CORE1	1	BAD IDROD FOR ADDITIONAL RODS	TRAC cannot find a cell number that matches IDROD.
CORE3	1	BAD IDROD FOR ADDITIONAL RODS	TRAC cannot find a cell number that matches IDROD.
CTAIN1	1	CONTAINMENT MODULE NOT YET IMPLEMENTED	Containment component will be in a future TRAC version.
CTAIN2	1	CONTAINMENT MODULE NOT YET IMPLEMENTED	Containment component will be in a future TRAC version.
CTAIN3	1	CONTAINMENT MODULE NOT YET IMPLEMENTED	Containment component will be in a future TRAC version.
DCHNID	1	INSUFFICIENT CORE FOR GRAPHICS DATA	There is insufficient memory for the INEL-NPA graphics data.
DCHNID	1	INSUFFICIENT CORE FOR PLOT VAR ID ARRAY	There is insufficient memory for the INEL-NPA plot variable ID array.
DELAY	1	ERROR IN DELAY TIME TABLE LOOKUP	An error was detected by sub-routine LININT when it tried to linearly interpolate the time delay table on a control block 100.
DMPIT	3	DUMP FILE DEFINE ERROR	File TRCDMP could not be created.
DMPIT	3	TYPE NOT RECOGNIZED	An invalid component type was encountered.
ELGR	2	FORM LOSS VALUE TOO HIGH	The input value of a form loss was such that when the code converted it into an equivalent FRIC, the FRIC value exceeded 10^{20}. A FRIC value exceeding 10^{20} will invoke the steam separator model at the cell edge under consideration. Obviously, such was not the user's intention, otherwise the user would have input a form-loss value exceeding 10^{20} in the first place.

ENDDMP	2	DUMP FILE NOT CLOSED	An error occurred during the closing of the TRCDMP file.
ENDDMP	2	ERROR COMPACTING FILE	An error occurred during the compacting of the TRCDMP file.
ENDGRF	2	GRAPHICS FILE NOT CLOSED	An error occurred during the closing of the TRCGRF file.
ENDGRF	2	ERROR COMPACTING FILE	An error occurred during the compacting of the TRCGRF file.
EOVLY	2	OVERLAY UNLOAD ERROR	An illegal overlay sequence exists.
EVALDF	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	An undefined variable was passed to subroutine EVALDF.
EVFXXX	1	NEED LOCAL DIM.GT.50	Local array FXXXO is dimensioned to be 50; for components with more than 50 mesh cells, subroutine EVFXXX cannot evaluate a QPPP factor for each mesh cell.
EVFXXX	1	TABLE LOOKUP ERROR	Subroutine LININT encountered an error while trying to linearly interpolate the component-action table value for the situation when the controlling trip is OFF after being ON.
EVLTAB	1	CNTL. BLOCK NOT FOUND	The negative ID number that defines the independent variable of the component-action table was not specified in the control-block list.
EVLTAB	1	SIGNAL VAR. NOT FOUND	The positive ID number that defines the independent variable of the component-action table was not specified in the signal-variable list.
EVLTAB	1	TABLE LOOKUP ERROR	Subroutine LININT found an error when evaluating the component-action table.
FBRCSS	1	BRANCH PATHS EXCEED 10	The number of branch paths on the secondary side of a steam-generator component that have not been investigated yet and are connected to branch paths already investigated exceeds the dimension of 10 for local arrays IIP, IJP, and IKP in subroutine FBRCSS.

FBRCSS	1	TOO MANY BREAKS	The number of BREAK components connected to the secondary side of a steam-generator component exceeds the dimension of 20 for temporary IA-array storage required by subroutine FBRCSS.
FILLX	1	GENSTATE FILL TABLE LOOKUP ERROR	There are zero entries in the FILL table.
GETBIT	1	ILLEGAL BIT SPECIFIED	The specified bit position is either too small or too large.
GETCRV	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	An undefined pump curve index was passed to subroutine GETCRV.
GRAF	1	DATA TYPE ERROR	There is an invalid data type in the graphics catalog.
GRAF	1	SCM OVERFLOW	There is insufficient SCM for packing graphics data.
GRFPUT	2	ERROR IN GRAPHICS OUTPUT	Integer is too large to be packed into a 15-bit word.
GRFPUT	1	ERROR: GRAPHICS EDIT TOO LARGE	The graphics edit is too large and cannot be written. A FORTRAN modification is required.
HOUT	4	OUTER ITERATION DID NOT CONVERGE	The outer-iteration procedure failed three consecutive times.
HTSTR3	1	NODES .GT. NRFMX	Maximum number of radial heat conduction nodes has been exceeded. Either the TRAC parameter NRFMX must be increased or NODES must be decreased.
HTSTR3	1	NZMAX .GT. NZFMX	Maximum number of axial heat conduction nodes has been exceeded. Either the TRAC parameter NZFMX must be increased or NZMAX must be decreased.
HVWEBB	1	FAILURE TO CONVERGE IN WEBB-CHEN	The iteration to solve for the two-phase friction factor in the Webb-Chen correlation failed.
ICOMP	1	FATAL INPUT ERROR(S)	An error was encountered during component data initialization causing JFLAG. NE. O at the end of subroutine ICOMP.

ICOMP	1	FRICTION LOSS HIGHER THAN TURBINE OUTPUT	The friction torque coefficients specified for the turbine are so large that the friction loss exceeds the normal design power from all stages.
ICOMP	1	INCONSISTENT JUNCTION NUMBERS	Inconsistent specification of junction numbers was made.
ICOMP	1	JUNCTION COUNT ERROR	The number of junctions specified is inconsistent with the number found.
ICOMP	1	JUNCTION NUMBERS WRONG	The junctions are assigned incorrectly.
ICOMP	2	LOOP SOURCE CONN. DIFF. DIRECTIONS	The vessel source connections of a component loop have cell-face connections to different directions. To eveluate this model, NAMELIST variable NOSETS must be set to 1 which results in the time step being constrained by the material-courant limit in the VESSEL components.
ICOMP	1	SCM OVERFLOW	Insufficient SCM is available to load problem.
ICOMP	1	TURBINE STAGES INCONSISTENT WITH INPUT	The user specified component numbers of the associated turbine stages under stage 1. This specification is not consistent with the other TURB components input.
ICOMP	1	UNRECOGNIZED COMPONENT	The component type was not recognized
ICOMP	1	WRONG TURB COMPONENT NUMBER ON VALVE	The VALVE component for IVTY option of 5 or 6 requires a TURB component number. This number is inconsistent with the TURB components input.
IGRAF	1	COMPONENT TYPE NOT RECOGNIZED	An invalid component type was encountered.
IGRAF	1	GRAPHICS FILE ALLOCATION FAILURE	An I/O error occurred while allocated space was sought for graphics file.
IGRAF	1	NO LCM SPACE FOR GRAPH CATALOG	Insufficient LCM is available.
IGRAF	1	NO SCM SPACE FOR GRAPH CATALOGUE	Problem too large to run with current code. User must reduce nodes or alter code.

IGRAF	1	SCM OVERFLOW	Insufficient SCM is available.
INIT	1	FAVOL & FA TOO LARGE	For a large change in volume-averaged flow areas across two adjacent cells, a flow loss must also be input for the involved junction. This can be accomplished by either inputting a form loss or setting NFF to less than zero for a one-dimensional component or CFZL to less than zero for a three-dimensional component.
INIT	1	FAVOL CHANGE TOO LARGE	For a large change in volume-averaged flow areas across two adjacent cells, a flow loss must also be input for the involved junction. This can be accomplished by either inputting a form loss or setting NFF to less than zero for a one-dimensional component or CFZL to less than zero for a three-dimensional component.
INIT	1	INTERFACE FA TOO LARGE	The flow area of a particular cell face cannot be larger than either of the two adjoining volume-averaged flow areas.
INPUT	2	CBETA MUST BE BETWEEN −1 & 1	The Bankoff interpolation constant (β) for interpolating between Wallis characteristic length dimension and Kutalatze characteristic length dimension must be between −1 and 1 in value.
INPUT	2	CCFLC IS .LE. ZERO	The intercept for the CCFL correlation must be greater than zero.
INPUT	2	CCFLM IS .LE. ZERO	The slope for the CCFL correlation must be greater than zero.
INPUT	2	DIAH MUST BE GT 0.0	The diameter of a single hole in the perforated plate of the CCFL model must be greater than 0.0 m.
INPUT	2	DUPLICATE COMP NUMBERS IN IORDER	Two components with the same number were found in the TRACIN file.

INPUT	1	FATAL INPUT ERROR(S)	A fatal input error was found when an input or restart file was read.
INPUT	1	FILE TRACIN DOES NOT EXIST	The input deck does not exist.
INPUT	2	GAMMA MUST BE GT 0.0	The ratio of open-plate flow area to total-plate flow area in the CCFL model must be greater than 0.0.
INPUT	2	HYDRO CMP NUM .GE. HT-ST CMP NUM	The component numbers for all heat structures must be larger than the largest hydro component number.
INPUT	1	INOPTS NAMELIST DATA NOT FOUND	The NAMELIST option was specified; however, the NAMELIST data for group INOPTS are not in the TRACIN file.
INPUT	1	INSUFFICIENT MEMORY TO PROCEED PAST INPUT PROCESSING	Insufficient memory exists to proceed past the input processing stage.
INPUT	2	NCCFL IS OUT OF BOUNDS	The number of CCFL parameter sets being input must be between zero and ten.
INPUT	2	NHOLES MUST BE GT 0	The number of holes in the perforated plate of the CCFL model must be greater than zero.
INPUT	1	NO LCM SPACE FOR CPD	Insufficient memory exists to store the trip and control block data.
INPUT	1	NO SPACE FOR BUFFERS	Insufficient LCM is available for I/O buffers.
INPUT	2	SCM OVERFLOW	Insufficient SCM is available for this problem. The user must reduce the number of nodes or redo the INPUT overlay.
INPUT	2	SOLUBILITY PARAMETERS NOT REASONABLE	The solubility parameters entered for option ISOLCN do not define a reasonable linear relationship between solubility and temperature or may generate negative solubilities.
INPUT	2	STDYST=2 AND NCONTR .LT.1	The constrained steady-state option requires at least one steady-state controller to be specified.
INPUT	2	TP MUST BE GT 0.0	The thickness of the perforated plate in the CCFL model must be greater than 0.0 m.

IOVLY	1	A-ARRAY OVERFLOW	The main SCM data array is too small. This message occurs only for the CDC 7600 version with a fixed A-dimension (~25000 words). Routine IOVLY directly issues diagnostic statistics. The global problem data are started at the high end of A, and the available space is smaller than the total dimension of A.
IOVLY	1	ERROR INITIALIZING SCM	Subroutine SETSCM found an error.
IOVLY	1	SCM SPACE TOO SMALL FOR OVERLAY	Insufficient SCM is available for this overlay.
IROD	2	BAD AXIAL-POWER SHAPE	Linear interpolation of the axial-power-shape table by subroutine LININT failed.
IROD	1	BAD FUEL-ROD POWER SUM	Evaluating the heat-structure component volume-integrated power gave a negative value.
IRODL	1	HS NOT ALLOW IN PLENUM	A heat-structure component cannot be connected to a plenum component.
ISTGEN	1	2 JNCTS. OF 1 CELL COMP. EXT.	Code cannot find two internal secondary junction numbers that have the same value.
ISTGEN	2	JUNCTION ERROR	Error in the specification of the secondary internal junction numbers of the steam generator.
ITEE	1	INVALID GEOMETRY FOR OFFTAKE MODEL	The geometry specified for the TEE component offtake model is invalid.
IVLVE	1	INVALID VALVE LOCATION	The valve interface where the flow area is adjustable does not lie between two cells within the VALVE component.
JFIND	1	JUNCTION PROBLEM	A junction number could not be located in the junction sequence array.
LCMTRN	2	SCM OVERFLOW	A small core memory overflow can occur when the NOLCM option is not defined and the amount of data which must be kept within the field length has exceeded the capacity of the executing computer.

LOAD	2	ARRAY FILLED-- OPERATION END NOT FOUND ON ARRAY CARD NO. XXXX OR NEXT CARD	Subroutine LOAD has filled up an array, but the letter "e" was not found at the end of the array input.
LOAD	2	ARRAY FILLED BUT OPERATION END NOT FOUND ON ARRAY CARD NO. XXXX	Subroutine LOAD has filled up an array, but the letter "e" was not found at the end of the array input.
LOAD	2	ARRAY FILLED BUT OPERATION END NOT FOUND-- SEE INPUT CARDS XXXX THRU XXXX	Subroutine LOAD has filled up an array, but the letter "e" was not found at the end of the array input.
LOAD	2	DATA OVERFLOWED ARRAY ON INPUT CARD NO. XXXX – REPEAT COUNT RESET TO ONE	When the array data were read, a repeat operation overfilled the array.
LOAD	2	ERROR--UNEXPECTED NAMELIST DATA ENCOUNTERED	When the array data were loaded, NAMELIST data were found.
LOAD	2	INPUT ERROR ENCOUNTERED ON CARD NO. XXXX – REST OF COMPONENT SKIPPED	The array-reading routine found an error flag on a card set by the free-format input-option preprocessor routine. Execution of TRAC stops after the entire input deck is processed.
LOAD	2	INPUT ERROR ON CARD NO. XXXX – REAL DATA ENCOUNTERED IN INTEGER ARRAY	Real data were found in an integer array.
LOAD	2	INPUT ERROR – NEW COMPONENT WAS ENCOUNTERED UNEXPECTEDLY ON CARD NO. XXXX	When the array data for a component were loaded, data for an additional component or an "END" card was specified.
LOAD	2	INTEGER INTERPOLATION NOT ALLOWED – SEE INPUT CARD NO. XXXX	When an integer array was read, an interpolation operation was specified.
LOAD	2	NOT ENOUGH DATA TO FILL ARRAY. SEE INPUT CARDS XXXX THRU XXXX	Subroutine LOAD encountered an "e" end of operation before the array was filled.

LOAD	2	OPERATION E ENCOUNTERED BUT INTERPOLATION INCOMPLETE–SEE INPUT CARD XXXX	When the array data were read, an end flag (E) was specified before both endpoints of an interval to be interpolated were read.
LOAD	2	REPEAT COUNT LESS THAN ONE – INPUT CARD NO. XXXX – COUNT RESET TO ONE	When the array data were read, a repeat count of less than one was found.
LOAD	2	REPEAT LEVEL CARD MISPLACED	When the array data were read, a repeat-level card was found.
LOAD	2	UNDEFINED OPERATION-"XXXX" ON ARRAY CARD NO. XXXX – REPEAT COUNT SET TO ONE	When the array data were read, an undefined load operation was specified.
LOAD	1	UNEXPECTED END-OF-FILE REACHED	When the array data were read, an unexpected end-of-file was found.
LOAD	2	ZERO OR FEWER INTERPOLATIONS–INPUT CARD NO XXXX –OPERATION TREATED AS BLANK	When the array data were read, an interpolation count of less than one was specified.
LOCPMP	1	VARIABLE NAME NOT RECOGNIZED	A programming error occurred when the user tried to locate the position of a TURBINE variable in its common block.
LOCTEE	1	VARIABLE NAME NOT RECOGNIZED	A programming error occurred when the user tried to locate the position of a TURBINE variable in its common block.
LOCTRB	1	VARIABLE NAME NOT RECOGNIZED	A programming error occurred when the user tried to locate the position of a TURBINE variable in its common block.
LOCVLV	1	VARIABLE NAME NOT RECOGNIZED	A programming error occurred when the user tried to locate the position of a VALVE variable in its common block.
MAIN	1	NO SPACE FOR VERSION INFORMATION	Insufficient LCM is available for version information.
MANAGE	1	BAD LEVEL/ROD NUMBER	The requested vessel level or rod number does not exist.

MANAGE	1	ILLEGAL INDEX IN COMPUTED GO TO	An invalid entry option was sent to subroutine MANAGE in variable INOPTS. This will only occur if there is a coding error.
MANAGE	1	SCM MEMORY OVERFLOW	Insufficient SCM is available.
MATSOL	1	BAD BANDED-MATRIX FACTORIZATION	The LU matrix-decomposition factorization of a banded matrix failed.
MATSOL	1	BAD CAPACITANCE-MTX FACTORIZATN	The LU matrix-decomposition factorization of the capacitance matrix (a full matrix) failed.
MATSOL	1	MU=ML.GE.65	The vessel-matrix bandwidth exceeds 64+1+64 and cannot be solved by the banded-matrix solver subroutines BDLSDC and BGLSSL.
MDINIT	1	INDEX TABLE OVERFLOW	The space allocated for the Master Dictionary index is insufficient.
MDINIT	1	VARIABLE TABLE OVERFLOW	The space allocated for a Master Dictionary variable table is insufficient.
MFROD	1	ILLEGAL MATERIAL ID NUMBER	The mate[illegible] ID specified is not valid.
MFROD	1	INTERFACE .NE. NCRZ+1	The last heat-transfer coarse node at hydro cell interfaces must be equal to NCRZ +1.
MODCMP	3	ERROR CHANGING COMPONENT	An error occurred when a component was modified. This will be preceded by a more specific error message (interactive mode only).
MODCMP	3	TYPE NOT RECOGNIZED	The component type specified is not available in TRAC.
MODIFY	−4	HALTED FOR MANUAL RESTART	A component has been modified using the interactive mode.
MSTRCT	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	An undefined or invalid material type number has been passed to subroutine MSTRCT.
MSTRCT	2	INCORRECT TABULAR MAT. I.D.	A wall-material identifier could not be located.
MSTRCT	2	TEMPERATURE OUTSIDE TABLE RANGE	Wall temperature is outside range of the tabular material data.

NAMLST	2	ALP HAS OUT-OF-RANGE VALUE	When specifying a default value for void fractions using the NAMELIST data, the allowable input range is such that $0.0 < ALP < 1.0$.
NAMLST	2	CCIF HAS OUT-OF-RANGE VALUE	When specifying a constant two-phase flow interfacial drag coefficient (when NIFSH = 1) using NAMELIST data, the allowable input range is such that $CCIF > 0.0$.
NAMLST	2	CFZ3 HAS OUT-OF-RANGE VALUE	When specifying a default value for three-dimensional loss coefficients using the NAMELIST data, the allowable input range is such that $CFZ3 \geq 0.0$.
NAMLST	2	CHM1# HAS OUT-OF-RANGE VALUE	When specifying subcooled multipliers for the choked-flow model using NAMELIST data, the allowable input range is such that $CHM1\# > 0.0$.
NAMLST	2	CHM2# HAS OUT-OF-RANGE VALUE	When specifying two-phase multipliers for the choked-flow model using NAMELIST data, the allowable input range is such that $CHM2\# > 0.0$.
NAMLST	2	DTSTRT HAS OUT-OF-RANGE VALUE	When specifying an initial time-step size using the NAMELIST data, the allowable input range is such that $DTSTRT > 0.0$ or $= -1.0$.
NAMLST	2	HD3 HAS OUT-OF-RANGE VALUE	When specifying a default value for three-dimensional hydraulic diameters using the NAMELIST data, the allowable input range is such that $HD3 \geq 0.0$.
NAMLST	2	HSTN HAS OUT-OF-RANGE VALUE	When specifying a default value for heat-structure temperatures in three-dimensional components using the NAMELIST data, the allowable input range is such that $HSTN \geq 0.0$.
NAMLST	2	HTCWL HAS OUT-OF-RANGE VALUE	When specifying a constant wall to liquid heat-transfer coefficient (when ICONHT = 1) using NAMELIST data, the allowable input range is such that $HTCWL > 0.0$.

NAMLST	2	HTCWV HAS OUT-OF-RANGE VALUE	When specifying a constant wall to vapor heat-transfer coefficient (when ICONHT = 1) using NAMELIST data, the allowable input range is such that HTCWV > 0.0.
NAMLST	2	IADDED HAS OUT-OF-RANGE VALUE	When adding the numerical-solution status-parameter message to the TRCMSG and TTY files using NAMELIST data, the allowable input range is such that IADDED ≥ 0.
NAMLST	2	ICDELT HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ICDELT are 0 and 1.
NAMLST	2	ICFLOW HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ICFLOW are 0, 1, and 2.
NAMLST	2	ICONHT HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ICONHT are 0 and 1.
NAMLST	2	IDIAG HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST INOPTS variable IDIAG are 0, 1, 2, 3, and 4.
NAMLST	2	IELV HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IELV are 0 and 1.
NAMLST	2	IGAS HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IGAS are 1, 2, and 3.
NAMLST	2	IGEOM3 HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IGEOM are 0 and 1.
NAMLST	2	IHOR HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IHOR are 0, 1, and 2.
NAMLST	2	IHORG HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IHORG are 0, 1, and 2.
NAMLST	[illegible]	IKFAC HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IKFAC are 0 and 1.
NAMLST	2	IMFR HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IMFR are 1 and 3.

NAMLST	2	INLAB HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable INLAB are 0 and 3.
NAMLST	2	INVAN HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable INVAN are 0 and 3.
NAMLST	2	IOFFTK HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IOFFTK are 0 and 1.
NAMLST	2	IPOWR HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IPOWR are −1, 0, and 1.
NAMLST	2	IPRCPV HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable IPRCPV are 0 and 1.
NAMLST	2	ISOLCN HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ISOLCN are 0 and 1.
NAMLST	2	ISTOPT HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ISTOPT are 0, 1, and 2.
NAMLST	2	ITHD HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable ITHD are 0 and 1.
NAMLST	2	LEVSTG HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable LEVSTG are 0 and 1.
NAMLST	2	NDIA1 HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NDIA1 are 1 and [illegible].
NAMLST	2	NEWRFD HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NEWRFD are 0 and 1.
NAMLST	2	NFRC1 HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NFRC1 are 1 and 2.
NAMLST	2	NFRC3 HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NFRC3 are 1 and 2.
NAMLST	2	NHTSTR HAS OUT-OF-RANGE VALUE	When specifying the number of heat-structure components using NAMELIST data, the allowable input range is such that NHTSTR $\geq$ 0.

NAMLST	2	NIFSH HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NIFSH are 0 and 1.
NAMLST	2	NLT HAS OUT-OF-RANGE VALUE	When specifying a number of hydro-component loops using the NAMELIST data, the allowable input range is such that NLT $\geq$ 1.
NAMLST	2	NOAIR.NE.1 WHEN IEOS.EQ.1	The NAMELIST variable NOAIR must equal 1 when the IEOS = 1 option (gas phase treated as noncondensable gas throughout the system) is selected.
NAMLST	2	NOAIR HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NOAIR are 0 and 1.
NAMLST	2	NORMDP HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NORMDP are 0 and 1.
NAMLST	2	NORMRS HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NORMRS are 0 and 1.
NAMLST	2	NOSETS HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NOSETS are 0, 1, and 2.
NAMLST	2	NRSLV HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NRSLV are 0 and 1.
NAMLST	2	NSEND HAS OUT-OF-RANGE VALUE	When specifying a calculation stop time using the NAMELIST data, the allowable input range is such that NSEND $\geq$ 0.0 or = −1.
NAMLST	2	NSDL & NSDU OUT-OF-RANGE VALUES	When specifying the first time step at which a short edit is to be printed to the TRCOUT file with additional diagnostics using the NAMELIST data, the allowable input range is such that NSDL $\geq$ 0.0 or = −1.
NAMLST	2	NSPL & NSPU HAVE OUT-OF-RANGE VALUES	When specifying the last time step at which a short edit is to be printed to the TRCOUT file with additional diagnostics using the NAMELIST data, the allowable input range is such that NSPL $\geq$ 0.0 or = −1.

NAMLST	2	NVGRAV HAS OUT-OF-RANGE VALUE	The allowable input values for the NAMELIST variable NVGRAV are 0 and 1.
NAMLST	2	P HAS OUT-OF-RANGE VALUE	When specifying a default value for initial pressures using the NAMELIST data, the allowable input range is such that $1.0 \leq P \leq 4.5 \times 10^7$.
NAMLST	2	PA HAS OUT-OF-RANGE VALUE	When specifying a default value for initial noncondensable-gas partial pressures using the NAMELIST data, the allowable input range is such that $0.0 \leq P \leq 4.5 \times 10^7$.
NAMLST	2	QPPP HAS OUT-OF-RANGE VALUE	When specifying a default value for volumetric heat distribution in the walls of one-dimensional components using the NAMELIST data, the allowable input range is such that QPPP ≥ 0.0.
NAMLST	2	TIMDL&TIMDU HAVE OUT-OF-RANGE VALUES	When specifying the times to begin and end a debug print using NAMELIST data, the allowable input ranges are such that TIMDL and TIMDU ≥ 0.0 or $= -1$.
NAMLST	2	TL HAS OUT-OF-RANGE VALUE	When specifying a default value for initial liquid temperatures using the NAMELIST data, the allowable input range is such that $273.15 \leq TL \leq 713.95$.
NAMLST	2	TPOWR HAS OUT-OF-RANGE VALUE	When specifying the time at which the core-power initialization at its steady-state level is activated using NAMELIST data, the allowable input range is such that TPOWR ≥ 0.0.
NAMLST	2	TV HAS OUT-OF-RANGE VALUE	When specifying a default value for initial vapor temperatures using the NAMELIST data, the allowable input range is such that $273.15 \leq TV \leq 3000.0$.
NAMLST	2	TW HAS OUT-OF-RANGE VALUE	When specifying a default value for initial wall temperatures using the NAMELIST data, the allowable input range is such that $TW > 0.0$.

NAMLST	2	VL HAS OUT-OF-RANGE VALUE	When specifying a default value for initial liquid velocities using the NAMELIST data, the allowable input range is such that $\lvert VL \rvert < 1.0 \times 10^4$.
NAMLST	2	VV HAS OUT-OF-RANGE VALUE	When specifying a default value for initial vapor velocities using the NAMELIST data, the allowable input range is such that $\lvert VV \rvert < 1.0 \times 10^4$.
NPACTL	1	INSUFFICIENT CORE FOR PLOT DATA	There is insufficient memory for the INEL-NPA graphics data.
NXTCMP	2	CARD NO. XXXX SKIPPED – DATA FOR NEW COMPONENT OR END CARD EXPECTED.	When the component data were read, no new component or end-of-file was found after the completion of the current component data.
NXTCMP	1	END-OF-FILE REACHED WHEN SEARCHING FOR NEXT COMPONENT	When the data for a new component were read, an end-of-file was found.
OFFTKE	1	INVALID GEOMETRY FOR OFFTAKE MODEL	The geometry specified for the TEE component offtake model is invalid.
OUT1D	1	COMPONENT TYPE NOT RECOGNIZED	Invalid component type was encountered.
OUT3D	1	COMPONENT TYPE NOT RECOGNIZED	Invalid component type was encountered.
OUT3D	1	EXTRA ELEMENTS OUTSIDE BANDWIDTH	The number of matrix rows having nonzero elements outside the vessel-matrix bandwidth exceeds LDIM, the maximum dimension for the order of the capacitance matrix.
OUTER	4	FATAL ERROR	A fatal error occurred.
POST	1	COMPONENT TYPE NOT RECOGNIZED	Invalid component type was encountered.
POST3D	1	COMPONENT TYPE NOT RECOGNIZED	Invalid component type was encountered.
POST3D	1	EXTRA ELEMNTS OUTSIDE BANDWIDTH	The number of matrix rows having nonzero elements outside the vessel-matrix bandwidth exceeds LDIM, the maximum dimension for the order of the capacitance matrix.
POSTER	1	NO SCM SPACE FOR CYLHT	Insufficient SCM is available.

PRCINT	2	ABORTED BY CONTROLLER	The user aborted this run (interactive mode only). No cleanup is done.
PRCINT	2	INTERRUPTED – CONTINUED	The user continued the program after an interruption (interactive mode only).
PRCINT	−4	STOPPED BY REQUEST	The user stopped the run (interactive mode only). Run terminates normally.
PREFWD	1	SCM TO SMALL FOR SCRATCH ARRAYS	Insufficient memory exists for the temporary vectors used by subroutine PREFWD.
PREIFD	1	INSUFFICIENT SCM FOR SCRATCH VECTORS	Insufficient memory exists for the temporary vectors used by subroutine PREFWD.
PREINP	1,2	INPUT ERROR DETECTED IN TRACIN. CARD NUMBER XXXX	The free-format input-option preprocessor routine found an input error. Possible causes include a missing positive character (for example, I.O.E. 07), the omission of the first (format-option switch) card, or a simple typographical error. An immediate fatal error occurs if the first card is incorrect. In all other cases, a flag is set that stops execution after the entire deck is processed.
PREP1D	1	COMPONENT TYPE NOT RECOCNIZED	Invalid component type was encountered.
PREP3D	1	COMPONENT TYPE NOT RECOGNIZED	Invalid component type was encountered.
PREP3D	1	EXTRA ELEMENTS OUTSIDE BANDWIDTH	The number of matrix rows having nonzero elements outside the vessel-matrix bandwidth exceeds LDIM, the maximum dimension for the order of the capacitance matrix.
PTRSPL	1	INSUFFICIENT MEMORY FOR PLENUM POINTERS	Insufficient memory exists for the initializing the plenum pointers.
PUMPD	1	CANNOT LOCATE HEAD CUPVE	The PUMP regime is outside the database.
PUMPD	1	CANNOT LOCATE TORQUE CURVE	The PUMP regime is outside the database.
PUMPSR	1	ERROR IN ROUTINE PUMPX	An error was encountered when a pump head or torque was evaluated.

PUMPSR	1	INSUFFICIENT SCM SPACE	Insufficient SCM is available for PUMP since calculations.
PUMPSR	2	PUMP BELOW OMTEST	The pump speed has fallen below the pump-impeller rotational speed OMTEST specified by input.
PUMPSR	1	PUMP SPEED NOT FOUND	The signal-variable or control-block ID number NPMPSD that defines the initial pump speed directly could not be found in the signal-variable or control-block list of ID numbers.
R1MACH	1	I OUT OF BOUNDS	The number of machine constants (required for the determination of eigenvalues) should be at least 1 but should not exceed 5. This number is out of bounds.
RACCUM	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change dimension VLT in GENVLT.
RBREAK	2	ERROR IN TABLE SPECIFICATIONS	Incompatible BREAK options were selected.
RBREAK	2	IBTY INCONSISTENT WITH ISOLUT	A solute-concentration table cannot be used at a BREAK unless the solute-tracker flag (ISOLUT) is set to one.
RBREAK	2	PAIN MUST NOT BE GREATER THAN PIN	The air partial pressure at the BREAK may not exceed the total pressure at the BREAK.
RBREAK	2	SCM OVERFLOW	Insufficient SCM is available for this BREAK.
RBREAK	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change dimension VLT in GENVLT.
RCNTL	2	# OF SET PT. FAC. TABLES .GT. 25 DIM	The number of set-point factor tables is greater than the local dimension of array IFSP (25), which stores the set-point factor-table ID numbers.

RCNTL	2	# OF T.S.E. OR T.C.T. .GT. 25 DIM.	The number of trip-signal expressions or trip-controlled trips is greater than the local dimension of array ISEN (25) or ITCN (25). These arrays are used to store the signal ID numbers that are compared to the signal ID numbers in the input.
RCNTL	2	ABSCISSA VALUES NOT INCREASING	The control-block table independent variable must be in increasing order.
RCNTL	2	BAD CBLK TABLE STORAGE	The total number of control-block FNG1 table values exceeds the number of values specified by NTCF (Main-Control Card Number 5).
RCNTL	2	BAD SIG. EXP. OPERATOR	The arithmetic-operator ID number for a subexpression within the signal-expression definition has an invalid input value of less than one or greater than eight.
RCNTL	2	BAD TRIP # DEFINING T-C-T SIGNAL	When specifying the number of trip ID numbers whose ISET set-status values are summed or multiplied to evaluate the trip-controlled signal, the allowable input range is such that $2 \leq$ INTN ≤ 10.
RCNTL	2	BAD TRIP SIGNAL-RANGE TYPE VALUE	When specifying a signal-range type number using the trip-defining variable input, the allowable input values for ISRT are ±1, ±2, ±3, ±4, and ±5.
RCNTL	2	BAD TRIP ID DEFINITION	A trip ID has an absolute value that is 0 or greater than 9999.
RCNTL	2	INVALID TRIP SET STATUS DEFINED	The trip set-status variable ISET has an invalid input value.
RCNTL	2	SET POINT FACT.TAB. # PAIRS.GT.10	The set-point factor table has more than 10 data pairs.
RCNTL	2	SET PT.FAC.TABLE DIM. TOO SMALL	The number of set-point factor-table parameters is less than the storage allocated for such parameters by variable NTSF.

RCNTL	2	TRIP-CONTROL TRIP DIM. TOO SMALL	The number of trip-controlled trip-signal parameters is less than the storage allocated for such parameters by variable NTCT.
RCNTL	2	TRIPS DOING DUMPS DIM. TOO SMALL	The number of trip IDs that produce restart dumps is greater than the storage allocated for such parameters by variable NTDF.
RCNTL	2	TRIP SIGNAL EXP. DIM. TOO SMALL	The number of trip signal-expression parameters is greater than the storage allocated for such parameters by variable NTSE.
RCOMP	2	GRAV IS OUTSIDE RANGE (−1.0, 1.0)	When specifying a gravity term, the allowable input range is such that $-1 \leq GRAV \leq 1$.
RCOMP	2	ICFLG MUST BE .LE. 5	Only five sets of multipliers are allowed in the choked-flow model.
RCOMP	2	ICONC & ISOLUT ARE INCONSISTENT	Solute concentrations were entered before the ISOLUT option was selected.
RCOMP	2	INCONSISTENT VALUES FOR ICFLG	All nonzero values of ICFLG must the the same in a given component.
RCOMP	2	LCCFL MUST BE GE 0 AND LE NCCFL	When specifying the CCFL calculation for a component, the allowable input range is such that $0 \leq LCCFL \leq NCCFL$.
RCOMP	2	NEGATIVE FRIC. GE. −1.0E+20 NOT ALLOWED	An additive friction-factor of less than -10^{20} can be used to select the liquid-separator model. In all other cases, the additive friction factor must be positive.
RCOMP	2	NFF MUST BE 0, 1, −1, OR −100	The only NFF options in TRAC are 0, 1, −1, or −100.
RCOMP	2	PA MUST EQUAL 0 IF NOAIR = 1	If the NOAIR = 1 NAMELIST option was selected, then all noncondensable-gas partial pressures must be input as zeros.
RCOMP	2	PA MUST NOT BE GREATER THAN P	The noncondensable-gas partial pressure may not exceed the total pressure for a hydrodynamic cell.

RCPVEC	2	BAD LOOP COUNT GIVEN FOR CONTROL PANEL VECTOR	An incorrect number of reactor coolant loops was specified. The number must be 1, 2, 3, or 4.
RCPVEC	2	BAD LOOP NUMBER (XXXX), ASSUMED YYYY	The interactive-edit input specifies a loop that does not exist.
RDCOMP	1	COMPONENT TYPE NOT RECOGNIZED	An invalid component type was specified.
RDDIM	2	ILLEGAL PUMP CURVE OPTION	An illegal PUMP option was specified on PUMP Card Number 9.
RDREST	1	COMPONENT DATA NOT FOUND	Data for a specific component were not found in the input or the restart file.
RDREST	1	DUMP NOT FOUND ON RESTART FILE	The restart dump at the time specified in the input file is not in the restart file.
RDREST	1	FILE TRCRST DOES NOT EXIST	Component data were omitted from the input deck, and a restart dump file to initialize the missing components cannot be found.
RDREST	1	IELV FROM TRCRST AND TRACIN DIFFER	The cell-centered evelation options in the input and the restart-file data differ. The IELV parameter must be set either to ON or to OFF in both files.
RDREST	1	IKFAC FROM TRCRST AND TRACIN DIFFER	The K-factor options in the input and the restart-file data differ. The IKFAC parameter must be set either to ON or to OFF in both files.
RDREST	1	ISOLUT FROM TRCRST AND TRACIN DIFFER	The solute-tracking options in the input and the restart-file data differ. The ISOLUT parameter must be set either to ON or to OFF in both files.
RDREST	1	ITHD FROM TRCRST AND TRACIN DIFFER	The heat-structure heat-transfer diameter options in the input and the restart-file data differ. The ITHD parameter must be set either to ON or to OFF in both files.
RDREST	1	NDIA1 FROM TRCRST AND TRACIN DIFFER	The one-dimensional component heat-transfer diameter options in the input and the restart-file data differ. The NDIA1 parameter must be set either to ON or to OFF in both files.

RDREST	1	NEWRFD FROM TRCRST AND TRACIN DIFFER	The reflood model options in the input and the restart-file data differ. The NEWRFD parameter must be set either to ON or to OFF in both files.
RDREST	1	NFRC1 FROM TRCRST AND TRACIN DIFFER	The one-dimensional component forward and reverse form-loss coefficient options in the input and the restart-file data differ. The NFRC1 parameter must be set either to ON or to OFF in both files.
RDREST	1	NFRC3 FROM TRCRST AND TRACIN DIFFER	The three-dimensional component forward and reverse form-loss coefficient options in the input and the restart-file data differ. The NFRC3 parameter must be set either to ON or to OFF in both files.
RDREST	1	NO DUMPS ON FILE	Incomplete dumps are specified in the TRCRST file.
RDREST	1	INCOMPATIBLE RESTART FILE FORM	The restart file cannot be used with this TRAC version.
RDREST	1	RESTART FILE HAS OPENING ERROR	An I/O error occurred when the restart file was opened.
RDREST	1	TYPE NOT RECOGNIZED IN RESTART	An invalid component type was specified.
REACCM	2	POINTER TABLE MISMATCH	The accumulator (ACCUM) pointer table does not match the restart-file data.
READI	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	The number of integer variables specified on an input card must not exceed 5.
READI	2	INPUT ERROR ON CARD NO. XXXX – ENCOUNTERED UNEXPECTED LOAD DATA	A load operation was found when integer data in I14 format were read.
READI	2	INPUT ERROR– NEW COMPONENT OR END ENCOUNTERED UNEXPECTEDLY CARD NO. XXXX	Data for a new component were found before all of the data for the current component were read.
READI	2	INPUT ERROR ON CARD NO. XXXX – REAL DATA ENCOUNTERED IN INTEGER FIELD	Real data were found when integer data in I14 format were read.

READI	2	INPUT ERROR – UNEXPECTED NAMELIST DATA ENCOUNTERED	When integer data in I14 format were read, NAMELIST data were found.
READI	2	REPEAT LEVEL CARD MISPLACED	A repeat-level card was found when integer data in I14 format were read.
READI	1	UNEXPECTED END-OF-FILE REACHED	An end-of-file was found when integer data in I14 format were read.
READR	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	The number of real variables specified on an input card must not exceed 5.
READR	2	INPUT ERROR– NEW COMPONENT OR END ENCOUNTERED UNEXPECTEDLY CARD NO. XXXX	Data for a new component were found before all of the data for the current component were read.
READR	2	INPUT ERROR ON CARD NO. XXXX – ENCOUNTERED UNEXPECTED LOAD DATA	A load operation was found when reading nonarray real data in E14.6 format.
READR	2	INPUT ERROR – UNEXPECTED NAMELIST DATA ENCOUNTERED	When reading real data in E14.6 format, NAMELIST data were found.
READR	2	REPEAT LEVEL CARD MISPLACED	A REPEAT LEVEL card was found when reading real data in E14.6 format.
READR	1	UNEXPECTED END-OF-FILE REACHED	An end-of-file was found when reading real data in E14.6 format.
REBRK	1	FATAL ERROR	An error stopped the processing of the input data.
REBRK	2	LCM OVERFLOW	Insufficient LCM is available for the BREAK data from the restart file.
REBRK	2	POINTER TABLE MISMATCH	The BREAK pointer table does not match the restart-file data.
REBRK	2	SCM OVERFLOW	Insufficient SCM is available for the BREAK data from the restart file.
RECNTL	1	CONTROL BLOCKS EXCEED DIMENSION	The amount of control-block data in the input and the restart files exceeds its storage allocation on Main-Control Card 5.

RECNTL	1	CONTROL PARA. STORAGE TOO SMALL	The variable storage that was allocated by the input data for the signal variables, control blocks, and trips is too small to contain the remaining data from the restart file.
RECNTL	1	NUMBER TRIPS EXCEEDS DIMENSION	The number of trips with different ID numbers from the input and the restart files exceeds the input data-storage dimension.
RECNTL	1	SET-PT-FACTOR TABLES EXCEED DIM	The number of different setpoint point factor-table ID numbers in the input and the restart files exceeds the input data-storage dimension.
RECNTL	1	SIG. VARIABLES EXCEED DIMENSION	The number of signal variables with different ID numbers in the input and the restart files exceeds the input data-storage dimension.
RECNTL	1	TIME STEP DATA EXCEED DIMENSION	The number of trip-controlled time-step data sets with different ID numbers in the input and the restart files exceeds the input data-storage dimension.
RECNTL	1	TOO MANY DMP TRIPS FROM RESTART	The number of trip ID numbers in the input and the restart files exceeds the input data-storage dimension. These trip ID numbers when set to ON generate restart dumps.
RECNTL	1	TOO MANY SETPOINT-FACTOR TABLES	The number of set-point factor tables in the restart file exceeds the input data-storage dimension.
RECNTL	1	TOO MANY SP. TIME-STEP DATA SETS	The number of trip-controlled time-step data sets in the restart file exceeds the input data-storage dimension.
RECNTL	1	TOO MANY TRIPS GENERATING DUMPS	The number of trip ID numbers in the restart file exceeds the input data-storage dimension. These trip ID numbers when set to ON generate restart dumps.
RECNTL	1	TRIP-SIGNAL EXPS. EXCEED DIMEN.	The number of signal-expression ID numbers in the input and the restart files exceeds the input data-storage dimension.

RECNTL	1	TRP-CONT-TRP SIGNALS EXCEED DIM.	The number of trip-controlled trip ID numbers with different ID numbers in the input and the restart files exceeds the input data-storage dimension.
REFILL	1	FATAL ERROR	An error stopped the processing of the input data.
REFILL	2	LCM OVERFLOW	Insufficient LCM is available for the FILL data from the restart file.
REFILL	2	POINTER TABLE MISMATCH	The FILL pointer table does not match the restart-file data.
REFILL	2	SCM OVERFLOW	Insufficient SCM is available for this FILL.
REHTST	2	POINTER TABLE SIZE HAS MISMATCH	The HTSTR pointer table does not match the restart-file data.
REPIPE	2	POINTER TABLE MISMATCH	The PIPE pointer table does not match the restart-file data.
REPLEN	2	POINTER TABLE MISMATCH	The PLENUM pointer table does not match the restart-file data.
REPRZR	2	POINTER TABLE MISMATCH	The pressurizer (PRIZER) pointer table does not match the restart-file data.
REPUMP	2	POINTER TABLE MISMATCH	The PUMP pointer table does not match the restart-file data.
RETEE	2	POINTER TABLE MISMATCH	The TEE pointer table does not match the restart-file data.
RETURB	2	POINTER TABLE MISMATCH	The restart pointers do not match the original pointers. Probably a newer code version with updated pointers was used for the restart, whereas an older version was used for the previous run.
REVLVE	2	POINTER TABLE MISMATCH	The VALVE pointer table does not match the restart-file data.
REVSSL	2	POINTER TABLE MISMATCH	The VESSEL pointer table does not match the restart-file data.
REVSSL	2	PROBLEM TOO LARGE	The problem being modelled is too large for the current TRAC parameter statements.
RFDBK	1	CORE NZ+1000 INTERFACE NOT FOUND	The hydro-cell interface NZ in the powered-core region could not be located in the A(LIDHT) array.

RFILL	2	BAD FILL TYPE OPTION	An illegal FILL option was specified on FILL Card Number 2.
RFILL	2	BAD TRIP ID DEFINITION	An incorrect trip ID of −1, < −9999, or > 9999 was specified.
RFILL	2	IFSV = 0 WHEN IFTY.GT.3	A FILL table, based on IFTY > 4, cannot be defined because no table independent-variable ID number was specified.
RFILL	2	INCONSISTENT INIT AND TABLE FLOW	The initial values for the FILL table and for the FILL initial state are not equal.
RFILL	2	PAIN MUST NOT BE GREATER THAN PIN	The noncondensable-gas partial pressure is greater than the total pressure in a FILL.
RFILL	2	SCM OVERFLOW	Insufficient SCM is available for the FILL data from the input file.
RFILL	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RHTSTR	2	DIMENSION NRFMX .LT. NODES	Maximum number of radial heat conduction nodes has been exceeded. Either the TRAC parameter NRFMX must be increased or NODES must be decreased.
RHTSTR	2	DIMENSION NZFMX .LT. NCRZ+1	Maximum number of axial heat conduction nodes has been exceeded. Either the TRAC parameter NZFMX must be increased or NCRZ and/or NZMAX must be decreased.
RHTSTR	2	EITHER IDBCI OR IDBCO MUST BE 2	Either the inner surface or the outer surface of the heat structure must have a boundary condition coupled to specified cells in one or more hydro components.
RHTSTR	2	FISPHI CANNOT BE .LT. ZERO	The number of fissions per initial fissile atom must be positive in value.
RHTSTR	2	GRAV IS OUTSIDE RANGE (−1.0, 1.0)	When specifying a gravity term, the allowable input range is such that $-1 \leq GRAV \leq 1$.

RHTSTR	2	HDRI MUST BE GREATER THAN ZERO	The thermal diameter for the inner surface of the heat-structure rod or slab must be greater than 0.0 m.
RHTSTR	2	HDRO MUST BE GREATER THAN ZERO	The thermal diameter for the outer surface of the heat-structure rod or slab must be greater than 0.0 m.
RHTSTR	2	HOT PATCHES ALLOWED IN ONLY ONE SLAB	Hot patch modelling is allowed in only one slab at this time.
RHTSTR	1	INSUFFICIENT MEMORY TO CONTINUE INPUT PROCESSING	Insufficient memory exists to continue input processing.
RHTSTR	2	IRFTR MUST .NE. 0 TO MODEL HOT PATCHES	Hot patch modelling requires the axial fine-mesh option to be selected.
RHTSTR	2	NEWRFD MUST = 1 TO MODEL HOT PATCHES	Hot patch modelling requires the new reflood model option to be selected.
RHTSTR	2	NHCELI(K) NOT INCREASING	The hydro cell numbers to which a heat-structure node is connected must be increasing in value.
RHTSTR	2	NHCELO(K) NOT INCREASING	The hydro cell numbers to which a heat-structure node is connected must be increasing in value.
RHTSTR	1	NOT ENOUGH MEMORY FOR A(LRFTN)	Insufficient memory exists to load the heat-structure temperature array.
RHTSTR	2	NZMAX .LT. NCRZ+1 +SUM(NFAX(I))	The maximum number of rows of nodes in the axial direction must be greater than the sum of all the fine-mesh and coarse-mesh nodes.
RHTSTR	2	Q235 CANNOT BE .LE. TO ZERO	The energy per fission from U^{235} must be positive.
RHTSTR	2	Q238 CANNOT BE .LE. TO ZERO	The energy per fission from U^{238} must be positive.
RHTSTR	2	Q239 CANNOT BE .LE. TO ZERO	The energy per fission from Pu^{239} must be positive.
RHTSTR	2	QAVG CANNOT BE .LE. TO ZERO	The average energy per fission must be positive.
RHTSTR	2	R239PF CANNOT BE .LE. TO ZERO	The atoms of U^{239} produced per fission must be positive.
RHTSTR	2	RANS CANNOT BE .LE. TO ZERO	The multiplier applied to the ANS79 decay heat must be positive.

RHTSTR	2	ROD RADII NOT MONO. INCREASING	Indicates input values for which RADRD(I+1) < RADRD(I).
RHTSTR	2	VLT SIZE EXCEEDS ITS LIMIT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RHTSTR	^	Z(K) NOT MONOTONIC	The axial location of heat-transfer nodes must be monotonically increasing in value along the length of the heat structure.
RKIN	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	An invalid value for IRPWTY has occurred.
RODHT	1	SINGULAR MATRIX IN BANSOL	An error has occurred within subroutine BANSOL during the solut'·· for the new heat-structure temperatures.
RPIPE	2	INCONSISTENT INIT & TABLE POWER	The initial values for the PIPE power-to-fluid table POWTB and for the PIPE power-to-fluid variable POWIN are not equal.
RPIPE	2	INCC:ISISTENT INIT & TABLE QPPPF	The initial values for the PIPE power-to-wall table QP3TB and for the PIPE power-to-wall variable QP3IN are not equal.
RPIPE	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RPLEN	2	ICONC & ISOLUT ARE INCONSISTENT	Solute concentrations were entered before the ISOLUT option was selected.
RPLEN	1	JUNS1 AND JUNS2 INCOMPATIBLE	The number of junctions on each side of the plenum cell should be either 0 or positive in value.
RPLEN	1	NPLJN .LE. JUNS1	The number of side 1 junctions must be less than the total number of plenum-component junctions.
RPLEN	1	NPLJN .LE. JUNS2	The number of side 2 junctions must be less than the total number of plenum-component junctions.

RPLEN	2	PA MUST NOT BE GREATER THAN P	The noncondensable-gas partial pressure may not exceed the total pressure for a hydrodynamic cell.
RPLEN	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RPRIZR	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RPUMP	2	BAD TRIP ID DEFINITION	An incorrect trip ID of −1, < −9999, or >9999 was specified.
RPUMP	2	FRIC(2) .NE. 0.	The value for FRIC(2) must be 0.0 in the PUMP.
RPUMP	2	INCONSISTENT INIT & TABLE QPPPF	The initial values for the power-to-wall table QP3TB and for the power-to-wall variable QP3IN are not equal.
RPUMP	2	INCONSISTENT INIT & TABLE SPEED	The initial values for the PUMP-speed table and for the PUMP speed are not equal.
RPUMP	2	IPMPSV.NE.0	The independent-variable ID number for the PUMP-speed table should not be defined for PUMP-type 2.
RPUMP	2	NCELLS.LT.2	An incorrect number of PIPE fluid cells was specified. The PIPE must have at least two fluid cells.
RPUMP	2	NPMPRF.NE.0	The number of the rate-factor table's entry pairs should be zero for PUMP-type 2.
RPUMP	2	NPMPSV.NE.O	The independent-variable ID number for the rate-factor table assigned to the PUMP-speed table should not be defined for PUMP-type 2.
RPUMP	2	NPMPTB.NE.0	The number of the PUMP-speed table's entry pairs should be zero for PUMP-type 2.
RPUMP	2	PUMP TYPE NOT RECOGNIZED	An incorrect PUMP type was specified.
RPUMP	2	QPPP-F TABLE PARAM. BAD	The power-to-wall table QP3TB is defined but its independent-variable ID number is zero.

RPUMP	2	SPEED TABLE PARAM. BAD	The signal-variable ID number for the rotational-speed-table's independent variable for PUMP-type 1 is invalid. The PUMP-type variable IPMPTY must be either 1 or 2.
RPUMP	2	TYPE 0 PUMP MUST HAVE A SPEED CONTROLER	The ID number of the signal-variable parameter or control-block parameter (NPMPSD) that defines the pump-impeller rotational speed initially when the controlling trip is OFF is invalid for a type 0 pump (IMPMTY = 0).
RPUMP	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RROD1	2	BAD TRIP ID DEFINITION	The trip ID number must be greater than zero but less than 10,000.
RROD1	2	INCONSISTENT REACT-POWER TABLE	The independent variable for the reactivity-power table (IRPWSV) must be specified when IRPWTY = 3, 4, 7, 13, 14, or 17.
RROD1	2	INCONSISTENT REACT-POWER TRIP	The trip ID number that controls the evaluation of the reactivity-power table (IRPWTR) must be specified when IRPWTY = 3, 4, 7, 13, 14, or 17.
RROD1	2	INVALID REACT-POWER TYPE OPTION	When specifying the neutronic point-kinetics or reactor-power option, the allowable input range for IRPWTY is such that $1 \leq$ IRPWTY ≤ 8 or $11 \leq$ IRPWTY ≤ 18.
RROD1	2	NOT ENOUGH FUEL RODS	The total number of rods or slabs defined by NRODS cannot be less than the number of different average (power) rods or slabs defined by NCRX.

RROD2	2	BAD ENTRY IN FP235/ FP239 TABLE	When specifying the fractions of fission power associated with U^{235} and U^{239} fission, the allowable input range for FP235 and FP239 is such that $0.0 \leq FP235 \leq 1.0$ and $0.0 \leq FP239 \leq 1.0$. In addition, it is assumed that $FP235 + FP239 + FP238 = 1.0$.
RROD2	2	FTD MUST BE .GT. 0.00 BUT .LE. 1.00	When specifying the fraction of theoretical fuel density, the allowable input range is such that $0.0 < FTD \leq 1.0$.
RROD2	2	INCONSISTENT HEATED LENGTHS	The total length for the independent variable for the axial power profile must equal the length of the heat structure.
RROD2	2	INIT & TABLE REACT-POWER UNEQUAL	The initial value of power/reactivity must be the same as the interpolated table value.
RROD2	2	NOT ENOUGH TEMPORARY STORAGE TO LOAD FP239 ARRAY. DECREASE NHIST.	Insufficient temporary storage exists to load the FP239 data. NHIST must be decreased.
RROD2	2	NOT ENOUGH TEMPORARY STORAGE TO LOAD PHIST ARRAY. DECREASE NHIST.	Insufficient temporary storage exists to load the PHIST data. NHIST must be decreased.
RROD2	2	ZPWZT(K) NOT MONOTONIC	The axial locations along the heat structure at which axial-power shape relative power densitites are defined must increase monotonically.
RSTGEN	2	GEN. H.T. IDI .EQ. IDO	The same fluid volume was specified for both sides of the same heat-transfer surface in the steam generator.
RSTGEN	2	H.T. I.D. ERROR	The component number (ICMP or OCMP) for a heat-transfer surface in the steam generator is incorrect.
RSTGEN	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	The computed GO TO index does not have a valid value of 1, 2, or 3.
RSTGEN	2	INCONSISTENT VALUES FOR ICFLG	All nonzero values of ICFLG must the the same in a given component.

RSTGEN	1	INT. JUNCTION ERROR	The number of secondary-side connections was found to be greater than NSJUN.
RSTGEN	2	NODES .LT. 1 NOT ALLOWED	A STGEN (steam generator) must have at least one radial heat-transfer node in the tube walls.
RSTGEN	2	NODES .NE. NDHT	The number of nodes in the steam-generator tubes and in the additional heat-transfer surfaces must be equal.
RSTGEN	1	NO. EXT. JUN. .LT. 2	The number of external junctions on the steam-generator secondary side is incorrect. The number must be two or more.
RSTGEN	2	NSCMP ERROR	The number of secondary internal components is incorrect; the limits are $1 \leq NSCMP \leq 10$.
RSTGEN	2	TYPE ERROR	The secondary component is not a PIPE or TEE.
RSTGEN	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RSTGEN	2	WALL AREA, WALL RADIUS ERROR	Either the steam-generator tube primary-side inner and/or secondary-side outer wall surface area is negative or the tube inner radius is not positive in value.
RSTGEN	2	WALL AREAS INCONSISTENT	The internal and external wall areas for generalized heat transfer are inconsistent with cylindrical geometry; thus, the energy will be calculated incorrectly in the wall-conduction calculation.
RTEE	1	ICBS1 & ICBS2 MUST BE <0	When modelling a separator component (SEPD), the control-block ID numbers that define carryover and carryunder must be negative.
RTEE	2	IENTRN MUST BE 1 TO INVOKE OFFTAKE MODEL	When specifying the offtake model option, the allowable input values for IENTRN are 0 and 1.

RTEE	2	INCONSISTENT INIT & TABLE POWER1	The TEE primary-side initial values for the power-to-fluid table POWTB and for the power-to-fluid variable PWIN1 are not equal.
RTEE	2	INCONSISTENT INIT & TABLE POWER2	The TEE secondary-side initial values for the power-to-fluid table POWTB and for the power-to-fluid variable PWIN2 are not equal.
RTEE	2	INCONSISTENT INIT & TABLE QPPPF1	The TEE primary-side initial values for the power-to-wall table QP3TB and for the power-to-wall variable QPIN1 are not equal.
RTEE	2	INCONSISTENT INIT & TABLE QPPPF2	The TEE secondary-side initial values for the power-to-wall table QP3TB and for the power-to-wall variable QPIN2 are not equal.
RTEE	2	INCONSISTENT VALUES FOR ICFLG	All nonzero values of ICFLG must the the same in a given component.
RTEE	1	INVALID VALUE OF ISTAGE	When modelling a separator component (SEPD), the allowable input values for the separator-type option ISTAGE are −3, −2, 0, 1, 2, and 3.
RTEE	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RTURB	2	#STAGES.LT.1	A TURB (turbine) must have at least one stage.
RTURB	2	INCONSISTENT INIT AND TABLE GEN POWER	The turbine power table's initial power and the initial operating power POWOP have different values.
RTURB	2	NCELLS.LT.3	The number of cells in the TURB component is incorrect; this component must have at least three cells.
RTURB	2	POWER TABLE PARAM. BAD	Direct power into the coolant table is defined, but its independent-variable ID number is zero.
RTURB	2	STAGE DESIGN PRESSURE RATIO .GT. 1.0	The stage downstream design pressure specified in input (PRES2) must be greater than the stage upstream design pressure specified in input (PRES1).

RTURB	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	Instructions were given in the TRCOUT file to increase LENDIM in BLKDAT and to change the dimension in GENVLT.
RVLVE	2	BAD FIRST VALVE TABLE	A second VALVE table is defined, but a first VALVE table is not defined.
RVLVE	2	BAD QPPPF TABLE SIGNAL	The QPPP-factor table is defined, but its independent-variable ID is zero.
RVLVE	2	BAD OVERRIDING TRIP VALVE ADJUST RATE	The overriding trip's VALVE adjustment rate is negative.
RVLVE	2	BAD OVERRIDING TRIP VALVE RANGE	The overriding trip's minimum and maximum VALVE closure states do not lie between 0 and 1.
RVLVE	2	BAD OV TRIP VALVE TYPE	An overriding trip is defined, but its VALVE type IVTYOV is not 0 or 1.
RVLVE	2	BAD TRIP ID DEFINITION	The trip ID number is greater than the maximum allowed value of 9999.
RVLVE	2	BAD VALVE TABLE DEFINE	The number of pair entries in the first VALVE table is inconsistent with the VALVE option IVTY value.
RVLVE	2	BAD VALVE TABLE MAX ADJUST RATE	The VALVE's maximum adjustment rate is negative.
RVLVE	2	BAD VALVE TABLE SIGNAL	The signal-variable ID number defining the VALVE table's independent variable is inconsistent with the VALVE option IVTY value.
RVLVE	2	BAD VALVE TABLE TRIP	A nonzero trip ID number is input when the VALVE type option indicates no trip control, or a zero trip ID number is input when the VALVE is to be trip controlled.
RVLVE	2	BAD VALVE TYPE OPTION	The VALVE option parameter IVTY has an input value outside the 0 to 6 defined range.
RVLVE	2	FAVLVE & XPOS INVALID	The input values of FAVLVE and XPOS are both outside their 0 to 1 physical range.

RVLVE	2	INCONSISTENT INIT & FIRST TABLE	The first VALVE table's initial value and the initial VALVE closure state (FAVLVE or XPOS) have different values.
RVLVE	2	INCONSISTENT INIT & SECOND TABLE	The second VALVE table's initial value and the initial VALVE closure state (FAVLVE or XPOS) have different values.
RVLVE	2	INCONSISTENT INIT & TABLE QPPPF	The QPPP-factor table's initial value and the initial QPPP factor QFPIN have different values.
RVLVE	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	In the TRCOUT file instructions are given to increase LENDIM in BLKDAT and change the dimension in GENVLT.
RVSSL	2	CORE ENTIRELY BLOCKED	The core-region flow area in the axial direction is zero at a VESSEL level causing axial-flow blockage through the core.
RVSSL	1	I/0 ERROR	An error occurred in a read routine while looking for a repeat card.
RVSSL	2	ICONC & ISOLUT ARE INCONSISTENT	The input values for ICONC and ISOLUT are not consistent with each other.
RVSSL	2	ILLEGAL REPEAT LEVEL NUMBER USED	An illegal level number was read from a REPEAT LEVEL card.
RVSSL	1	ILLEGAL VALUE FOR IVSSBF	The only allowed values for IVSSBF are 0, 2, 20, and 22.
RVSSL	2	INCONSISTENT CORE DEFINING DATA	Indicates either NASX $<$ IDCU or NRSX $<$ IDCR or IDCL $\geq$ IDCU when a downcomer region is present (IDCU $\neq 0$, IDCL $\neq 0$, IDCR $\neq 0$).
RVSSL	2	INCONSISTENT CORE DIM PARAMETERS	The core-region model parameters ICRU, ICRL, ICRR, NODES, NCRX, and NCRZ are defined inconsistently.
RVSSL	2	INCONSISTENT LEVEL ELEVATIONS	Indicates input values for which $Z_{i+1} \leq Z_i$.
RVSSL	2	INCONSISTENT RING RADII	Indicates input values for which $r_{i+1} \leq r_i$.
RVSSL	2	INCONSISTENT THETA ANGLES	Indicates input values for which $\theta_{i+1} \leq \theta_i$.

RVSSL	1	INSUFFICIENT MEMORY TO CONTINUE INPUT PROCESSING	Insufficient memory exists to load the VESSEL input data.
RVSSL	2	LAST THETA ANGLE IS INCORRECT	When specifying the last θ angle, the allowable input values for TH(NTSX) are 30, 45, 60, 90, 120, 180, or 360 degrees.
RVSSL	2	NEWRFD MUST = 1 TO MODEL SPACER GRIDS	In order to model spacer grids within the VESSEL core region, the new reflood model must also be selected.
RVSSL	2	NSGRID MUST BE .GE. 0	The number of spacer grids in the VESSEL core region cannot be negative.
RVSSL	2	PAN MUST EQUAL 0 IF NOAIR = 1	If the NOAIR = 1 NAMELIST option was selected, then all noncondensable-gas partial pressures must be input as zeros.
RVSSL	2	PAN MUST NOT BE GREATER THAN PN	The noncondensable-gas partial pressure is greater than the total pressure in a cell of a VESSEL level.
RVSSL	2	PROBLEM TOO LARGE	The VESSEL dimensions are larger than the maximum allowed by the TRAC parameters NXRMX, NYTMX, and NZMX. These parameters must be increased or the VESSEL size reduced.
RVSSL	1	UNEXPECTED END-OF-FILE REACHED WHILE READING VESSEL LEVEL DATA	An end-of-file was encountered while reading VESSEL level data.
RVSSL	2	VLT EXCEEDS ITS LIMIT-SEE TRCOUT	In the TRCOUT file, instructions are given to increase LENDIM in BLKDAT and change the dimension in GENVLT.
SCLMOM	2	INCONSISTENT BD FLW-AREA RATIOS	The ratio of the interface flow area to its adjacent internal mesh-cell flow area at the VESSEL-component outer-wall boundary does not have its value defined the same as the ratio for the interface one mesh-cell distance outside the wall boundary. These values must be equal and positive when an internal boundary condition is defined.

SCMLCM	2	SCM OVERFLOW	Insufficient SCM is available for reading in component array data.
SETCMP	2	CONTAINMENT MODULE NOT IMPLEMENTED	A control-panel vector input record has specified a CTAIN (containment) component.
SETCMP	2	INVALID COMPONENT TYPE – AAAA	The component type selected as part of the control-panel vector could not be found.
SETCMP	2	PARAMETER XXXX IS INVALID FOR AAAA	The parameter selected as part of the control-panel vector is not valid.
SETCMP	2	TURBINE MODULE NOT IMPLEMENTED	This version of the interactive facility does allow use of the TURB (turbine) component in control-panel vector input.
SETCPV	1	SPECIFICATION ERRORS FORCE TERMINATION	An error has been discerned while control-panel vector input records were processed. A flag is set so TRAC will halt after all input-data records have been processed.
SETLCM	1,2	A-ARRAY OVERFLOW (CALLED BY SUBPROGRAM AAAA)	A subroutine of TRAC has requested more memory than is available.
SETLCM	1,2	CANNOT EXPAND MEMORY (CALLED BY SUBPROGRAM AAAA)	A subroutine of TRAC has requested more memory than is available.
SGEEV	1	JOB.NE. 0, AND N .GT. LDV	The user has requested eigenvector calculation in addition to the eigenvalues. However, the leading dimension of the array V, where eigenvectors are stored, is less than the order of the input matrix A.
SCEEV	2	LDA. GT.LDV, ELEMENTS OF A OTHER THAN N BY N INPUT ELEMENTS HAVE BEEN CHANGED.	The leading dimension of array V, where eigenvectors are stored, should be equal [illegible] the order of the input matrix A. If this is [illegible] the case, the elements of A are rearranged.
SGEEV	2	LDA. LT.LDV, ELEMENTS OF V OTHER THAN THE THE N BY N OUTPUT ELEMENTS HAVE BEEN CHANGED.	The leading dimension of array V, where eigenvectors are stored, should be equal to the order of the input matrix A. If this is not the case, the elements of A are rearranged.

SGEEV	1	N .GT. LDA	The order of the input matrix A exceeds the leading dimension of A.
SGEEV	1	N .LT. 1	The order of the input matrix A is less than 1.
SOUND	2	CANNOT CONVERGE FOR MAXIMUM VAPOR FLOW	The iterative solution, for determining the choking point by iterating on the cell-edge pressure while maximizing the mass flux, did not converge.
SOUND	2	CANNOT CONVERGE ON PAIR AT THE CELL EDGE	Cannot converge on the non-condensable condensable gas partial pressure while the conditions at the cell edge are estimated from the cell-center values.
SOUND	2	CANNOT FIND POSITIVE FLOW PRESSURE	When the flow is maximized by iteration of the cell-edge pressure, no physically realistic pressure value gives positive flow. This should never happen except under some extreme nonequilibrium conditions.
SOUND	2	CANNOT FIND THE EQUILIBRIUM CONDITION	Calculating the thermodynamic equilibrium condition in the presence of a noncondensable requires an iterative type solution, which did not converge.
SOUND	2	CANNOT FIND THE MAXIMUM FLOW POINT	When the flow is maximized by iteration of the cell-edge pressure, the decrease in pressure (down to physically realistic values) always keeps increasing the flow. Thus, the choking condition is never determined.
SOUND	2	CANNOT LOCATE SATURATION LINE	Saturation conditions could not be found corresponding to an isentropic expansion from the cell center to the choking plane.
SOUND	2	SOUND SPEED SOLUTION DID NOT CONVERGE	The iterative solution, for determining the choking point by iterating on the cell-edge pressure while maximizing the mass flux, did not converge.
SRCHCL	2	COMPONENT XXXX NOT IN COMPONENT LIST	The component number XXXX specified on a central panel vector input card is not in the component list (interactive only).

SRCHMDT	2	CATEGORY AAAA NOT FOUND	The requested component type was not found in the NPA Master Dictionary.
SRTLP	1	SRTLP FAILURE	SRTLP failed because of errors in component input data related to junction numbers. See file TRCOUT for additional clues.
STEADY	1	FAVOL CHANGE TOO LARGE	The change in volume-averaged flow area across an interface was found to be too large without requiring a form loss at that interface.
STEADY	−2	STEADY-STATE SOLUTION NOT CONVERGED	The problem did not reach a steady state within the specified time domains.
STGN3X	1	INSUFFICIENT SPACE FOR CYLHT	Insufficient SCM is available.
STINIT	2	INVALID COMPONENT FOR AAAA	The requested component number was not in the component list.
STINIT	2	INVALID COMPONENT TYPE AAAA FOR BBBB	The requested component type was not found in the component type list (ITYTAB).
STINIT	2	UNABLE TO LOCATE VARIABLE AAAA IN MASTER DICTIONARY	A variable that was requested by the NPA interface could not be located in the Master Dictionary.
SVSET	1	TRIP ID NOT FOUND	The trip ID number assigned to a signal variable defining the trip-signal or set-status value could not be found in the list of trip ID numbers.
SVSET1	1	ILLEGAL INDEX IN COMPUTED GO TO	The computed GO TO index based on the signal-variable parameter ISVN does not have a valid value.
SVSET1	1	INVALID SIG.-VAR. PARAM. NUMBER	The signal-variable parameter ISVN does not have a valid value based on definable parameters for a one-dimensional hydro component.
SVSET3	1	ILLEGAL INDEX IN COMPUTED GO TO	The computed GO TO index based on the signal-variable parameter ISVN does not have a valid value.
SVSET3	1	INVALID SIG.-VAR. PARAM. NUMBER	The signal-variable parameter ISVN does not have a valid value based on definable parameters for a three-dimensional vessel component.

SVSET3	1	TOO FEW LEVELS DIMENSIONED FOR	A vessel component has more than 50 levels and arrays VOLLEV and DZLEV are dimensioned in subroutine SVSET3 for a maximum of 50.
SVSETH	1	ILLEGAL INDEX IN COMPUTED GO TO	The computed GO TO index based on the signal-variable parameter ISVN does not have a valid value.
[illegible]H	1	INVALID SIG.-VAR. PARAM. NUMBER	The signal-variable number ISVN does not have a valid value based on definable parameters for a heat-structure component.
SVS[illegible]	1	NO POWER IN THIS HEAT STRUCTURE	The signal variable parameter reactor power (ISVN = 18) or reactor period (ISVN = 19) cannot be defined for a nonpowered (NOPWR = 1) heat-structure component.
[illegible]	1	CNRL. BLOCK NOT FOUND	The control block specified as part of the separator model could not be found.
[illegible]	1	NEED .GE. 2 CONTROL BLOCKS	At least two control blocks are needed for the separator model.
TF3DS	1	NMS=10 IN PARSET1 IS TOO SMALL	The number of source connections to a single three-dimensional vessel cell has exceeded 10. The parameter NMS must be increased.
THERMO	2	LIQUID TEMP LIMIT EXCEEDED	The liquid temperature in some cell has fallen below 273.15 K or has risen above 713.94 K
THERMO	2	PRESSURE LIMIT EXCEEDED	The pressure in some cell has fallen below 1.0 Pa or risen above 45 $\times 10^6$ Pa.
THERMO	2	VAPOR TEMP LIMIT EXCEEDED	The vapor temperature in some cell has fallen below 273.15 K or risen above 3000 K.
TIMCHK	2	TERMINATING DUE TO TIME LIMIT	The CPU time limit was reached before the end of the problem.
TIMSTP	4	CANNOT REDUCE TIME STEP FURTHER	The time step was reduced to the minimum allowed, and the outer iteration failed to converge.
TRAC	2	THIS EXECUTABLE HAS MEMORY PRESET TO ZERO	Los Alamos recommends that memory be preset to negative indefinite.

TRANS	1	FAVOL CHANGE TOO LARGE	The change in volume-averaged flow area across an interface was found to be too large without requiring a form loss at that interface.
TRIP	1	INVALID TRIP ID NUMBER	The set status of a requested trip ID number is undefined.
TRIPS	1	UNDEFINED INTERACTIVE CONTROL BLOCK	The control block defined in the NPA interactive commands could not be found.
TRPSET	1	CNTL BLOCK NOT FOUND	A control-block ID number that defines a subexpression argument value for the trip signal could not be found in the list of control-block ID numbers.
TRPSET	1	CNTL SIGNAL NOT FOUND	A control-block ID number that defines the trip signal could not be found in the list of control-block ID numbers.
TRPSET	1	EXP. SIGNAL NOT FOUND	A signal-variable ID number that defines a subexpression argument value for the trip signal could not be found in the list of signal-variable ID numbers.
TRPSET	1	ILLEGAL INDEX IN COMPUTED GO TO STATEMENT	An incorrect value was assigned to the trip signal-expression variable ISE. This will only occur if there is a coding error.
TRPSET	1	SET-P-FACTOR TABLE ID NOT FOUND	The set-point-factor table's ID number was not found in the list of set point-factor table ID numbers.
TRPSET	1	SIGNAL EXP. NOT FOUND	A signal-expression ID number that defines the trip signal could not be found in the list of signal-expression ID numbers.
TRPSET	1	S-P-FAC TABLE CON BLK NOT FOUND	The control-block ID number that defines the set point-factor table's independent variable was not found in the list of control-block ID numbers.
TRPSET	1	S-P-FAC TABLE SIG VAR NOT FOUND	The signal-variable ID number that defines the set-point-factor table's independent variable was not found in the list of signal-variable ID numbers.

TRPSET	2	TOO MANY PENDING ISET CHANGES	There are too many delay time pending set-status changes for a trip.
TRPSET	1	TRIP-CONT-TRIP SIGNAL NOT FOUND	The trip-controlled trip signal ID number that defines the trip-controlled trip signal could not be found in the list of trip-controlled trip-signal ID numbers.
TRPSET	1	TRIP ID NO. NOT FOUND	The trip ID number used to define the trip-controlled trip signal could not be foun
TRPSET	1	TRIP SIGNAL NOT FOUND	A signal-variab... ID number that defines the trip signal could not be found in the list of signal-variable ID numbers.
VLVEX	2	TURBINE CANNOT MEET POWER DEMAND	The turbine has been overloaded so much that with the governing valve fully open, it still cannot meet the power demand. This situation could sometimes temporarily occur under highly transient conditions when the steam flow through the turbine has not caught up with the power demand.
VSSL1	1	VENT VALVE TABLE LOOKUP ERROR	An error was encountered while trying to interpolate in the vent valve table.
VSSL2	[illegible]	EXTRA ELEMENTS OUTSIDE BANDWIDTH	The number of matrix rows having nonzero elements outside the vessel-matrix bandwidth exceeds LDIM, the maximum dimension for the order of the capacitance matrix.

APPENDIX H

UPDATE/HISTORIAN DEFINABLE NAMES IN TRAC

Name	Description
ASIZE	Sets the A array (container array) to a fixed size.
CRAY	Coding is unique to CRAY computers.
CYB205	Coding is unique to Cyber 205 computer (not tested in the released version).
EIGHTB	Coding is unique to a machine with eight 8-bit bytes in a word.
FOURB	Coding is unique to a machine with four 8-bit bytes in a word.
HEX	Uses hexadecimal rather than octal.
IBM	Uses coding unique to IBM computers.
INEL	Uses coding to write graphics output in INEL format.
INTERACT	Interactive version (not supported).
L7600	Coding is unique to CDC 7600 LTSS operating system (not supported).
LANL	Coding uses local LANL routines (on CTSS) or is unique to LANL computing environment.
MEL	Coding needed for link to MELPROG to generate MELPROG/TRAC severe core damage code.
MVS	Coding for IBM MVS operating system.
NOLCM	Coding for current machines with contiguous memory rather than small core/large core split as on a CDC 7600.
NPA	Additional coding for LANL Nuclear Plant Analyzer (NPA) link.
OVLAY	Code is overlaid.
S7600	Coding is unique to CDC 7600 Scope operating system (not supported).
SRPNPA	Special logic for SRP NPA link.
TENB	Coding is unique to a machine with ten 6-bit bytes in a word.
UNICOS	Coding needed for UNICOS operating system.
VAX	Coding for VAX (not supported).
VDM	Coding to use variable-dimension memory by expanding blank common dynamically during execution.
VECTOR	Selects special vectorized local LANL routines (on CTSS).

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11. ABSTRACT (200 words or less)

The Transient Reactor Analysis Code (TRAC) was developed to provide best-estimate predictions of postulated accidents of light-water reactors. The TRAC-PF1/MOD2 program provides this capability for pressurized water reactors and for many thermal-hydraulic test facilities. The code features either a one- or a three-dimensional treatment of the pressure vessel and its associated internals, a two-fluid nonequilibrium hydrodynamics model with a noncondensable gas field and solute tracking, flow-regime-dependent constitutive equation treatment, optional reflood tracking capability for bottom-flood and falling-film quench fronts, and consistent treatment of entire accident sequences, including the generation of consistent initial conditions.

This manual is the third volume of a four-volume set of documentation on TRAC-PF1/MOD2. This guide was developed to assist the TRAC programmer and contains information on the TRAC code and data structure, the TRAC calculational sequence, memory management, and various machine configurations supported by TRAC.

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