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TRAC-BF1/MOD1: An Advanced Best-Estimate Computer Program for BWR Accident Analysis

User's Guide

Edited by
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Idaho National Engineering Laboratory
EG&G Idaho, Inc.

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ABSTRACT

The TRAC-BWR code development program at the Idaho National Engineering Laboratory has developed versions of the Transient Reactor Analysis Code (TRAC) for the U.S. Nuclear Regulatory Commission and the public. The TRAC-BF1/MOD1 version of the computer code provides a best-estimate analysis capability for analyzing the full range of postulated accidents in boiling water reactor (BWR) systems and related facilities. This version provides a consistent and unified analysis capability for analyzing all areas of a large- or small-break loss-of-coolant accident (LOCA), beginning with the blowdown phase and continuing through heatup, reflood with quenching, and, finally, the refill phase of the accident. Also provided is a basic capability for the analysis of operational transients up to and including anticipated transients without scram (ATWS). The TRAC-BF1/MOD1 version produces results consistent with previous versions. Assessment calculations using the two TRAC-BF1 versions show overall improvements in agreement with data and computation times as compared to earlier versions of the TRAC-BWR series of computer codes.

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SUMMARY

The TRAC-BWR Code Development Program at the Idaho National Engineering Laboratory (INEL) is developing versions of TRAC (Transient Reactor Analysis Code) to provide the U.S. Nuclear Regulatory Commission (NRC), and the public, a best-estimate capability for the analysis of postulated accidents and transients in boiling water reactor (BWR) systems and related experimental facilities. The first publicly released version of the code, TRAC-BD1, provided a basic capability for the analysis of design basis loss-of-coolant accidents (DBLOCAs). The second publicly released version of the code, TRAC-BD1/MOD1, was developed to provide an analysis capability for operational transients, including anticipated transients without scram (ATWS), as well as to provide an improved analysis capability for both large- and small-break LOCAs. The third release, TRAC-BF1, is a further improvement, particularly in the areas of computational speed and space-dependent (one-dimensional) neutron kinetics modeling capability. The fourth release, TRAC-BF1/MOD1, again improves the calculational speed, provides an improved steam separator-dryer model, and corrects many errors or omissions.

The code provides a consistent and unified analysis capability for an entire accident sequence. For a large break LOCA, this includes the blowdown phase, heatup, reflood with quenching, and finally, the refill phase of the LOCA accident sequence. For an ATWS event initiated by the closure of the main steam isolation valve, the sequence includes the initiating event, the reactor power excursion caused by void collapse and terminated by reactivity feedback, periodic power excursion caused by cycling of the safety relief valves, and ultimate reactor shutdown though the injection of soluble boron poison.

Unique features of the code include (a) a full nonhomogeneous, nonequilibrium, two-fluid thermal-hydraulic model of two-phase flow in all portions of a BWR system, including a three-dimensional thermal-hydraulic treatment of a BWR vessel; (b) detailed modeling of BWR fuel bundle, including a thermal radiation heat transfer model for radiative heat transfer between multiple fuel rod groups, liquid, and vapor phases, and the fuel channel wall, with quench front tracking on all fuel rod surfaces and inside and outside of the fuel channel wall for both bottom flooding and falling film quench fronts; (c) detailed models of BWR hardware, such as jet pumps and separator-dryers; and (d) a countercurrent flow limiting model for BWR-like geometries.

Other features of the code include a nonhomogeneous, thermal equilibrium critical flow model and flow-regime-dependent constitutive relations for the interchanges of mass, energy, and momentum between the fluid phases and between the phases and structure.

New features of TRAC-BF1 and TRAC-BF1/MOD1 not available in the previously released versions of the code include

- Balance of plant component models, such as turbines, feedwater

heaters, and steam condensers

- A simple lumped parameter containment model

- A comprehensive control system model

- Reactivity feedback model, including the effect of soluble boron

- Boron transport model

- Noncondensable gas transport model, including the effects of noncondensable gas on heat transfer

- Mechanistic separator-dryer model

- Two-phase level tracking model

- Generalized component-to-component heat and mass transfer models

- Moving mesh quench front tracking model for fuel rods and both inside and outside surfaces of fuel channel wall

- Improved constitutive relations for heat, mass, and momentum transfer between the fluid phases and between the fluid phases and structure

- A free format input processor with extensive error checking.

From the very beginning of the TRAC-BD1/MOD1 development, adherence to a strict quality control program ensured that a well-documented, working version of the code would be available at all times. All changes to the code, however small, are given a program change label that appears on the modified FORTRAN statements and on all documentation that accompanies the changes. This ensures that all changes are traceable to documents that describe the basis for the change and the model developer making the change. A set of test cases was developed and executed after each successive working version of the code was assembled to ensure that recent changes did not affect changes or models inserted into previous versions of the code.

After the final working version of TRAC-BF1/MOD1 was assembled, a series of developmental assessment test cases was executed. These test cases provided insight into the code simulation capabilities for various separate effects hydrodynamic tests, separate effects heat transfer tests, and integral system effects tests. On the whole, agreement between the TRAC-BF1/MOD1 simulation of the various problems and measured test data is excellent.

The TRAC-BF1/MOD1 code is described by three documents: *TRAC-BF1/MOD1: An Advanced Best-Estimate Computer Program for Boiling Water Reactor Accident Analysis, Volumes 1 and 2*, and *TRAC-BF1/MOD1 Models and Correlations*. *Volume 1: Model Description* describes the thermal-hydraulic models, numerical methods, and component models available. *Volume 2: User's Guide* describes the input and output of the TRAC-BF1/MOD1 code and provides guidelines for use of the code modeling of BWR systems. *TRAC-BF1/MOD1 Models and Correlations* is designed for those users wishing a detailed mathematical description of each of the models and correlations available in TRAC-BF1/MOD1. This document reflects the as-coded configuration of the descriptive information provided in Volume 1.

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TRAC-BD1/MOD1 and TRAC-BF1 are the results of technical collaboration between General Electric Company (GE), and EG&G Idaho, Inc., at the Idaho National Engineering Laboratory (INEL). Substantial contributions to the models in TRAC-BD1/MOD1 and TRAC-BF1 have been made by Messrs. Mohammed Alamgir, Jens G. M. Andersen, Chester Cheung, Kee H. Chu, James C. Shaug, and Bharat S. Shiralkar of GE. In addition, the contributions of Messrs. Felix Aguilar, Douglas W. Croucher, Stewart R. Fisher, Scott T. Free, James M. Milton, Charles M. Mohr, Jr., Andrew C. Peterson, Jr., Robert E. Phillips, Jay W. Spore, Mildred A. Stone, John E. Tolli, and Cheng-chii Tsai of the INEL in various stages of this development are greatly appreciated. Also, the work of Messrs. Everett G. Gruen, Douglas G. Hall, Kenneth C. Wagner, Phillip D Wheatley, and Briant L. Charboneau on the developmental assessment of TRAC-BD1/MOD1 and TRAC-BF1 is sincerely acknowledged.

Like the earlier versions of this code, TRAC-BD1/MOD1 and TRAC-BF1 have many inherited features of TRAC-PD2 developed at the Los Alamos National Laboratory (LANL). The contribution of these features, as well as the useful consultations obtained from the members of the Safety Code Development Group at LANL, is gratefully appreciated. Finally, the sponsorship of the U.S. Nuclear Regulatory Commission (NRC), as well as technical discussions and project support provided in the course of this development by Dr. Fuat Odar, Dr. Richard Lee, Dr. Yi-Shung Chen, and Mr. Harold Scott of the NRC and Drs. Debu Majumdar and Walter H. Rettig, of the Department of Energy, Idaho Field Office, is sincerely appreciated.

TRAC-BF1/MOD1: AN ADVANCED BEST-ESTIMATE COMPUTER PROGRAM FOR BOILING WATER REACTOR ACCIDENT ANALYSIS
VOLUME 2: USER'S GUIDE

1. INTRODUCTION

The TRAC-BF1/MOD1 User's Guide is a revision of TRAC-BD1/MOD1 User's Guide[1-1,2,3] with many additions and changes relevant to TRAC-BF1/MOD1. The contents of this volume cover the input description entirely. The input variables and formats are described for each of the TRAC-BF1/MOD1 component models.

The TRAC-BF1/MOD1 code is described by three documents: *TRAC-BF1/MOD1: An Advanced Best-Estimate Computer Program for Boiling Water Reactor Accident Analysis, Volumes 1 and 2, and TRAC-BF1/MOD1 Models and Correlations. Volume 1: Model Description* describes the thermal-hydraulic models, numerical methods, and component models available. *Volume 2: User's Guide* describes the input and output of the TRAC-BF1/MOD1 code and provides guidelines for use of the code modeling of BWR systems. *TRAC-BF1/MOD1 Models and Correlations* is designed for those users wishing a detailed mathematical description of each of the models and correlations available in TRAC-BF1/MOD1. This document reflects the as-coded configuration of the descriptive information provided in Volume 1.

1.1 REFERENCES

1-1. J. Spore et al., *TRAC-BD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Loss-of-Coolant Analysis*, NUREG/CR-2178, October 1981.

1-2. R. W. Shumway et al., *TRAC-BD1/MOD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Transient Analysis, Volume 2: Users Guide*, NUREG/CR-3633, EGG-2294, April 1984.

1-3. W. L. Weaver et al., *TRAC-BF1 Manual: Extensions to TRAC-BD1/MOD1*, EGG-2417, August 1986.

2. INPUT DESCRIPTION

2.1 GENERAL INPUT ORGANIZATION

A TRAC-BF1/MOD1 input deck is divided into major data types, including problem control, trip, component, reactor power, control system, EXTRACT, and time step data. These data are contained in the INPUT file and can be in any order. Since each card has a card identifier, the deck can be shuffled, except for continuation cards.

The problem control data contain general control parameters, including problem title cards, restart and dump control information, transient and steady-state control information, problem size information, and problem convergence criteria. These data must always be present in the INPUT file.

The trip data are required only if the user wishes to specify one or more trips. For restart runs, only data for those trips added or modified are included in the trip data block. Data for unmodified trips from a previous run are obtained from the restart dump file.

The main body of the input deck contains data that describe in detail each TRAC-BF1/MOD1 component. For restart problems, only those components added to the problem or modified are included in the input data file. The rest of the component data are obtained from the restart file. All geometrical and thermal-hydraulic input data are in the Standard International (SI) Unit System.

Another data set contains optional control system input data. If no control system is required, this data set may be omitted. If a control system is required, the user may select either a set of default steady-state controllers with simplified input or a detailed control system model with specific input being required for each controller in the system. Control system data should be included in a restart input deck only if controller parameters are to be changed.

EXTRACT is a TRAC-BF1/MOD1 subprogram that extracts component data from an existing restart dump file and converts it to card images in TRAC-BF1/MOD1 input format. This extraction feature is user-convenient to facilitate the setup of restart input decks. The EXTRACT data block should be included in the INPUT file only if the variable NEXTR is not zero in the first data block.

Time step size data must always be present in the INPUT file, except during EXTRACT runs.

All input data contained in the INPUT file are read into the code in free format using the Idaho National Engineering Laboratory (INEL) INP input package. A free format version of the LOAD input procedure is used to provide the user with additional flexibility in specifying data arrays.

General Input Organization

Detailed descriptions of the input requirements and user-convenient features mentioned above are given in the following sections of this volume. A sample INPUT deck is given in the back of this report.

2.2 TRIPS

Trips provide the means of simulating the actions of a power plant protective system in response to transient or abnormal conditions. Trips control such actions as reactor scrams, valve openings, and pump startups. In TRAC-BF1, the actions are performed by the component modules. The VALVE module, for example, has been coded to open (or close) a valve once an appropriate trip occurs. Other modules have been coded similarly. A trip condition is indicated by a status flag, which is set after a trip has occurred. A problem description can have any number of trips specified with one or more components referencing the same trip.

The criteria for deciding when a trip has occurred are based on three parameters supplied as input: a signal index (ISID), a signal setpoint (TSP), and a signal delay time (TDT). The signal index defines the type of variable to be observed (the variable used to activate the trip) and can correspond to a pressure, temperature, water level, or any number of other component parameters. Parameter differentials and multiple parameters may also be chosen. The signal setpoint defines the setting at which the trip will occur. This setting may be an upper limit of the observed variable, if ISID >0, or a lower limit if ISID <0. The signal delay time serves to simulate the time necessary to process the signal and initiate the action. A trip status flag is set after the observed variable has reached the signal setpoint and the subsequent signal delay time has lapsed.

Trips needed in a problem are declared when specifying the component module input. Eight parameters are used to define each trip: ITID, ISID, TSP, TDT, ID1, ID2, ID3, and ID4. ITID is the trip identification number. This number is arbitrarily chosen to distinguish one trip from another. Table 2-1 provides the correspondence between the signal index and the variable types. The parameters ID1 through ID4 are qualifiers that specify the location of the observed variable(s) in the component data base. ID1 identifies the component by the component ID number. ID2 is a second component qualifier and is zero unless the component is a VESSEL. If the component is a VESSEL, the value of ID2 corresponds to the VESSEL axial level. Parameters ID3 and ID4 specify the element(s) if the variable is an array. The possible choices of ID3 and ID4 and their meanings are given in Table 2-2.

For illustrative purposes, consider

ITID = 16	ID1 = 6
ISID = 1	ID2 = 0
TSP = 1.7e7	ID3 = 3
TDT = 0.1	ID4 = 0.

Trip ID 16 is arbitrary; however, it is this number that must be used in the component input to identify this trip. The positive signal index of 1 means that an upper pressure limit is defined. TSP defines the pressure limit to be 17.0 MPa. TDT defines the trip delay time of 0.1 second after the

Table 2-1. ISID trip signal index values and variable types.

Trip signal index (ISID)	Common usage (all components)	Exceptions
0	Reactor time (values of ID1 through ID4 are ignored)	
1	Pressure	
2	Liquid temperature	
3	Vapor temperature	
4	Vapor fraction	
5	Wall temperature	VESSEL: s[illegible] temperatures
6	(Not used in TRAC-BF1)	
7	(Not used in TRAC-BF1)	
8	Mixture velocity	
9	Relative velocity	
10	(Not used in TRAC-BF1)	
11	Vessel downcomer level trip ID1 = VESSEL number ID2 = 1 ID3 = azimuthal zone number ID4 = 0.	

pressure limit is reached. ID1 = 6 means the pressure is found in the data base for Component 6. ID2 = 0 means this component is not a VESSEL. ID3 = 3 and ID4 = 0 mean that the third pressure in the array of pressures (pressure of the third cell) is the tested variable.

Table 2-2. TRIP cell selection logic

Cells tested in Component ID1 and Level ID2 (if it is a VESSEL).

	ID4 < 0	ID4 = 0	ID4 > 0
ID3 > 0	None	ID3	Difference between value in Cell ID3 and ID4
ID3 = 0	None	None	ID4
ID3 < 0	Each cell from -ID3 to -ID4	None	None

2.3 DUMP/RESTART FEATURE

At user-specified times during problem execution, TRAC-BF1/MOD1 automatically generates the dump/restart data file, TRCDMP, which contains snapshots of the state of the system. Any one of these snapshots (dumps) may be used to initialize all or part of the system for subsequent calculations or for EXTRACT. The times at which dumps are generated are determined by several criteria. The user may specify a dump interval on the time step cards. A dump will be created whenever this interval of time has elapsed since the last dump. These dumps are added sequentially to the end of the TRCDMP file. A dump may also be initiated by the user with one or more of the trips. When the conditions of this trip occur, a dump is added to the end of the TRCDMP file. This permits the restart of a problem from the occurrence of particular events of interest.

In addition to these user-specified dumps, TRAC-BF1/MOD1 will automatically generate dumps at various times. A dump is generated at the end of the initialization stage. Another dump is generated at the end of the steady-state or transient calculation and at intermediate points in the calculation based on CPU time utilized and remaining for the job. A message containing the dump time step number is written on the output file whenever a dump is taken.

To use a dump file in initializing a subsequent calculation, the name of the file must be changed from TRCDMP to TRCRST (restart) and the time step number of the desired dump must be specified on card MAINXX. If the specified time step number is negative, TRAC-BF1/MOD1 will use the dump with the largest time step number and overwrite the initial time (TIMET on Card MAINXX) with the time taken from that dump.

Data retrieved from the selected restart dump depend on what has already been found in the input file. The code compares the total list of components specified by the user in the IORDER array of the problem control data with components found in the component data of the input file. Data for any components not found in the component data block are initialized from the restart dump. Thus, if the user desires to alter a component or add a new component at the beginning of a restart run, the new or altered component data must be included in the component data block. If new or altered components are not required, no component data need be included in the component data block. In principle, components may also be deleted in a restart run by removing the component number from the IORDER array; however, this procedure may cause problems, for the following reasons. If components are added or deleted in a restart run, care must be taken to ensure that the junctions specified in the resulting component set are internally consistent and that the IORDER array contains only the numbers of components to be used in the restart run. Input values of NCOMP and NJUN found in the control data block must also reflect the number of components and junctions used in the restart run.

Trip data are handled in much the same way as component data during restart. NTRX is the total number of trips to be read. If the number of trips found in the input data is <NRTX, the remaining trips will be initialized in the state found on the restart dump. New trips or trips requiring alteration may be included in the trip data for a restart run. The user should exercise caution when including a trip that has already been activated in a previous run in the trip input data for a restart. The code will consider such a trip to be reactivated at the beginning of the restart transient and will redefine the time at which the trip occurred. This may lead to erroneous results when using table look-ups based on time after trip occurrence, such as the reactor power-time table. In general, trips that do not require alteration should not be included in the trip data block for a restart run.

Some reactor power data are retrieved from the restart file on restart runs. No power data may be changed on restart except for the power/reactivity table. The first card and this table must be included in the restart deck whether or not changes are desired. If the other power data cards are not found in the input deck, they will be obtained from the restart file.

Selected control system parameters may be altered on restart by inputting special change cards specifying the new parameter values. If no control system change cards are found in the input deck, the control system will be initialized in the state specified on the restart dump file.

2.4 STEADY-STATE CALCULATION

The steady-state capability of TRAC-BF1/MOD1 is designed to provide time-independent solutions that may be of interest in their own right or as initial conditions for transient calculations. The steady-state calculation utilizes the transient fluid dynamics and heat transfer routines to search for time-independent conditions. The search is terminated when the user is satisfied that the time rates of change of thermal and fluid variables are reduced to sufficiently small values. This operation is normally performed in a series of steady-state restarts, continuing until acceptable steady-state convergence is obtained. The restart dump file, TRCDMP, from the final steady-state run, contains the initial conditions for transient calculation.

TRAC-BF1/MOD1 will terminate automatically when the percent rate of change of the state variables is smaller than a user-specified value. Users specify the steady-state convergence value in the MAIN card of the input deck. A final dump and a major edit, showing the rate of change of the state variables, is given at problem termination. If a continued steady-state calculation is desired, the problem can be restarted with a smaller convergence number.

Although the same subroutines are used in both the transient and steady-state calculations, there are important ways in which their behavior differs between the two calculations. The most significant differences are:

1. The time-step size used by the heat transfer and fluid flow calculations can be different during a steady-state calculation. The ratio of these time-step sizes is specified through the input variable, RTWFP, found in the time-step data block. This permits compensation for the difference in natural time scales of the two processes.

2. Trips are inhibited during steady-state calculations. Thus, even though conditions may exist that would cause a trip during a transient, the trip will not be activated during the steady-state calculation. Table look-ups are also suppressed during steady-state calculations.

The problem time, TIMET, is not automatically reset to zero after steady-state conditions are reached. If it is desired that the transient begin at time zero, TIMET on card MAINXX must be set to zero in the restart input deck used for beginning the transient. The value of DSTEP on the same card must also refer to a specific restart dump number, usually the last dump in the steady-state restart dump file.

2.4.1 Manual Initialization

The most common objective of a steady-state calculation is to drive a reactor system model to a specified steady-state condition for use as the initial condition in a subsequent transient calculation. This objective can be met by the manual adjustment of system parameters in a series of steady-state runs. For example, the recirculation pump speed may be manually adjusted in a series of steady-state runs until the desired steady-state core mass flow rate is obtained. For simple systems, this procedure will lead quickly to a specified steady state.

2.4.2 Control System-Assisted Initialization

For complex systems, the procedure described above will often require a large number of steady-state runs to achieve the desired steady-state condition. To simplify this procedure, an option is available using simple default control systems to provide automatic adjustment of selected system parameters during a steady-state run. For example, the default steady-state flow control system automatically adjusts recirculation pump speed until a specified core mass flow rate is reached. Other default control systems are available to adjust the reactor pressure by controlling the valve area of the pressure control valve in the reactor main steam line and to adjust the downcomer water level by controlling the feedwater mass flow rate. The use of these three types of default steady-state control systems will often greatly reduce the amount of time required to initialize a system model. The default control systems are designed for use with a full-scale BWR reactor system and may require adjustment for use with other systems, such as small-scale test facilities, although some internal scaling is performed.

Additional user-supplied controllers may be used during steady state runs to assist in adjusting system parameters not included in the default controller set. Both default and user-supplied steady-state controllers are operative only during steady-state runs. Other controllers, designated as transient controllers, may be included in the same input deck as the steady-state controllers but become operative only when a transient run is performed. Steady-state controllers need not be removed from the input deck when a transient run is performed. Transient controllers needed for calculations including 1-D kinetics must be input in the steady-state run. For additional information on the use of steady-state controllers, see Subsection 4.12.8 in Volume 2 of the TRAC-BD1/MOD1 Manual.[2-1]

2.5 EXTRACT Subcode

Subcode EXTRACT is designed to facilitate the setup of restart input decks. The user may wish to make minor alterations to an existing component for a restart run, such as altering a flow area on a cell face or changing the rated torque of a pump. If the user wishes to change any input parameter for a given component, TRAC-BF1/MOD1 requires that all the data for that component be included in the restart input file. The TRAC-BF1/MOD1 restart feature requires that all input data for that component be included in the component data block, even though only a small number of variables may actually be altered from their original values. EXTRACT assists in setting up an altered restart input deck by reading component data from a specified dump on a restart dump file and converting these data to card images of component data input sets. The component input sets created are in standard TRAC-BF1/MOD1 input format and correspond to the state of the component at the time of the specified restart dump. The card image data set extracted in this manner may be altered as required by the user and used in the component data block for the restart run. The input data file for EXTRACT is the restart dump file, and the card deck output from EXTRACT is on file TAPE3.

EXTRACT is run using a TRAC-BF1/MOD1 input deck set up as for a restart run, with all component data to be taken from the restart file, TRCRST (TRCDMP from the previous run). If the user wishes to use EXTRACT, the main control variable, NEXTR, must be set equal to the number of components to be extracted from the restart file. If NEXTR>0, TRAC-BF1/MOD1 will proceed with its normal restart input processing, reading component data from file TRCRST and storing it internally in LCM component data arrays. Control is then transferred to the EXTRACT overlay, which continues reading from the INPUT file to obtain the list of components to be extracted. EXTRACT then obtains the requested component data from the LCM component data arrays and converts it to the form of input card images. These data are obtained for the dump specified by the variable DSTEP on Card MAINXX. Card image component data sets for the specified components are then written to file TAPE3.

2.6 FREE FORMAT INPUT STRUCTURE

TRAC-BF1/MOD1 problem decks are input in a free format structure, using the INEL INP input package. In this format, each data card is labeled with a unique card identifier containing information about the type of data included on the card. Cards are identified in the code by their card identifier rather than by their order within the deck. This structure simplifies the finding of data within the deck, helps to maintain a record of deck alterations, and eliminates the necessity for maintaining an exact card order within the deck.

A TRAC-BF1/MOD1 free format input deck consists of a title card, optional comment cards, data cards, and a terminator card. The order of the title, comment, and data cards is unimportant, except that in the case of duplicate data card identifiers, the last card with that identifier will be used; similarly, the last title card will be used. Care should be taken to avoid the spurious use of duplicate cares throughout the deck. These often lead to confusion, particularly if more than one modeler uses the same deck.

1. **Title Card.** A title card must be entered for each problem. A title card is identified by an equal sign (=) as the first nonblank character.

2. **Comment Cards.** An asterisk (*) or a dollar sign ($) appearing as the first nonblank character identifies the card as a comment card. Blank cards are treated as comment cards. The only processing of comment cards is the printing of contents. Comment cards may be placed anywhere in the input deck.

3. **Data Cards.** The data cards contain integer, floating-point, or alphanumeric data. Blanks preceding and following data fields are ignored.

   The first field on a data card is a card identifier, consisting of an alphabetic name immediately followed by an integer. The code converts the alphabetic names to numbers for use by INP subroutines. A list of the alphabetic card name types and their numerical equivalents is shown in Table 2-3.

   Each card identifier is compared to previously entered identifiers. If a matching identifier is found, the data entered on the previous card are replaced by data on the current card with this identifier. If the current card has no data, the card identifier and data on the previous card with the same identifier are deleted.

   Comment information may follow the data fields on any data card by initiating the comment with an asterisk or dollar sign.

   A number field is started by either a digit (0 through 9), a sign (+ or -), or a decimal point (.) A comma or a blank terminates the

Table 2-3. Types of INP data cards.

Card Identifier	Initial Representation	Card Identifier	Initial Representation
OPTIONS	1	PIPEIDCNX	5IDCNX
TIMING	8	PUMPIDCNX	6IDCNX
CHECKOUT	9	SEPDIDCNX	11IDCNX
CCFLUTP	10	TEEIDCNX	7IDCNX
CCFLSEO	20	TURBIDCNX	10IDCNX
TITLEXX	1XX	VALVEIDCNX	8IDCNX
MAINXX	2XX		
COMPLISTXX	3XX		
TRIPDUMPXX	4XX		
TRIPCNX	1CNX		
MPROPCNXX	1CNXX	VESSELIDLVCNX	11DLVCNX
BREAKIDCNX	1IDCNX	POWERODCNX	100000CNX
CHANIDRGCNX	2IDRGCNX	STEADYSTCNX	104000CNX
CONTANSYCNX	300SYCNX	CNTRLCNXXX	1050CNXXX
FILLIDCNX	3IDCNX	EXTRACTXX	1100000XX
HEATRIDCNX	9IDCNX	TIMESTEPCNX	120000CNX
JETPIDCNX	4IDCNX		

Digits are represented above as follows:

ID = A unique 2-digit component identification. This is stored as variable ID.

RG = A 2-digit CHAN rod group number.

SY = A 2-digit component type for containment.

LV = A 2-digit VESSEL level number.

CN = A 2-digit card number or, in some cases, an array name.

XX = A 2-digit sequence number that can be between 00 and 99 inclusive unless otherwise noted.

X = A 1-digit sequence number that can be between 0 and 9 inclusive unless otherwise noted.

number field. The number field contains a mantissa and an optional exponent. A number field without a decimal point or an exponent is an integer; a number field with either a decimal point, an exponent, or both, is floating point. A floating-point field without a decimal point is assumed to have a decimal point immediately in front of the first digit. The exponent denotes the power of ten to be applied to the number part of the field. The exponent part has an E or D and a sign (+ or -), followed by a number giving the power of ten. These rules for floating-point numbers are identical to those for entering data in FORTRAN E or F format fields except that no blanks are allowed between characters. The only exception to this is a blank following an E or D denoting an exponent; this blank is treated as a plus sign. Acceptable ways of entering floating-point numbers are illustrated by the following six fields:

12.45 +12.45 1245+2 1.245+1 1.245E 1 1.245E+1

A field starting with a letter is alphanumeric. The field is terminated by a comma, a blank, or the end of the card. Blanks and commas can be included by enclosing the field in quotes.

4. **Terminator Card.** The last card in an input deck must have a period (.) as the first data field if another input deck follows.

At the beginning of the problem, two listings of the input cards are printed. The first shows the cards just as they are read, and the second shows them after the card identifiers have been converted to integers. The second list represents what INP is processing, and any messages from INP will appear in this list. These include messages indicating replacement or deletion of data caused by duplicate card identifiers, as well as error messages. This second list is frequently useful in diagnosing errors encountered later on in input processing.

When a card format error is detected, a line containing a dollar sign ($) located under the character causing the error and a comment giving the card column of the error are printed. An error flag is set such that input processing continues, but the problem is aborted at the end of input processing. Often another error comment is producing during input processing when the program attempts to process the erroneous data.

2.7 LOAD Format

TRAC-BF1/MOD1 uses the LOAD input format to read most array variables. The principal advantage of this format is to simply the input of repeated data within an array. A LOAD format data card contains an INP card identifier, an operation, a repeat count, a list of data constants, and an operation end indicator. A description of LOAD operations is shown in Table 2-4.

Table 2-4. LOAD operations.

Operation	Description
F	Fill array with data constant starting at current data index
Rnn	Repeat data constant nn times.
Mnn	Multiple repeat. Repeat data constant 10*nn times.
Inn	Interpolate between data constant and succeeding data constant with nn points.
S	Skip to next card (continue).
E	End of data array.

Some restrictions in the use of the LOAD format are:

1. End of data for an array must be signaled by E.
2. Overstore or partial fill of an array is not allowed.
3. Integer interpolation is not allowed.
4. Blanks or commas must separate LOAD operations and data constants.
5. No blank is allowed within an operation (e.g., use R03 instead of R 3).

Following are some examples of the use of LOAD format:

1. Fill the array with integer 57.

   ```
   PIPE1[illegible]NX    F  57 E
   ```

2. Place 3.25 into the first two array positions, 0.2×10^{-7} into the third position, and fill the rest of the array with 4.1.

```
PIPEIDCNX   R02  3.25  0.2E-7   F 4.1  E
```

3. Use interpolation to load array with values 7., 9., 11., 13., and 15.

```
PIPEIDCNX   I03  7  15  E
```

For arrays in LOAD format, users may set CN in the card identifier to either the 2-digit card number or to the actual array name, both of which are shown in the input description in Section 3. No blanks are allowed in the identifier.

For arrays with two or three dimensions, the LOAD convention is to vary the first subscript most rapidly. For example, the wall temperature array TW, dimensioned NODES by NCELLS, is read $TW_{1,1}$, $TW_{2,1}$, ... $TW_{NODES,1}$, etc.

2.8 PLOTTING CAPABILITY

A wide variety of plot data are generated and stored by TRAC-BF1. The set of data points for a single item of data (such as the pressure in component number 5 in cell 3) at a series of time points is called a channel. Each channel has a unique identifier generated by TRAC-BF1 that is used by auxiliary plot programs to retrieve the data. This channel identifier consists of up to four pieces. For component-related data, the four pieces are the variable name (alphanumeric), the component number, (a two-digit integer), the axial level or rod group number (a two-digit integer), and a cell number (a two-digit integer). The alphanumeric and numeric parts of the channel identifier are separated by a minus sign with no blanks allowed. Each of the integers must be a two-digit number with a leading zero required if the number is less than 10.

For variables that are not component-related, such as the time-step size (DELT), the number "001" is used for the rest of the identifier following the variable name and minus sign, except for the control system. For the control system, the number used is the user control block number, left-filled with zeros to give three digits if less than 100. The user may obtain a complete list of the channel identifiers created for his particular TRAC-BF1 run either by specifying NOGRAF = 1 on the CHECKOUT card (by setting the seventh variable to an integer 1) or by running the auxiliary program BSUM on his HUNI output file. The only exception to the use of three digits for these variables is that the time channel is simply "TIMET-1."

Some examples of channel identifiers are "PV-020001," "MODCHANW-123456," and "TOTPOW-001." In the first case, the identifier indicates the pressure in component number 2, cell 1. The second indicates the channel wall heat transfer mode in component 12, rod group 34, cell 56, where the component must be a CHAN. The third indicates the total reactor power.

Lists of the plot variable names generated by the code are found in Tables 2-5, 2-6, and 2-7 in three different formats. The first is an alphabetical list by the plot variable name. All duplicates due to the variable being used by more than one component are eliminated. The plot variable names are then listed alphabetically, showing the components that use the names. Finally, the plot variables are listed according to the order they are encountered in the code logic, showing them component by component.

In the tables for the plot variable names, the headings have the following meanings: "Name" is the plot variable name; "Description" is the TRAC internal description that is used to identify to the TRAC programmers and manual users the items to be written to the graphics file; "Units code" is a number used by the ISDMS plotting programs to supply a label for the y-axis. The part of this y-axis label that is the units is shown under "Units value" without the rest of the label that may be found in the MAGNUM manual. The heading "Rod/Level" indicates whether part of the channel identifier must include a nonzero number for the rod, in the case of the CHAN component, or

Table 2-5. Summary of plot variables in alphabetical order.

Name	Description	Units Code	Units Values	Rod/ Level
AIRP	AIR PRESSURE	137	PA	0
ALPA	ALPHA ABOVE LEVEL	95	(NONE)	0
ALPB	ALPHA BELOW LEVEL	95	(NONE)	0
ALPC	CORE LEVEL AVERAGE VOID FRACTION	95	(NONE)	0
ALPCU	CARRYUNDER VOID FRACTION	95	(NONE)	0
ALPHA	VOID FRACTION	95	(NONE)	0
ALPHP	PUMP VOID FRACTION	95	(NONE)	0
ALPHTR	VOID FRACTION TO D.C.	95	(NONE)	0
ALPM	ALPHA MINUS	95	(NONE)	1
ALPP	ALPHA PLUS	95	(NONE)	1
AREA	VALVE AREA	193	M2	0
BCAV	AVERAGE BORON	350	PPM	0
BORC	BORON(PPM)	350	PPM	0
BORONI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
BORONT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
BORRC	CORE LEVEL AVERAGE BORON CONCENTRATION	350	(NONE)	0
CBOUT	CONTROL BLOCK OUTPUT	77	(NONE)	0
CHANTW	CHAN SURFACE TEMPERATURE FOR GROUP # [NGRP+1]	74	K	0
CHANWHL	CHAN HTC LIQUID [NGRP+1]	155	W/((M2)(K))	0
CHANWHV	CHAN HTC VAPOR [NGRP+1]	155	W/((M2)(K))	0
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0
CNDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
CNDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
CNDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
CNDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
CNDRODI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
CNDRODT	TOTAL CNDROD TIME PERCENTAGE	77	(NONE)	0
CONTLI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
CONTLT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
CONTMI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0

Table 2-5. (continued)

Name	Description	Units Code	Units Values	Rod/ Level
CONTMT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
CONVLOC	CONVERGENCE LOCATION	77	(NONE)	0
CTOETIME	CPU TIME/ELAP. TIME	77	(NONE)	0
CTRLF	CONTROL FRACTION	77	(NONE)	0
CURLIMIT	COURANT T.S. LIMIT	77	(NONE)	0
CURLOC	COURANT LOCATION	77	(NONE)	0
DELP	PUMP DELTA - P	347	PA	0
DELT	TIME STEP SIZE	77	(NONE)	0
DMPITI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
DMPITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
DTCTS	CONTAINMENT TIMESTEP	77	(NONE)	0
DTLMAX	MAXIMUM TL CHANGE	84	K	0
DTRMAX	MAXIMUM TR CHANGE	84	K	0
DTSMAX	MAXIMUM TS CHANGE	84	K	0
DTVMAX	MAXIMUM TV CHANGE	84	K	0
DZLEV	LEVEL POSITION	191	M	1
EDITI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
EDITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
EFFAPP	APPLICABLE EFFICIENCY	77	(NONE)	0
EFFEFF	EFFECTIVE EFFICIENCY	77	(NONE)	0
EGV	GLOBAL EIGENVALUE	77	(NONE)	0
ERMC	COMPONENT PERCENT MASS ERROR	56	PERCENT	
ERMSCT	SYSTEM PERCENT MASS ERROR	56	PERCENT	
FRAPI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
FRAPT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0
FRICIR	RADIAL INTERFACIAL FRICTION COEFFICIENT	208	(NONE)	
FRICIT	THETA INTERFACIAL FRICTION COEFFICIENT	208	(NONE)	
FRICIZ	AXIAL INTERFACIAL FRICTION COEFFICIENT	208	(NONE)	
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0

Table 2-5. (continued)

Name	Description	Units Code	Units Values	[illegible]
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0
GAMMA	PHASE MASS EXCH	157	KG/S	0
GRAFI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
GRAFT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
HAIL	H.T. COEF.*AREA, LIQUID TO INTERFACE	155	W/K	0
HAIV	H.T. COEF.*AREA, VAPOR TO INTERFACE	155	W/K	0
HEAD	PUMP HEAD	239	M2/SEC2	0
HLWALLI	INSIDE WALL H.T. COEF. TO LIQUID	155	W/M2-K	0
HLWALLO	OUTER WALL H.T. COEF. TO LIQUID	155	W/M2-K	0
HTCDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
HTCDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
HTCDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
HTCDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
HTCRODI	INTERNAL HTCROD TIME PERCENTAGE	77	(NONE)	0
HTCRODT	TOTAL HTCROD TIME PERCENTAGE	77	0	
HVWALLI	INSIDE WALL H.T. COEF. TO VAPOR	155	W/M2-K	0
HVWALLO	OUTER WALL H.T. COEF. TO VAPOR	155	W/M2-K	0
HYDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
HYDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
HYDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
HYDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
LIQLEV	SHELL LIQUID LEVEL	191	M	0
LLEV	D/C LIQUID LEVEL	191	M	0
LSTEMP	LUMPED SLAB TEMPERATURE	84	K	1
LVLEV	LEVEL VELOCITY	235	M/S	0
MFCU	CARRYUNDER FLOW RATE	79	KG/SEC	0
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0
MFLOW	MASS FLOW RATE	79	KG/SEC	0
MODCHANW	CHAN-WALL HT MODE (NGRP+1)	51	(NONE)	0
MODROD	ROD HEAT TRANSFER MODE	51	(NONE)	1

Table 2-5. (continued)

Name	Description	Units Code	Units Values	Rod/ Level
MODTIM	TIME STEP MOD	77	(NONE)	0
MODWALLI	INNER WALL MODE	51	(NONE)	0
MR	M RATIO	77	(NONE)	0
MRAPP	APPLICABLE M RATIO	77	(NONE)	0
MREFF	EFFECTIVE M RATIO	77	(NONE)	0
NSTEP	NUMBER OF TIME STEPS	77	(NONE)	0
OITNO	NUMBER OF ITERATIONS	77	(NONE)	0
OMEGAN	PUMP SPEED (RAD/SEC)	89	RAD/SEC	0
OMEGAP	PUMP SPEED (RAD/SEC)	89	RAD/SEC	0
OMEGTUR	TURBINE SPEED	89	RAD/SEC	0
PDHL	DECAY POWER HYDRAULIC LEVEL	351	(NONE)	0
PDHN	DECAY POWER NEUTRONIC LEVEL	351	(NONE)	0
PEAKGRUP	GROUP # FOR PEAK RDT	77	(NONE)	0
PEAKRODT	PEAK ROD TEMPERATURE	84	K	0
PEAKTLEV	LVL # FOR PEAK RDT	77	(NONE)	0
PFLOW	PUMP MASS FLOW RATE	79	KG/SEC	0
POWERI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0
POWERT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0
PV	PRESSURE	137	PA	0
QCONV	CONV HEAT FLUX FOR GROUP	388	W/(M2)	1
QHS	HEAT INTO STRUCTURE	77	(NONE)	0
QRAD	RAD HEAT FLUX FOR GROUP	388	W/(M2)	1
QTOT	TOTAL HEAT FLUX FOR GROUP	388	W/(M2)	1
QUENBOTC	BOTTOM FLOOD Q POSITION	83	M	0
QUENBOTO	WALLOUT BF Q POSITION	83	M	0
QUENTOPC	FALLING FILM Q POSITION	83	M	0
QUENTOPO	WALLOUT FF Q POSITION	83	M	0
RADHL	RAD HTC LIQUID LIQUID FOR GROUP	155	W/M2-K	1
RADHV	RAD HTC LIQUID VAPOR FOR GROUP	155	W/M2-K	1
RADI	INTERNAL RADIATION TIME PERCENTAGE	77	(NONE)	0

Table 2-5. (continued)

Name	Description	Units Code	Units Values	Rod/ Level
RADT	TOTAL RADIATION TIME PERCENTAGE	77	(NONE)	0
RCBC	BORON REACTIVITY	77	(NONE)	0
RCCL	CONTROL REACTIVITY	77	(NONE)	0
RCFB	FEEDBACK REACTIVITY	77	(NONE)	0
RCTF	FUEL REACTIVITY	77	(NONE)	0
RCTM	MOD REACTIVITY	77	(NONE)	0
RCTT	TOTAL REACTIVITY	77	(NONE)	0
RCVD	VOID REACTIVITY	77	(NONE)	0
RHL	CONTAINMENT COMPARTMENT LIQUID MASS	229	KG	0
RHOM	MIXTURE DENSITY	71	KG/M3	0
RHOP	PUMP MIXTURE DENSITY	71	KG/M3	0
RMA	CPMNT AIR MASS	229	KG	0
RML	CPMNT LIQUID MASS	229	KG	0
RMS	CPMNT STEAM MASS	229	KG	0
ROA	AIR DENSITY	71	KG/M3	0
RODHL	ROD HTC LIQUID FOR GROUP	155	W/M2-K	1
RODHV	ROD HTC VAPOR FOR GROUP	155	W/M2-K	1
RODTIN	ROD PLOT TEMPERATURE FOR GROUP	84	K	1
RODTL	ROD SURFACE TEMPERATURE LIQUID, FOR GROUP	84	K	1
RODTV	ROD SURFACE TEMPERATURE VAPOR, FOR GROUP	84	K	1
RPOWL	PROMPT POWER HYDRAULIC LEVEL	152	(NONE)	0
RPOWN	PROMPT POWER NEUTRONIC LEVEL	152	(NONE)	0
SMOM	PUMP MOMENTUM SOURCE	240	M/SEC2	0
TFAV	AVERAGE FUEL TEMPERATURE	84	K	0
TFC	AVERAGE FUEL TEMPERATURE	84	K	0
THS	HEAT STR TEMPERATURE PROF	77	(NONE)	0
TIMET	REACTOR TIME (SECOND)	36	SEC	0
TL	LIQUID TEMPERATURE	84	K	0
TMAV	AVERAGE MODERATOR TEMPERATURE	84	K	0
TMC	AVERAGE MODERATOR TEMPERATURE	84	K	0

Table 2-5. (continued)

Name	Description	Units Code	Units Values	Rod/ Level
TORQM	MOTOR TORQUE	90	N-M	0
TORQTUR	TURBINE TORQUE	90	N-M	0
TORQUE	PUMP TORQUE	90	N-M	0
TOTPOW	TOTAL REACTOR POWER	351	W	0
TSAT	SATURATION TEMPERATURE	84	K	0
TSURF	ROD SURFACE TEMPERATURE	84	K	1
TV	VAPOR TEMPERATURE	84	K	0
TWALLI	INNER WALL T	74	W/M2-K	0
UL	CPMNT LIQUID ENERGY	309	J	0
UV	CPMNT VAPOR ENERGY	309	J	0
VDAV	AVERAGE VOID FRACTION	95	(NONE)	0
VFLOW	VOLUMETRIC FLOW RATE	241	M3/SEC	0
VLEAK	LEAK VELOCITY	79	KG/SEC	0
VLEV	LEVEL VELOCITY	147	M/S	1
VLN	LIQUID VELOCITY	79	KG/SEC	0
VLRN	LIQUID RADIAL VELOCITY	65	M/SEC	1
VLTN	LIQUID THETA VELOCITY	65	M/SEC	1
VLZN	LIQUID AXIAL VELOCITY	65	M/SEC	1
VM	MIXTURE VELOCITY	65	M/SEC	0
VR	RELATIVE VELOCITY	79	KG/SEC	0
VVN	VAPOR VELOCITY	65	M/SEC	0
VVRN	VAPOR RADIAL VELOCITY	183	M/SEC	1
VVTN	VAPOR THETA VELOCITY	182	M/SEC	1
VVZN	VAPOR AXIAL VELOCITY	183	M/SEC	1
ZPOWN	NEUTRONIC AXIAL POWER FRACTION	77	(NONE)	0
ZPOWR	AXIAL POWER FRACTION	77	(NONE)	0

Table 2-6. Complete list of plot variables in alphabetical order.

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
AIRP	AIR PRESSURE	137	PA	0	4	PIP GEN
AIRP	AIR PRESSURE	137	PA	0	4	TEE GEN
AIRP	AIR PRESSURE	137	PA	0	4	BRK
AIRP	AIR PRESSURE	137	PA	0	4	VLV GEN
AIRP	AIR PRESSURE	137	PA	0	4	FIL
AIRP	AIR PRESSURE	137	PA	1	5	VSL
AIRP	CPMNT AIR PRESSURE	137	PA	0	4	CTN
AIRP	AIR PRESSURE	137	PA	0	4	CHN GEN
AIRP	AIR PRESSURE	137	PA	0	4	PUM GEN
ALPCU	CARRYUNDER VOID FRACTION	95	(NONE)	0	2	TEE
ALPHA	VOID FRACTION	95	(NONE)	0	4	BRK
ALPHA	VOID FRACTION	95	(NONE)	0	4	FIL
ALPHA	VOID FRACTION	95	(NONE)	0	4	PUM GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	CHN GEN
ALPHA	VOID FRACTION	95	(NONE)	1	5	VSL
ALPHA	VOID FRACTION	95	(NONE)	0	4	TEE GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	VLV GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	PIP GEN
ALPHP	PUMP VOID FRACTION	95	(NONE)	0	2	PUM
ALPHIR	VOID FRACTION TO D.C.	95	(NONE)	0	2	TEE
ALPM	ALPHA MINUS	95	(NONE)	1	5	VSL
ALPP	ALPHA PLUS	95	(NONE)	1	5	VSL
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	VLV GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	CPN GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	TEE GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	1	5	VSL
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	PUM GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	PIP GEN
AREA	VALVE AREA	193	M2	0	4	VLV
BCAV	AVERAGE BORON	350	PPM	0	0	SPL TME
BORC	BORON(PPM)	350	PPM	0	4	TEE GEN
BORC	BORON(PPM)	350	PPM	0	4	PIP GEN
BORC	BORON(PPM)	350	PPM	0	4	FIL
BORC	BORON(PPM)	350	PPM	0	4	PUM GEN
BORC	BORON(PPM)	350	PPM	0	4	CHN GEN
BORC	BORON(PPM)	350	PPM	0	4	VLV GEN

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
BORC	BORON(PPM)	350	PPM	0	4	BRK
BORC	BORON(PPM)	350	PPM	1	5	VSL
BORONI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
BORONT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CBOUT	CONTROL BLOCK OUTPUT	77	(NONE)	0	6	CON SYS
CHANTW	CHAN SURFACE TEMPERATURE FOR GROUP # (NGRP+1)	74	K	0	4	CHN
CHANWHL	CHAN HTC LIQUID (NGRP+1)	155	W/((M2)(K))	0	4	CHN
CHANWHV	CHAN HTC VAPOR (NGRP+1)	155	W/((M2)(K))	0	4	CHN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	VLV GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	PUM GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	1	5	VSL
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	PIP GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	CHN GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	TEE GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	VLV GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	CHN GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	TEE GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	PIP GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	PUM GEN
CNDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDRODI	INTERNAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CNDRODT	TOTAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CONTLI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTLT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTMI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTMT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONVLOC	CONVERGENCE LOCATION	77	(NONE)	0	0	SPL TIME
CTOETIME	CPU TIME/ELAP. TIME	77	(NONE)	0	0	SPL TIME
CURLIMIT	COURANT T.S. LIMIT	77	(NONE)	0	0	SPL TIME
CURLOC	COURANT LOCATION	77	(NONE)	0	0	SPL TIME
DELP	PUMP DELTA - P	347	PA	0	2	PUM
DELT	TIME STEP SIZE	77	(NONE)	0	0	SPL TIME
DMPIT1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
DMPITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
DTCTS	CONTAINMENT TIMESTEP	77	(NONE)	0	0	SPL TIME
DTLMAX	MAXIMUM TL CHANGE	84	K	0	0	SPL TIME
DTRMAX	MAXIMUM TR CHANGE	84	K	0	0	SPL TIME
DTSMAX	MAXIMUM TS CHANGE	84	K	0	0	SPL TIME
DTVMAX	MAXIMUM TV CHANGE	84	K	0	0	SPL TIME
DZLEV	LEVEL POSITION	191	M	1	5	VSL
EDITI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
EDITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
EFFAPP	APPLICABLE EFFICIENCY	77	(NONE)	0	2	TEE
EFFEFF	EFFECTIVE EFFICIENCY	77	(NONE)	0	2	TEE
FRAPI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
FRAPT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	VLV GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	VLV GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	VLV GEN
GAMMA	PHASE MASS EXCHANGE	157	KG/S	0	4	CHN
GRAPI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
GRAFT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HEAD	PUMP HEAD	239	M2/SEC2	0	2	PUM
HTCDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
HTCRODI	INTERNAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
HTCRODT	TOTAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
HYDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
LIQLEV	SHELL LIQUID LEVEL	191	M	0	2	TEE
LLEV	D/C LIQUID LEVEL	191	M	0	4	VSL
LSTEMP	LUMPED SLAB TEMPERATURE	84	K	1	5	VSL
MFCU	CARRYUNDER FLOW RATE	79	KG/SEC	0	2	TEE
MFLEAK	BREAK MASS FLOW RATE	79	KG/SEC	0	2	BRK
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	VLV GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	FIL
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	PUM GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	TEE GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	CHN GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	PIP GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	PIP GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	CHN GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	PUM GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	TEE GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	VLV GEN
MODCHANW	CHAN-WALL HT MODE (NGRP+1)	51	(NONE)	0	4	CHN
MODTIM	TIME STEP MOD	77	(NONE)	0	0	SPL TIME
MR	M RATIO	77	(NONE)	0	2	TEE
NRAPP	APPLICABLE N RATIO	77	(NONE)	0	2	TEE
NPEFF	EFFECTIVE N RATIO	77	(NONE)	0	2	TEE
NSTEP	NUMBER OF TIME STEPS	77	(NONE)	0	0	SPL TIME
OITNO	NUMBER OF ITERATIONS	77	(NONE)	0	0	SPL TIME
OMEGAN	PUMP SPEED (RAD/SEC)	89	RAD/SEC	0	2	PUM
OMEGAP	PUMP SPEED (RAD/SEC)	89	RAD/SEC	0	2	PUM
OMEGTUR	TURBINE SPEED	89	RAD/SEC	0	2	TEE
PEAKGRUP	GROUP # FOR PEAK RDT	77	(NONE)	0	2	CHN
PEAKRODT	PEAK ROD TEMPERATURE	84	K	0	2	CHN
PEAKTLEV	LVL # FOR PEAK RDT	77	(NONE)	0	2	CHN
PFLOW	PUMP MASS FLOW RATE	79	KG/SEC	0	2	PUM

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
POWERI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
POWERT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
PV	PRESSURE	137	PA	0	4	PUM GEN
PV	CPMNT PRESSURE	137	PA	0	4	CTN
PV	PRESSURE	137	PA	0	4	CHN GEN
PV	PRESSURE	137	PA	0	4	PIP GEN
PV	PRESSURE	137	PA	0	4	TEE GEN
PV	PRESSURE	137	PA	0	4	VLV GEN
PV	PRESSURE	137	PA	0	4	BRK
PV	PRESSURE	137	PA	1	5	VSL
PV	PRESSURE	137	PA	0	4	FIL
QHS	HEAT INTO STRUCTURE	77	(NONE)	0	4	CTN
QUENBOTC	BOTTOM FLOOD Q POSITION	83	M	0	2	CHN
QUENBOTO	WALLOUT BF Q POSITION	83	M	0	2	CHN
QUENTOPC	FALLING FILM Q POSITION	83	M	0	2	CHN
QUENTOPO	WALLOUT FF Q POSITION	83	M	0	2	CHN
RADI	INTERNAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
RADT	TOTAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
RCBC	BORON REACTIVITY	77	(NONE)	0	0	SPL TIME
RCCL	CONTROL REACTIVITY	77	(NONE)	0	0	SPL TIME
RCFB	FEEDBACK REACTIVITY	77	(NONE)	0	0	SPL TIME
RCTF	FUEL REACTIVITY	77	(NONE)	0	0	SPL TIME
RCTM	MOD REACTIVITY	77	(NONE)	0	0	SPL TIME
RCTT	TOTAL REACTIVITY	77	(NONE)	0	0	SPL TIME
RCVD	VOID REACTIVITY	77	(NONE)	0	0	SPL TIME
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	TEE GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	PUM GEN
RHOM	MIXTURE DENSITY	71	KG/M3	1	5	VSL
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	PIP GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	CHN GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	VLV GEN
RHOP	PUMP MIXTURE DENSITY	71	KG/M3	0	2	PUM
RMA	CPMNT AIR MASS	229	KG	0	4	CTN
RML	CPMNT LIQUID MASS	229	KG	0	4	CTN
RMS	CPMNT STEAM MASS	229	KG	0	4	CTN
ROA	AIR DENSITY	71	KG/M3	0	4	VLV GEN

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
ROA	AIR DENSITY	71	KG/M3	1	3	VSL
ROA	AIR DENSITY	71	KG/M3	0	4	CHN GEN
ROA	AIR DENSITY	71	KG/M3	0	4	PIP GEN
ROA	AIR DENSITY	71	KG/M3	0	4	BRK
ROA	AIR DE[illegible]TY	71	KG/M3	0	4	TEE GEN
ROA	AIR DENSITY	71	KG/M3	0	4	PUM GEN
ROA	AIR DENSITY	71	KG/M3	0	4	FIL
SMOM	PUMP MOMENTUM SOURCE	240	M/SEC2	0	2	PUM
TFAV	AVERAGE FUEL TEMPERATURE	84	K	0	0	SPL TIME
THS	HEAT STR TEMPERATURE PROF	7[illegible]	(NONE)	0	4	CTN
TIME1	REACTOR TIME (SECOND)	36	SEC	0	0	SPL TIME
TL	LIQUID TEMPERATURE	84	K	0	4	VLV GEN
TL	LIQUID TEMPERATURE	84	K	0	4	FIL
TL	LIQUID TEMPERATURE	84	K	0	4	CHN GEN
TL	POOL TEMPERATURE	84	K	0	4	CTN
TL	LIQUID TEMPERATURE	84	K	1	5	VSL
TL	LIQUID TEMPERATURE	84	K	0	4	PUM GEN
TL	LIQUID TEMPERATURE	84	K	0	4	PIP GEN
TL	LIQUID TEMPERATURE	84	K	0	4	BRK
TL	LIQUID TEMPERATURE	84	K	0	4	TEE GEN
TMAV	AVERAGE MOD TEMPERATURE	84	K	0	0	SPL TIME
TORQM	MOTOR TORQUE	90	N-M	0	2	PUM
TORQTUR	TURBINE TORQUE	90	N-M	0	2	TEE
TORQUE	PUMP TORQUE	90	N-M	0	2	PUM
TOTPOW	TOTAL REACTOR POWER	351	W	0	0	SPL TIME
TSAT	SATURATION TEMPERATURE	84	K	0	4	CHN GEN
TSAT	SATURATION TEMPERATURE	84	K	1	5	VSL
TSAT	SATURATION TEMPERATURE	84	K	0	4	VLV GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	PIP GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	TEE GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	PUM GEN
TV	VAPOR TEMPERATURE	84	K	0	4	CHN GEN
TV	VAPOR TEMPERATURE	84	K	0	4	PUM GEN
TV	VAPOR TEMPERATURE	84	K	0	4	TEE GEN
TV	VAPOR TEMPERATURE	84	K	1	5	VSL
TV	VAPOR TEMPERATURE	84	K	0	4	PIP GEN

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
TV	VAPOR TEMPERATURE	84	K	0	4	FIL
TV	VAPOR TEMPERATURE	84	K	0	4	CTN
TV	VAPOR TEMPERATURE	84	K	0	4	BRK
TV	VAPOR TEMPERATURE	84	K	0	4	VLV GEN
UL	CPMNT LIQUID ENERGY	309	J	0	4	CTN
UV	CPMNT VAPOR ENERGY	309	J	0	4	CTN
VDAV	AVERAGE VOID FRACTION	95	(NONE)	0	0	SPL ME
VFLOW	VOLUMETRIC FLOW RATE	241	M3/SEC	0	2	PUM
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	TEE GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	VLV GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	CHN GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	PUM GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	PIP GEN
VLEV	LEVEL VELOCITY	147	M/S	1	5	VSL
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	PUM GEN
VLN	LIQUID VELOCITY	65	M/SEC	0	4	FIL
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	TEE GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	PIP GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	VLV GEN
VLN	LIQUID VELOCITY	183	M/SEC	0	4	BRK
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	CHN GEN
VLRN	LIQUID RADIAL VELOCITY	65	M/SEC	1	5	VSL
VLTN	LIQUID THETA VELOCITY	65	M/SEC	1	5	VSL
VLZN	LIQUID AXIAL VELOCITY	65	M/SEC	1	5	VSL
VM	MIXTURE VELOCITY	65	M/SEC	0	4	PIP GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	PUM GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	CHN GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	TEE GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	FIL
VM	MIXTURE VELOCITY	65	M/SEC	0	4	VLV GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	PIP GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	VLV GEN
VR	RELATIVE VELOCITY	65	M/SEC	0	4	FIL
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	PUM GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	TEE GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	CHN GEN

Table 2-6. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
VVN	VAPOR VELOCITY	65	M/SEC	0	4	FIL
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	TEE GEN
VVN	VAPOR VELOCITY	183	M/SEC	0	4	BRK
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	PIP GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	CHN GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	VLV GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	PUM GEN
VVRN	VAPOR RADIAL VELOCITY	183	M/SEC	1	5	VSL
VVTN	VAPOR THETA VELOCITY	183	M/SEC	1	5	VSL
VVZN	VAPOR AXIAL VELOCITY	183	M/SEC	1	5	VSL

Table 2-7. Complete list of plot variables by component.

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
TIMET	REACTOR TIME (SEC)	36	SEC	0	0	SPL TIME
DELT	TIME STEP SIZE	77	(NONE)	0	0	SPL TIME
DTLMAX	MAXIMUM TL CHANGE	84	K	0	0	SPL TIME
DTVMAX	MAXIMUM TV CHANGE	84	K	0	0	SPL TIME
DTSMAX	MAXIMUM TS CHANGE	84	K	0	0	SPL TIME
DTRMAX	MAXIMUM TR CHANGE	84	K	0	0	SPL TIME
TOTPOW	TOTAL REACTOR POWER	351	W	0	0	SPL TIME
TFAV	AVERAGE FUEL TEMPERATURE	84	K	0	0	SPL TIME
TMAV	AVERAGE MOD TEMPERATURE	84	K	0	0	SPL TIME
VDAV	AVERAGE VOID FRACTION	95	(NONE)	0	0	SPL TIME
BCAV	AVERAGE BORON	350	PPM	0	0	SPL TIME
RCTF	FUEL REACTIVITY	77	(NONE)	0	0	SPL TIME
RCTM	MOD REACTIVITY	77	(NONE)	0	0	SPL TIME
RCVD	VOID REACTIVITY	77	(NONE)	0	0	SPL TIME
RCBC	BORON REACTIVITY	77	(NONE)	0	0	SPL TIME
RCFB	FEEDBACK REACTIVITY	77	(NONE)	0	0	SPL TIME
RCCL	CONTROL REACTIVITY	77	(NONE)	0	0	SPL TIME
RCTT	TOTAL REACTIVITY	77	(NONE)	0	0	SPL TIME
DTCTS	CONTAINMENT TIMESTEP	77	(NONE)	0	0	SPL TIME
NSTEP	NUMBER OF TIME STEPS	.7	(NONE)	0	0	SPL TIME
OITNO	NUMBER OF ITERATIONS	77	(NONE)	0	0	SPL TIME
CTOETIME	CPU TIME/ELAP. TIME	77	(NONE)	0	0	SPL TIME
CURLIMIT	COURANT T.S. LIMIT	77	(NONE)	0	0	SPL TIME
MODTIM	TIME STEP MOD	77	(NONE)	0	0	SPL TIME
CURLOC	COURANT LOCATION	77	(NONE)	0	0	SPL TIME
CONVLOC	CONVERGENCE LOCATION	77	(NONE)	0	0	SPL TIME
DMPITI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
DMPITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
EDITI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
EDITT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
GRAFI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
GRAFT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTLI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTLT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTMI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CONTMT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
FRAPI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
FRAPT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
POWERI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
POWERT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
BORONI	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
BORONT	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HTCDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
CNDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDI3	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDT3	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDI1	INTERNAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
HYDDT1	TOTAL CPU TIME PERCENTAGE	77	(NONE)	0	0	SPL MODT
MFLEAK	BREAK MASS FLOW RATE	79	KG/SEC	0	2	BRK
VLN	LIQUID VELOCITY	183	M/SEC	0	4	BRK
VVN	VAPOR VELOCITY	183	M/SEC	0	4	BRK
PV	PRESSURE	137	PA	0	4	BRK
AIRP	AIR PRESSURE	137	PA	0	4	BRK
TL	LIQUID TEMPERATURE	84	K	0	4	BRK
TV	VAPOR TEMPERATURE	84	K	0	4	BRK
ALPHA	VOID FRACTION	95	(NONE)	0	4	BRK
BORC	BORON(PPM)	350	PPM	0	4	BRK
ROA	AIR DENSITY	71	KG/M3	0	4	BRK
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	FIL
VM	MIXTURE VELOCITY	65	M/SEC	0	4	FIL
VR	RELATIVE VELOCITY	65	M/SEC	0	4	FIL
VLN	LIQUID VELOCITY	65	M/SEC	0	4	FIL
VVN	VAPOR VELOCITY	65	M/SEC	0	4	FIL
PV	PRESSURE	137	PA	0	4	FIL
AIRP	AIR PRESSURE	137	PA	0	4	FIL
TL	LIQUID TEMPERATURE	84	K	0	4	FIL

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
TV	VAPOR TEMPERATURE	84	K	0	4	FI[illegible]
ALPHA	VOID FRACTION	95	(NONE)	0	4	FIL
BORC	BORON(PPM)	350	PPM	0	4	FIL
ROA	AIR DENSITY	71	KG/M3	0	4	FIL
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	VLV GEN
FRICWAL	LIQUID FRICTION FACTOR	[illegible]	(NONE)	0	4	VLV GEN
FRICWAV	VAPOR FRICTION FACTOR	206	(NONE)	0	4	VLV GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	VLV GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	VLV GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	VLV GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	[illegible]	VLV GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	VLV GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	VLV GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	VLV GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	VLV GEN
PV	PRESSURE	137	PA	0	4	VLV GEN
AIRP	AIR PRESSURE	137	PA	0	4	VLV GEN
TL	LIQUID TEMPERATURE	84	K	0	4	VLV GEN
TV	VAPOR TEMPERATURE	84	K	0	4	VLV GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	VLV GEN
BORC	BORON(PPM)	350	PPM	0	4	VLV GEN
ROA	AIR DENSITY	71	KG/M3	0	4	VLV GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	VLV GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	VLV GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	VLV GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	VLV GEN
AREA	VALVE AREA	193	M2	0	4	VLV
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	PIP GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	PIP GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	PIP GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	PIP GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	PIP GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	PIP GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	PIP GEN

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	PIP GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	PIP GEN
PV	PRESSURE	137	PA	0	4	PIP GEN
AIRP	AIR PRESSURE	137	PA	0	4	PIP GEN
TL	LIQUID TEMPERATURE	84	K	0	4	PIP GEN
TV	VAPOR TEMPERATURE	84	K	0	4	PIP GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	PIP GEN
BORC	BORON(PPM)	350	PPM	0	4	PIP GEN
ROA	AIR DENSITY	71	KG/M3	0	4	PIP GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	PIP GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	PIP GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	PIP GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	PIP GEN
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	PUM GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	PUM GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	PUM GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	PUM GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	PUM GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	PUM GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	PUM GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	PUM GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	PUM GEN
PV	PRESSURE	137	PA	0	4	PUM GEN
AIRP	AIR PRESSURE	137	PA	0	4	PUM GEN
TL	LIQUID TEMPERATURE	84	K	0	4	PUM GEN
TV	VAPOR TEMPERATURE	84	K	0	4	PUM GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	PUM GEN
BORC	BORON(PPM)	350	PPM	0	4	PUM GEN
ROA	AIR DENSITY	71	KG/M3	0	4	PUM GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	PUM GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	PUM GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	PUM GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	PUM GEN
OMEGAP	PUMP SPEED (RADIATION/SECOND)	89	RAD/SEC	0	2	PUM

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
OMEGAN	PUMP SPEED (RADIATION/SECOND)	89	RAD/SEC	0	2	PUM
RHOP	PUMP MIXTURE DENSITY	71	KG/M3	0	2	PUM
VFLOW	VOLUMETRIC FLOW RATE	241	M3/SEC	0	2	PUM
ALPHP	PUMP VOID FRACTION	95	(NONE)	0	2	PUM
HEAD	PUMP HEAD	239	M2/SEC2	0	2	PUM
TORQUE	PUMP TORQUE	90	N-M	0	2	PUM
SMOM	PUMP MOMENTUM SOURCE	240	M/SEC2	0	2	PUM
DELP	PUMP DELTA - P	347	PA	0	2	PUM
PFLOW	PUMP MASS FLOW RATE	79	KG/SEC	0	2	PUM
TCJQM	MOTOR TORQUE	90	N-M	0	2	PUM
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	TEE GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	TEE GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	TEE GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	TEE GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	TEE GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	TEE GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	TEE GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	TEE GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	TEE GEN
PV	PRESSURE	137	PA	0	4	TEE GEN
AIRP	AIR PRESSURE	137	PA	0	4	TEE GEN
TL	LIQUID TEMPERATURE	84	K	0	4	TEE GEN
TV	VAPOR TEMPERATURE	84	K	0	4	TEE GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	TEE GEN
BORC	BORON(PPM)	350	PPM	0	4	TEE GEN
ROA	AIR DENSITY	71	KG/M3	0	4	TEE GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	TEE GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	TEE GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	TEE GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	TEE GEN
OMEGTUR	TURBINE SPEED	89	RAD/SEC	0	2	TEE
TORQTUR	TURBINE TORQUE	90	N-M	0	2	TEE
ALPHTR	VOID FRACTION TO D.C.	95	(NONE)	0	2	TEE
LIQLEV	SHELL LIQUID LEVEL	191	M	0	2	TEE

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
MFCU	CARRYUNDER FLOW RATE	79	KG/SEC	0	2	TEE
ALPCU	CARRYUNDER VOID FRACTION	95	(NONE)	0	2	TEE
MR	M RATIO	77	(NONE)	0	2	TEE
NREFF	EFFECTIVE N RATIO	77	(NONE)	0	2	TEE
EFFEFF	EFFECTIVE EFFICIENCY	77	(NONE)	0	2	TEE
NRAPP	APPLICABLE N RATIO	77	(NONE)	0	2	TEE
EFFAPP	APPLICABLE EFFICIENCY	77	(NONE)	0	2	TEE
CLEVL	COLLAPSED LIQUID LEVEL	191	M	0	2	CHN GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	CHN GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	CHN GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	CHN GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	CHN GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	CHN GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	CHN GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	CHN GEN
PV	PRESSURE	137	PA	0	4	CHN GEN
AIRP	AIR PRESSURE	137	PA	0	4	CHN GEN
TL	LIQUID TEMPERATURE	84	K	0	4	CHN GEN
TV	VAPOR TEMPERATURE	84	K	0	4	CHN GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	CHN GEN
BORC	BORON(PPM)	350	PPM	0	4	CHN GEN
ROA	AIR DENSITY	71	KG/M3	0	4	CHN GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	CHN GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	CHN GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	CHN GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	CHN GEN
QUENTOPC	FALLING FILM Q POSITION	83	M	0	2	CHN
QUENBOTC	BOTTOM FLOOD Q POSITION	83	M	0	2	CHN
QUENTOPO	WALLOUT FF Q POSITION	83	M	0	2	CHN
QUENBOTO	WALLOUT BF Q POSITION	83	M	0	2	CHN
PEAKTLEV	LVL # FOR PEAK RDT	77	(NONE)	0	2	CHN
PEAKGRUP	GROUP # FOR PEAK RDT	77	(NONE)	0	2	CHN
PEAKRODT	PEAK ROD TEMPERATURE	84	K	0	2	CHN

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
CHANWHL	CHAN HTC LIQUID (NGRP+1)	155	W/((M2)(K))	0	4	CHN
CHANWHV	CHAN HTC VAPOR (NGRP+1)	155	W/((M2)(K))	0	4	CHN
GAMMA	PHASE MASS EXCHANGE	157	KG/S	0	4	CHN
CHANTW	CHAN SURFACE TEMPERATURE FOR GROUP # (NGRP+1)	74	K	0	4	CHN
MODCHANW	CHAN-WALL HT MODE (NGRP+1)	51	(NONE)	0	4	CHN
HTCRODI	INTERNAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CNDRODI	INTERNAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
RADI	INTERNAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
HTCRODT	TOTAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CNDRODT	TOTAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
RADT	TOTAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
PV	PRESSURE	137	PA	1	5	VSL
AIRP	AIR PRESSURE	137	PA	1	5	VSL
TL	LIQUID TEMPERATURE	84	K	1	5	VSL
TV	VAPOR TEMPERATURE	84	K	1	5	VSL
ALPHA	VOID FRACTION	95	(NONE)	1	5	VSL
BORC	BORON(PPM)	350	PPM	1	5	VSL
ROA	AIR DENSITY	71	KG/M3	1	3	VSL
RHOM	MIXTURE DENSITY	71	KG/M3	1	5	VSL
TSAT	SATURATION TEMPERATURE	84	K	1	5	VSL
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	1	5	VSL
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	1	5	VSL
VLTN	LIQUID THETA VELOCITY	65	M/SEC	1	5	VSL
VLZN	LIQUID AXIAL VELOCITY	65	M/SEC	1	5	VSL
VLRN	LIQUID RADIAL VELOCITY	65	M/SEC	1	5	VSL
VVTN	VAPOR THETA VELOCITY	183	M/SEC	1	5	VSL
VVZN	VAPOR AXIAL VELOCITY	183	M/SEC	1	5	VSL
VVRN	VAPOR RADIAL VELOCITY	183	M/SEC	1	5	VSL
DZLEV	LEVEL POSITION	191	M	1	5	VSL
VLEV	LEVEL VELOCITY	147	M/S	1	5	VSL
ALPP	ALPHA PLUS	95	(NONE)	1	5	VSL
ALPM	ALPHA MINUS	95	(NONE)	1	5	VSL
LSTEMP	LUMPED SLAB TEMPERATURE	84	K	1	5	VSL
LLEV	D/C LIQUID LEVEL	191	M	0	4	VSL
PV	CPMNT PRESSURE	137	PA	0	4	CTN
AIRP	CPMNT AIR PRESSURE	137	PA	0	4	CTN

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
MFCU	CARRYUNDER FLOW RATE	79	KG/SEC	0	2	TEE
ALPCU	CARRYUNDER VOID FRACTION	95	(NONE)	0	2	TEE
MR	M RATIO	77	(NONE)	0	2	TEE
NREFF	EFFECTIVE N RATIO	77	(NONE)	0	2	TEE
EFFEFF	EFFECTIVE EFFICIENCY	77	(NONE)	0	2	TEE
NRAPP	APPLICABLE N RATIO	77	(NONE)	0	2	TEE
EFFAPP	APPLICABLE EFFICIENCY	77	(NONE)	0	2	TEE
CLEVL	COLLAPSED LIQUID LEVEL	191	K	0	2	CHN GEN
FRICWAL	LIQUID FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICWAV	VAPOR FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
FRICINTR	INTERNAL FRICTION FACTOR	208	(NONE)	0	4	CHN GEN
VM	MIXTURE VELOCITY	65	M/SEC	0	4	CHN GEN
VR	RELATIVE VELOCITY	79	KG/SEC	0	4	CHN GEN
MFLEAK	LEAK MASS FLOW RATE	79	KG/SEC	0	2	CHN GEN
VLEAK	LEAK VELOCITY	79	KG/SEC	0	2	CHN GEN
MFLOW	MASS FLOW RATE	79	KG/SEC	0	4	CHN GEN
VLN	LIQUID VELOCITY	79	KG/SEC	0	4	CHN GEN
VVN	VAPOR VELOCITY	79	KG/SEC	0	4	CHN GEN
PV	PRESSURE	137	PA	0	4	CHN GEN
AIRP	AIR PRESSURE	137	PA	0	4	CHN GEN
TL	LIQUID TEMPERATURE	84	K	0	4	CHN GEN
TV	VAPOR TEMPERATURE	84	K	0	4	CHN GEN
ALPHA	VOID FRACTION	95	(NONE)	0	4	CHN GEN
BORC	BORON(PPM)	350	PPM	0	4	CHN GEN
ROA	AIR DENSITY	71	KG/M3	0	4	CHN GEN
RHOM	MIXTURE DENSITY	71	KG/M3	0	4	CHN GEN
TSAT	SATURATION TEMPERATURE	84	K	0	4	CHN GEN
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	0	4	CHN GEN
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	0	4	CHN GEN
QUENTOPC	FALLING FILM Q POSITION	83	M	0	2	CHN
QUENBOTC	BOTTOM FLOOD Q POSITION	83	M	0	2	CHN
QUENTOPO	WALLOUT FF Q POSITION	83	M	0	2	CHN
QUENBOTO	WALLOUT BF Q POSITION	83	M	0	2	CHN
PEAKTLEV	LVL # FOR PEAK RDT	77	(NONE)	0	2	CHN
PEAKGRUP	GROUP # FOR PEAK RDT	77	(NONE)	0	2	CHN
PEAKRODT	PEAK ROD TEMPERATURE	84	K	0	2	CHN

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
CHANWHL	CHAN HTC LIQUID (NGRP+1)	155	W/((M2)(K))	0	4	CHN
CHANWHV	CHAN HTC VAPOR (NGRP+1)	155	W/((M2)(K))	0	4	CHN
GAMMA	PHASE MASS EXCHANGE	157	KG/S	0	4	CHN
CHANTW	CHAN SURFACE TEMPERATURE FOR GROUP # (NGRP+1)	74	K	0	4	CHN
MODCHANW	CHAN-WALL HT MODE (NGRP+1)	51	(NONE)	0	4	CHN
HTCRODI	INTERNAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CNDRODI	INTERNAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
RADI	INTERNAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
HTCRODT	TOTAL HTCROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
CNDRODT	TOTAL CNDROD TIME PERCENTAGE	77	(NONE)	0	2	CHN
RADT	TOTAL RADIATION TIME PERCENTAGE	77	(NONE)	0	2	CHN
PV	PRESSURE	137	PA	1	5	VSL
AIRP	AIR PRESSURE	137	PA	1	5	VSL
TL	LIQUID TEMPERATURE	84	K	1	5	VSL
TV	VAPOR TEMPERATURE	84	K	1	5	VSL
ALPHA	VOID FRACTION	95	(NONE)	1	5	VSL
BORC	BORON(PPM)	350	PPM	1	5	VSL
ROA	AIR DENSITY	71	KG/M3	1	3	VSL
RHOM	MIXTURE DENSITY	71	KG/M3	1	5	VSL
TSAT	SATURATION TEMPERATURE	84	K	1	5	VSL
CHTI	H.T. COEFFICIENT - VAPOR TO INTERFACE	155	W/((M2)(K))	1	5	VSL
ALV	H.T. COEFFICIENT - LIQUID TO INTERFACE	155	W/((M2)(K))	1	5	VSL
VLTN	LIQUID THETA VELOCITY	65	M/SEC	1	5	VSL
VLZN	LIQUID AXIAL VELOCITY	65	M/SEC	1	5	VSL
VLRN	LIQUID RADIAL VELOCITY	65	M/SEC	1	5	VSL
VVTN	VAPOR THETA VELOCITY	183	M/SEC	1	5	VSL
VVZN	VAPOR AXIAL VELOCITY	183	M/SEC	1	5	VSL
VVRN	VAPOR RADIAL VELOCITY	183	M/SEC	1	5	VSL
DZLEV	LEVEL POSITION	191	M	1	5	VSL
VLEV	LEVEL VELOCITY	147	M/S	1	5	VSL
ALPP	ALPHA PLUS	95	(NONE)	1	5	VSL
ALPM	ALPHA MINUS	95	(NONE)	1	5	VSL
LSTEMP	LUMPED SLAB TEMPERATURE	84	K	1	5	VSL
LLEV	D/C LIQUID LEVEL	191	M	0	4	VSL
PV	CPMNT PRESSURE	137	PA	0	4	CTN
AIRP	CPMNT AIR PRESSURE	137	PA	0	4	CTN

Table 2-7. (continued)

Name	Description	Units Code	Units Value	Rod/ Level	Type	Component
TL	POOL TEMPERATURE	84	K	0	4	CTN
TV	VAPOR TEMPERATURE	84	K	0	4	CTN
RML	CPMNT LIQUID MASS	229	KG	0	4	CTN
RMS	CPMNT STEAM MASS	229	KG	0	4	CTN
RMA	CPMNT AIR MASS	229	KG	0	4	CTN
UV	CPMNT VAPOR ENERGY	309	J	0	4	CTN
UL	CPMNT LIQUID ENERGY	309	J	0	4	CTN
QHS	HEAT INTO STRUCTURE	77	(NONE)	0	4	CTN
THS	HEAT STR TEMPERATURE PROF	77	(NONE)	0	4	CTN
CBOUT	CONTROL BLOCK OUTPUT	77	(NONE)	0	6	CON SYS

for the level, in the case of the VESSEL component. A nonzero value indicates that, for the CHAN or VESSEL, this number must be included. Thus, a channel identifier of the form NAME-CCLLNN would be used for variables with a rod or level, and an identifier of the form NAME-CCOONN would be used for the other variables, where NN is the component number, LL is the rod or level number, and NN is the cell number. The heading "Type" indicates to programmers where the data are in the TRAC data base (0 = selected variables, 2 = real variable length table, 3 = integer variable length table, 4 = array data, 5 = rod or level data, 6 = control system data).

Programmers adding new plot variables should be aware of the reason for using exactly six or three digits (or one for TIMET-1) in the numeric field. They must also realize that all the channel names must be unique for all characters prior to the nth position, where n is the position of the left-most minus sign. (For example, ABC- and AB- are not unique to the left of position 3 and should not both be used as identifiers.) The reason for these requirements is that the collating sequence on the CDC and ASCII collating sequence are different for non-alphabetic characters. Therefore, to maintain machine-independent collating sequences (and identical coding regardless of machine), the above rules must be observed.

The plot data are stored in the HUNI-B format, a data storage format developed for use with the Idaho Scientific Data Management System[2-2] (ISDMS). This format replaces the CWAF format used in earlier versions of TRAC-B, and all references to CWAF in the TRAC-BD1/MOD1 manual are now superseded.

2.9 REFERENCES

2-1. R. W. Shumway et al., *TRAC-BD1/MOD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Transient Analysis, Volume 2: Users Guide*, NUREG/CR-3633, EGG-2294, April 1984.

2-2. H. R. Bruestle et al., *Idaho Scientific Data Management System*, EGG-IS-5287, November 1980.

3. INPUT SPECIFICATIO. S

A detailed description of the data to be entered on the cards in a TRAC-BF1/MOD1 problem deck is given in this section. Unless specifically noted otherwise, all quantities sho''ld be entered in SI units. A list of units associatd with input variables is given in Table 3-1.

Table 3-1. SI units used for TRAC-BF1/MOD1 input.

Input quantity	SI unit
Length	m
Mass	kg
Time	s
Volume	m^3
Temperature	K
Pressure	Pa
Velocity	m/s
Density	kg/m^3
Torque	N-m
Power	W
Specific heat	J/kg-K
Thermal conductivity	W/m-K
Heat transfer coefficient	W/m^2-K
Volumetric heat source	W/m^3

In the following input description, the R, I, or A shown for each variable means real, integer, or alphanumeric, respectively.

For any real or integer input variables that are optional in the following input descriptions, the default value is zero unless otherwise noted. For alphanumeric input, the default is blanks. The input can be in any order the user finds convenient.

3.1 MAIN CONTROL DATA

3.1.1 TRAC-BF1 Title Card

This card must be present. An equal sign (=) is the first nonblank character, followed by any alphanumeric characters used for a deck name.

3.1.2 Non-Free Field Control Cards

Two input cards may require processing prior to the use of the free field input processing routines. These cards are, therefore, in a fixed format, namely "A10,F10.0". The first of these cards is required when running more than 77 seconds of CPU time. The second can be used to adjust the initial dynamic storage allocation for input processing. However, this card is rarely needed, since preload normally supplies this capability.

Card identifier (Starting in Column 1)	Floating point value (Columns 11-20)
*-MXTIME	Maximum time in seconds for job (or job step, depending on the operating system). Default = 1.0E+7.
*-LAST	Initial input processing storage allocation. (See the discussion of dynamic dimensioning and preload processing before attempting to use.)

3.1.3 General Control Card, OPTIONS

All variables on tnis card are optional, and the card may be omitted if all variables are to use default values. Example: (for extracting 25 components) OPTIONS 0 0 0 25 0.

Word	Variable	Description (OPTIONS)
W1-I	IEOS	Air/water option. If IEOS = 1, water vapor is replaced by air throughout TRAC. (Default = 0).
W2-I	NTRACE	Flag indicating level of detailed error traceback desired. NTRACE = -1, no traceback. 0-5, 9 various levels of traceback. (Levels 6 through 8 are currently inactive.)

Word	Variable	Description (OPTIONS)
		(Default = 0).
W3-I	IST	Subroutine timing option. 1 = no timing. 0 = minimum list of subroutines timed. 1 = medium list, 2 = maximum list. (Default = -1).
W4-I	NEXTR	The number of components to be extracted from a TRAC Dump file. (Default = 0).
W5-I	MASTPR	Control parameter for debugging printout. Most of this debugging output concerns storage allocations. (Default value = 5). None of the options below produce a large amount of extra output. 0 or 5 = no debugging output 3 = detailed debugging output 4 = general debugging output

3.1.4 Secondary Title Cards, TITLEXX

These cards are optional. They may contain any alphanumeric information, which must be enclosed in quotes on each card.

3.1.5 Main Control Cards, MAINXX

The first 17 variables are required.

Word	Variable	Description (MAIN)
W1-I	DSTEP	Time step number of dump to be used for restart. If DSTEP is less than zero, the last dump will be used for restart or extraction.
W2-R	TIMET	Problem start time. If TIMET is less than zero, the start time will be the time specified on the retrieved dump.
W3-I	STDYST	Steady-state calculation indicator: 0 = no steady-state calculation, 1 = steady-state calculation.
W4-I	TRANSI	Transient calculation indicator 1 = transient calculation, 0 = no transient to be calculated.

Word	Variable	Description (MAIN)
W5-I	NCOMP	Number of components.
W6-I	NJUN	Number of junctions.
W7-I	IPAK	Water packing option (0 = off, 1 = on). It is recommended that IPAK=0 be used.
W8-R	EPSO	Convergence criterion for outer iteration (suggested value = 1.0 E-04).
W9-R	EPSI	Convergence criterion for vessel iteration (suggested value = 1.0 E-05).
W10-R	EPSS	Convergence criterion for steady-state calculation (relative change/second in percent) (suggested value = 0.1).
W11-I	IMPCON	Fully implicit option for conduction boundary condition. IMPCON not equal to zero sets fully implicit option for both steady-state and transient calculations. Input as zero unless surface temperature instability is noted.
W12-I	OITMAX	Maximum number of outer iterations (suggested value = 8).
W13-I	IITMAX	Maximum number of vessel iterations. (If the number of vessel cells is 64 or less, use IITMAX=0. This results in direct inversion of the vessel matrix. For more than 64 vessel cells, use IITMAX=10 if insufficient SCM storage is available for direct inversion.)
W14-R	CSF1D	Maximum Courant number in one-dimensional components.
W15-I	NTRX	Number of trips specified, including vessel level trips.
W16-I	NLEAKP	Number of leak paths. One leak path connects two components.
W17-I	NAXN	Number of hydraulic levels in neutronic core region. NAXN=0 implies no CHAN components in the problem. NAXN cannot change on restart.
W18-I	NDMPTR	Number of trips on which a dump is to be taken.
W19-I	ICTR	Control system flag 0 = no control system calculation
	+1	= control system calculation with control system data included in major edit
	-1	= control system calculation with no edit of control system data (default = 0).

Word	Variable	Description (MAIN)
W20-I	IBORC	Boron tracking control flag. 0 = no boron tracking 1 = boron tracking calculation performed (default = 0).
W21-I	IAIR	Noncondensible gas control flag. 0 = no noncondensible gas 1 = noncondensible gas calculation performed (default = 0).
W22-I	NROT	Number of turbine rotor assemblies (default = 0).
W23-I	NUMMPT	Number of material property tables. This should be the total of those on the restart file plus any new tables, excluding replacement tables, on the input file (default = 0).
W24-I	LEV1	Level tracking option flag for all 1-D (non-vessel) components. 0 = no level tracking 1 = level tracking performed (default = 0).
W25-I	NDISLP	Number of disconnected 1-D loops in model. Used mainly when modeling condensers (default = 0).
W26-I	ICONTA	Containment option flag. 0 = no containment model 1 = containment model to be used (default = 0).

3.1.6 Component List Cards, COMPLISTXX

User must input the number of every component which enters into the problem solution. The numbers need not be consecutive or in order.

Word	Variable	Description (COMPLIST)
W1-I	IORDER(1)	1st component number.
W2-I	IORDER(2)	2nd component number.
W3-I	IORDER(3)	etc.

3.1.7 Program Checkout Card, CHECKOUT

The program checking option card, CHECKOUT, provides options for stopping the code in various manners, rewinding the output file, controlling the amount of dump information displayed, and controlling machine dependencies and debugging printout, as described below.

Word	Variable	Description (CHECKOUT)
W1-I	ITSTOP	Time step at which job is to terminate normally. The default value of zero is replaced by a value of 10,000,000 and therefore does not stop the run. To save execution time for checkout runs, if ITSTOP = 2, then the graphics catalog generation is turned off by resetting NOGRAF to 7 automatically.
W2-I	IESTOP	Edit sequence number at which job is to terminate normally. The default value of zero is replaced by a value of 10,000,000 and therefore does not stop the run.
W3-I	MKFAIL	Time step at which run is to be forced to fail with a Mode 1 error. This option is for programmer use only to check out the ability of TRAC to recover from disastrous type errors. The default value of zero is replaced by a value of 10,000,000 and therefore does not stop the run.
W4-I	IRWIND	Time step at which the TRAC output file is to be rewound to minimize output. If IRWIND is set to -1, the output file is rewound prior to the last edit if termination is made normally; otherwise, the output file is not rewound. The default, zero, implies no rewinding.
W5-I	IDUMPP	Size of automatic dump display. IDUMPP words on either side of the abnormal termination location will be printed in a detailed format. f IDUMP is <0, the automatic dump display and abort reprieve logic will be skipped. (The purpose of this option with a value <0 is to allow preserving the dump information if a normal dump is desired.)
W6-I	IREMTI	Flag for skipping the remaining time calculation. Use IREMTI >0 in order to skip the call to the subroutine that calculates the remaining time. The use of this routine is important in saving the dump and, particularly, the graphics files, so IREMTI should be set positive only if this routine does not work on a particular operating system.
W7-I	NOGRAF	= 0, do graphics processing = 1, do graphics processing and print channel summary

Word	Variable	Description (CHECKOUT)
		= 2, do graphics processing with detailed debugging output = 7, skip graphics processing
W8-I	IEVTSE	Every time step edit debugging flag = 0, no special edits >0, get an edit every time step from time step IEVTSE on. <0, get an edit every time step from time step IEVTSE at the usual call to EDIT and after calling subroutine OUTER and before calling subroutine POST.

3.2 TRIP DATA

3.2.1 Trip Data Cards, TRIPCNX

NTRX sets (1 set per trip) of trip cards are input unless information is being read from a TRAC restart file (TRCRST). If less than NTRX sets are input, the remaining trips are initialized from the TRCRST file. (It should be noted that the state as well as the definition of the trip is obtained from the restart file.) Trips with IDs equal to or greater than 1000 will cause the time step size to be reduced to the minimum allowable size (i.e., DTMIN) and then allowed to recover.

The card number, CN, must be different for each trip. For each trip, the first four variables are required.

Word	Variable	Description (TRIP)
W1-I	ITID	Trip ID number.
W2-I	ISID	Trip signal index identifies variable to be observed (see Table 2-1). The trip will occur as the setpoint value is approached from below if ISID is positive and as the point is approached from above if ISID is negative.
W3-R	TSP	Trip setpoint defines the value at which the trip will occur.
W4-R	TDT	Trip time delay. Trip occurs after delay time elapses following the time when the setpoint is reached.
W5-A	TTITLE	User trip description. Use 11 to 16 characters enclosed in quotes.
W6-I	ID1	First trip qualifier. Identifies the component ID number associated with trip number ITID. ID1-ID4 are ignored if ISID=0.
W7-I	ID2	Second trip qualifier ID2 = 0 unless ID1 is a VESSEL. For a VESSEL, ID2 = VESSEL axial level associated with the trip. For a downcomer level trip, set ID2 = 1 and the collapsed level height will be taken from the top of the vessel to the bottom of the downcomer.
W8-I	ID3	Third trip qualifier.
W9-I	ID4	Fourth trip qualifier. ID3 and ID4 give the cell numbers

Word	Variable	Description (TRIP)
		where the parameter given by ISID is monitored. See Table 2-2.
W10-A	NAMEUV	For versions with the Nuclear Plant Analyzer capability only. Name of user-defined interactive control variable. (FUTYPE = "U") as specified on ICVARXX cards. If NAMEUV is present, ISID must have a value of 12 or -12.

3.2.2 Trip Dump Cards, TRIPDUMPXX

These cards must contain NDMPTR integers; 0 ≤ NDMPTR ≤ 99. XX is a sequence number between 00 and 99 inclusive.

Word	Variable	Description (TRIP)
W1-I	IDMPTR(1)	First trip ID number which causes dump.
W2-I	IDMPTR(2)	Second trip ID number which causes dump.
W3-I	IDMPTR(3)	etc.

3.3 TIME STEP DATA

This set of input information is the time step cards for controlling the calculation. The problem time span is separated into domains. Each domain (specified by one card number, CN) may have different minimum and maximum time step sizes and edit intervals.

3.3.1 Time Step Data Cards, TIMESTEPCNX

The CN's must be in ascending order as the TEND's increase, but need not be sequential.

Word	Variable	Description (TIMESTEP)
W1-R	DTMIN	Minimum allowable time step size for this time domain.
W2-R	DTMAX	Maximum allowable time step size for this time domain.
W3-R	TEND	End of this time domain.
W4-R	RTWFP	Ratio between heat transfer and fluid dynamics time step sizes. RTWFP $\geq$1.0 (used only for steady-state calculations, suggested value = 1.0E+3).
W5-R	EDINT	Print edit interval for this time domain.
W6-R	GFINT	Graphics edit interval for this time domain.
W7-R	DMPINT	Restart dump interval for this time domain.
W8-R	SEDINT	Short print edit interval for this time domain.

3.3.2 Time Step Multiplier Card, SOPTION

One card containing a trip number may be included for controlling the heat transfer time step size for the transient calculation. If a card is present and contains a valid trip number, the hydrodynamic time step will be multiplied by RTFWP (on time step data cards) until the trip is activated. After the trip, or if the card is not input, the heat transfer time step will equal the hydrodynamic time step.

Time Step Data

Word	Variable	Description (SOPTION)
W1-I	IHTTRP	Trip number for heat transfer time step multiplier.

3.4 COMPONENT DESCRIPTION DATA

NCOMP or fewer sets of component description cards are input. If less than NCOMP sets are input, the remaining components are initialized from the restart file TRCRST. The format of each set is dependent upon the component type. All tables that involve pairs of numbers (x,y) should have data supplied in ascending order of the independent variable x.

Each component requires the user to supply a junction number JUN for each of its connecting points. A PIPE will require two junction numbers, one for each end. A junction is the point at which two components are connected. A unique junction number must be assigned to each connecting point and referenced by both of the components that are to be joined. For example, if two PIPES are to be joined, then the junction number of the connecting end of each PIPE needs to be the same. No component may connect to itself, and every junction must connect two components. A single-ended components (BREAK or FILL) may be used to complete a junction.

3.4.1 BREAK Component (BREAK)

BREAK Header Card, BREAKID000

NOTE: A BREAK cannot be connected directly to a VESSEL.

Word	Variable	Description (BREAK)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

BREAK Simple Parameter Card, BREAKID01X

All nine words are required.

Word	Variable	Description (BREAK)
W1-I	JUN1	Junction number at which break is located.
W2-I	IBROP	BREAK table read option. 0 = BREAK conditions constant or determined by control system 1 = read pressure table 2 = read pressure and temperature tables 3 = read pressure, temperature, and void fraction tables. Use IBROP=0 for steady state (STDYST=1 on Card MAINXX).
W3-I	NBTB	Number of pairs for each BREAK table.
W4-I	ISAT	BREAK temperature table use option (make consistent with IBROP). 0 = use TIN or table for liquid and vapor temperatures 1 = use TIN or table for liquid temperature and set vapor to T_{sat} 2 = use TIN or table for vapor temperature and set liquid to T_{sat} 3 = set liquid and vapor to T_{sat} 4 = use separate tables for liquid and vapor temperature.
W5-I	ICOMT	Flag to indicate connection of BREAK to containment.

Word	Variable	Description (BREAK)
		ICOMT = 0 implies no connection.
		ICOMT <0 implies the BREAK is located in the pool region of the containment compartment whose user ID is ICOMT .
		ICOMT >0 implies the BREAK is located in the vapor region of the containment compartment whose user ID is ICOMT.

(NOTE: ICOMPT and IBROP must not both be nonzero. Also, ICHOKE should be zero at the 1-D component junction before any BREAK with ICOMT=1.)

Word	Variable	Description (BREAK)
W6-R	DXIN	Length of BREAK cell. (Generally taken to be the same as its neighboring cell in the adjacent PIPE.)
W7-R	VOLIN	Volume of BREAK cell. (Generally taken to be the same as its neighboring cell in the adjacent PIPE.)
W8-R	ALPIN	Void fraction of mixture at BREAK. (Usually 1.0).
W9-R	TIN	Temperature of mixture at BREAK. (Usually taken to be the saturation temperature corresponding to the BREAK pressure.)
W10-R	PIN	Pressure at BREAK.

BREAK Simple Parameter Card, BREAKID02X

Word	Variable	Description (BREAK)
W1-R	BORCIN	Boron concentration in BREAK (ppm) (default = 0.0, required if IBORC = 1 and BORCIN not equal to 0.0).

BREAK Simple Parameter Card, BREAKID03X

Word	Variable	Description (BREAK)
W1-R	PAIN	Noncondensible gas pressure in BREAK (default = 0.0, required if IAIR = 1 and PAIN not equal to 0.0).

BREAK Table Cards, BREAKID13X-BREAKID16X

Omit these cards if NBTB=0. Tables are in LOAD format. Table values are not used for steady-state runs. (All tables are in time, variable pairs. Only the liquid temperature table is needed unless ISAT = 4. All variables are real.)

CN	Variable	Dimension	Description (BREAK)
13	PTB	2*NBTB	Pressure table.
14	TLTB	2*NBTB	Liquid temperature table.
15	TVTB	2*NBTB	Vapor temperature table.
16	ALPTB	2*NBTB	Void fraction table.
17	BORTB		Boron concentration table (optional, default = 0.0, used when BREAK option uses any other table and IBORC = 1).
18	PATB		Noncondensible gas pressure table (optional, used when BREAK option uses any other table and IAIR = 1, default = 0.0).

3.4.2 CHANNEL Component (CHAN)

CHAN Header Card, CHANID0000O

Word	Variable	Description (CHAN)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User-optional description of component. Up to 30 characters may be used. Enclose them in quotes.

CHAN Simple Parameters Card 1, CHANID0001X

The first 11 variables are required.

Word	Variable	Description (CHAN)
W1-I	NCELLS	Number of fluid cells in this CHAN.
W2-I	NODES	Number of radial heat transfer nodes in CHAN wall (Minimum = 1).
W3-I	JUN1	Junction number for junction adjacent to cell 1.
W4-I	JUN2	Junction number of junction adjacent to cell NCELLS.
W5-I	MAT	Material ID of CHAN wall. 2 = Zircaloy 6 = SS 304 7 = SS 316 8 = SS 347 9 = Carbon steel A508 10 = Inconel 718 11 = ZrO_2 21-99 = Input table.
W6-I	ICHF	CHF calculation flag. Neg = No CHF allowed. 0 = use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow. (Suggested value = 2).

Word	Variable	Description (CHAN)
		Note that the CHAN heat transfer coefficients used for convection on the printout may be negative because of the axial averaging done internally.
W7-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component which is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.
W8-I	IEDTEM	Rod temperature print/plot. >0 print all internal temperatures and write node IEDTEM to RODTIN on plot file. = 0 no printing or plotting. < 0 no printing; write node IEDTEM to RODTIN on plot file.
W9-I	ITMIN	ITMIN = 0, homogeneous nucleation equation. ITMIN = 1, Shumway correlation
W10-R	RADIN	Inner radius of CHAN wall.[a]
W11-R	TH	CHAN wall thickness.

NOTE: The following four variables are not used for cells that transfer heat to another component. They are used only if the user wishes to define an ambient external condition.

Word	Variable	Description (CHAN)
W12-R	HOUTL	Heat transfer coefficient between outside CHAN wall and surrounding liquid.
W13-R	HOUTV	Heat transfer coefficient between outside CHAN wall and vapor.
W14-R	TOUTL	Liquid temperature outside CHAN.
W15-R	TOUTV	Vapor temperature outside CHAN.

a.. The value of RADIN is the equivalent radius of a single channel assembly. This equivalent radius is normally chosen such that the perimeter of a circle of radius RADIN is equal to the perimeter of a square of side BUNDW, as illustrated on Figure 3-1. RADIN is used to calculate the heat transfer area between the channel wall and fluid in the channel.

CHAN Simple Parameter Card, CHANID0002X

Only the first three variables are required.

Word	Variable	Description (CHAN)
W1-I	NGRP	Number of rod groups in channel.
W2-I	NCHANS	Number of fuel channel assemblies represented by this CHAN component.
W3-I	NODESR	Number of fuel rod radial heat transfer nodes including fuel, gap, and cladding.

NOTE: This value is used for all rod groups.

Word	Variable	Description (CHAN)
W4-I	NMWRX	Metal-water reaction option. (0 = off, 1 = on.)
W5-I	NFCI	Fuel clad interaction (FCI) option. Currently must be input as 0.
W6-I	NFCIL	Limit on FCI calculations per time step.
W7-I	NRFDT	Rod and channel wall fine mesh trip ID. (If zero, no fine mesh calculation is performed.)
W8-I	NZMAX	Maximum number of axial fine mesh nodes per rod. (If NRFDT>0, then NZMAX $\geq$ NCRZ + 1). This number includes the coarse mesh nodes on heated region cell boundaries and internal fine mesh nodes.
W9-I	NZMAXW	Maximum number of axial fine mesh nodes on channel wall (If NRFDT>0, then NZMAXW > NCELLS + 1). This number includes the coarse mesh nodes on heated region cell boundaries and internal fine mesh nodes.

CHAN Simple Parameter Card, CHANID0003X

The first 14 variables are required. Variables 15 through 18 are required only if the fine mesh conduction calculation is to be performed (NRFDT > 0).

Word	Variable	Description
W1-R	HGAPO	Fuel rod gap conductance coefficient. (Must be input, but not used.)

CHAN Component Data

Word	Variable	Description (CHAN)
W2-R	PDRAT	Fuel rod pitch-to-diameter ratio (see Figure 3.4-1.
W3-R	PLDR	Pellet dish radius. (If zero, no calculation of pellet dishing.)
W4-I	ICRNK	Number of cells below neutronic core region. ICRNK must equal ICRLH for point kinetics. ICRNK + NAXN must be $\leq$ NCELLS.
W5-I	ICRLH	Number of cells below lower tie plate. Lower tie plate located at top of cell ICRLH.
W6-I	NCRZ	Number of cells between upper and lower tie plates. Upper tie plate located at top of cell ICRLH + NCRZ.
W7-I	NROD	Number of fuel rods in a single bundle row (i.e., NROD = 4 for the bundle in Figure 3.4-1).
W8-R	BUNDW	Inside channel width (see Figure 3.4-1).
W9-R	ALPTST	Threshold void fraction for radiation calculation (suggested value = 0.9).
W10-R	EPSR	Fuel rod surface emissivity.
W11-R	EPSC	Channel wall inside emissivity.
W12-I	IRAD	Radiation heat transfer option. IRAD = 0 includes steam and droplets in radiation heat transfer calculation. IRAD = 1 does not include steam and droplets in radiation heat transfer calculation.
W13-I	NRAD	Number of time steps between radiation calculations.
W14-I	IANI	Anisotropic radiation reflection flag. 0 = No anisotropic correction. 1 = Correct view factors for anisotropic reflection.
W15-R	DZNHT	Minimum spacing between rod fine mesh nodes and rows (see Section 4.4.3 of TRAC-BD1/MOD1 Manual, Vol. 2).[3.4-1]
W16-R	DTXHTW(1)	Minimum temperature difference to insert or delete fine mesh row on wall (H.T. Modes 2 and 3).
W17-R	DTXHTW(2)	Minimum temperature difference to add or delete fine mesh row on wall (other H.T. modes than above).
W18-R	DZNHTW	Minimum spacing between wall fine mesh node rows.

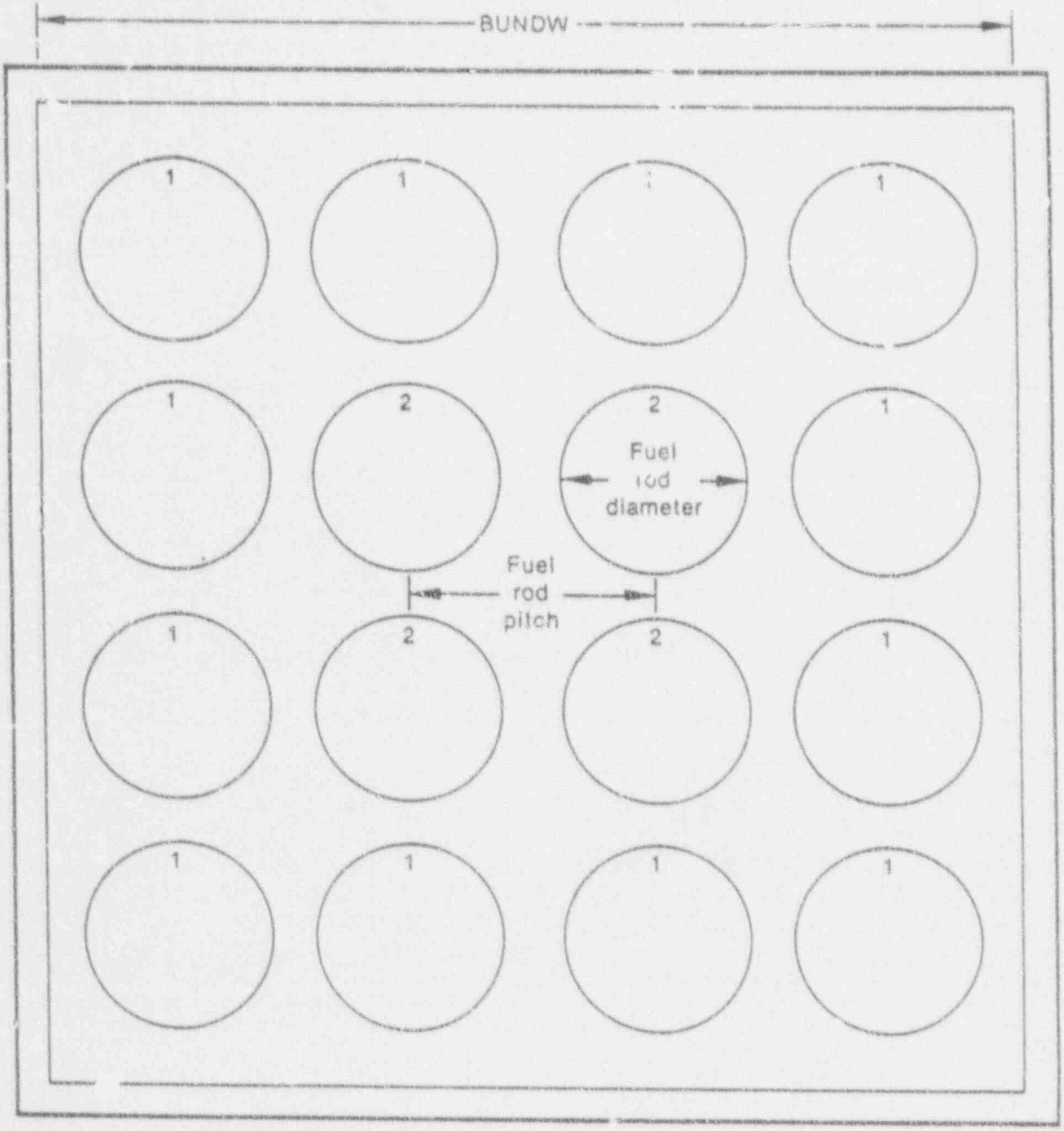


Figure 3.4-1. A 4x4 fuel bundle.

CHAN Leak Path Data Cards, CHANID0004X

Input these cards only for the "From" component of a leak path (see Section 4.1).

X	Word	Variable	Description (CHAN)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area. (For CHAN component, input value should be for one channel assembly.)
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell. (Default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL. (Default = 0).

CHAN Simple Parameter Card, CHANID00050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (CHAN)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values.)
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

CHAN Array Cards, CHANIDRG41X-CHANIDRG91X

Input one set for each of the following variables, using LOAD Format. Either CN or the variable name may be used in the card identifier. For example, the cell volume cards could be either CHANIDRG42X or CHANIDRGVOLX. RG = 00 for all arrays except RDTN.

CN	Variable	Dimension	Description (CHAN)
41	DX	NCELLS	Cell lengths.
42	VOL	NCELLS	Cell volumes of a single channel assembly.
43	FA	NCELLS+1	Cell edge flow areas of a single channel assembly.
44	FKLOS	NCELLS+1	Additive form loss coefficients for forward mixture mass flow. FKLOS is defined by $\Delta P = 1/2\ FKLOS \rho V^2$ (Default = 0.0).
45	GRAV	NCELLS+1	Gravity direction factors (see Section 4.12.5). GRAV must be 1 for the boiling length in the critical quality correlation to work properly.
46	HD	NCELLS+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELLS+1	Ratio, surface roughness/hydraulic diameter. (Default = 0.0).
48	ICHOKE	NCELLS+1	Choking calculation flag (integer). (0 = no choking, 1 = choking calculation.). (Default = 0).
49	ICCFL	NCELLS+1	CCFL control flag (integer). ICCFL = 0 Turn off CCFL model ICCFL = 1 CCFL upper tie plate constants ICCFL = 2 CCFL side entry orifice constants. (Default = 0).
50	WETP	NCELLS+1	Wetted perimeter of a single channel assembly (input only if any entry in ICCFL equals 2).
51	ALP	NCELLS	Initial void fraction.
52	VL	NCELLS+1	Initial liquid velocity.
53	VV	NCELLS+1	Initial vapor velocity.

CN	Variable	Dimension	Description (CHAN)
54	TL	NCELLS	Initial liquid temperatures.
55	TV	NCELLS	Initial vapor temperatures.
56	P	NCELLS	Initial pressures.
57	BORC	NCELLS	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC ≠ 0.0).
58	QPPP	NCELLS	Volumetric heat sources in CHAN wall.
59	TW	NODES *(NCELLS+1)	Initial wall temperatures.
60	KLVC	NCELLS+1	Vessel levels to which wall nodes will transfer heat. Omit if IPVHT = 0 or if component IPVHT is not a VESSEL. Input zeros if component IPVHT is not a vessel. CHAN initialization will check this input, but the first entry will not be changed; and the lowest CHAN wall node will be assumed to lie at the bottom of VESSEL level KLVC(1). None: Each CHAN cell may transfer heat to only one cell in component IPVHT. It is not permissible to model a CHAN cell transferring heat to two or more cells in component IPVHT. However, several CHAN cells may transfer heat to a single cell of component IPVHT. This means that the CHAN cell boundaries must coincide with cell boundaries of component IPVHT and that there may be one or more whole CHAN cells between the boundaries of one cell IPVHT component.
61	KRVC	NCELLS+1	Cell number in component IPVHT = NUM to which heat is transferred. Omit if IPVHT = 0. If component IPVHT is a VESSEL, the first value of the KRVC array will be used for the cell to which heat is transferred. If IPVHT is not a VESSEL, the first value will be used to set the first outer component cell to which the CHAN transfers heat and the rest of the values will be recalculated in initialization.
62	RKLOS	NCELLS+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition. (Default = 0.0).

CN	Variable	Dimension	Description (CHAN)
63	PA	NCELLS	Noncondensible gas pressure (default = 0.0, required if IAIR = 1 and PA ≠ 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell. -1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell, (input only if LEV1 = 1; default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0.0).
67	DZLV1	NCELLS	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0.0).
68	VLEV1	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0.0).
71	RDPWR	NODESR*NGRP	Relative radial power density within an individual rod. Input centerline-to-surface distribution for each rod group (see Section 5.4.4).
72	CPOWR	NGRP	Rod-to-rod power distribution within the fuel bundle (see Section 5.4.4).
73	RADPW	NCRZ	Fraction of total reactor power on each heated core level that is generated by a single bundle in this CHAN. RADPW is normalized at each core level such that sum of RADPW(K)·NCHANS(K) = 1, where K is number of CHAN components.
74	RDX	NGRP	Number of rods in each rod group (floating point).
75	RADRD	NODESR*NGRP	Rod node radii (cold) Node 1 radius = 0.
76	MATRD	(NODESR-1)* NGRP	Rod material ID numbers (integer). Rod must include one and only one gap. The gap cannot be at the rod center or span more than the region between two adjacent nodes.

CN	Variable	Dimension	Description (CHAN)
7			ID: Material Type 1 Mixed oxide fuel 2 Zircaloy 3 Fuel-clad gap 4 Boron nitride insulation 5 Constant/nichrome heater 6 Stainless steel Type 304 7 Stainless steel Type 316 8 Stainless steel Type 347 9 Medium carbon steel A508 10 Inconel 718 11 ZrO_2 21-99 Input table.
77	HGAP	NCRZ*NGRP	Fuel rod gap conductance constant ($W/m^2 \cdot K$). Use a small value for water rods (See Section 4.4.4 in Reference 3.4-1).
78	NFAX	NCRZ*NGRP	Number of fixed fine mesh nodes per cell. Total per rod must be equal to or less than NZMAX - NCRZ - 1 (omit if NRFDT = 0).
79	NFAXW	NCELLS	Number of fixed fine mesh nodes per cell. Total must be equal to or less than NZMAXW - NCELLS - 1 (omit if NRFDT = 0).
80	FPUO2	NGRP	Fraction of PuO_2 in mixed oxide fuel. (Default = 0.0).
81	FTD	NGRP	Fraction of theoretical density. (Default = 0.95).

NOTE: The next 6 arrays are not used unless NFCI = 1.

CN	Variable	Dimension	Description (CHAN)
82	GMIX	7*NGRP	Mole fraction of gas gap constituents.
83	GMLES	NGRP	Moles of gap gas per rod.
84	PGAPT	NGRP	Average gap pressure.
85	PLVOL	NGRP	Plenum volume in each fuel rod above pellet stack.
86	PSLENN	NGRP	Pellet stack length.
87	CLENN	NGRP	Total cladding length.
88	BURN	NCRZ*NGRP	Fuel burnup, MWD/MTU.

CN	Variable	Dimension	Description (CHAN)
89	RFTN	NODESR*NGRP*(NCRZ+1)	Fuel rod temperatures at each node. RG in the card identifier is the rod group number. For each RG, NODESR·(NCRZ+1) values are input.
90	IROD	NROD*NROD+1	Rod group number associated with each radiating surface (integer). Channel wall is last surface, and group containing channel wall is last group. This geometry will be used to calculate view factors. On EXTRACT, the actual view factors will replace this array. Beginning in the upper left-hand corner rod in Figure 3.4-1, the values of IROD that would be input for this particular rod grouping are: 1 1 1 1 1 2 2 1 1 2 2 1 1 1 1 1 3 E

NOTE: The following is user-input relative to the CHAN-to-CHAN reactivity weighting factor per bundle. Not needed unless 1-D neutron kinetics or point-kinetics with reactivity feedback reactor power options are used with user-input reactivity weighting selected (IRPOP = 6,7,8 and ITMW = -1).

CN	Variable	Dimension	Description (CHAN)
93	RCTWF	NAXN	This array allows reactivity weighting other than volumetric. The code will normalize on each level by summing NCHANS·RCTWF·VOL over all the CHAN components.
99	DTXHT	2*NGRP	NGRP pairs of temperature differences at which rows of H.T. nodes are added or deleted from rods, 1 pair per group (in group or rod). First value is used for H.T. regimes 2 and 3, the second for other regimes (omit if NRFDT = 0).

3.4.3 CONTAINMENT Component (CONTAN)

CONTAN Header Card (CONTAN0000000)

Word	Variable	Description (CONTAN)
W1-A	CTITLE	User optional description of containment

CONTAN Control Card (CONTAN000001X)

Word	Variable	Description
W1-R	DTIME	Time interval at which the containment calculation is updated during the primary loop calculation.
W2-I	NCOMT	Number of COMPARTMENTS in containment.
W3-I	NHS	Number of HEAT STRUCTURES in containment.
W4-I	NCOOL	Number of COOLERS in containment.
W5-I	NJCT	Number of PASSIVE JUNCTIONS in containment.
W6-I	NJCTF	Number of FORCED JUNCTIONS in containment.
W7-I	NJCTS	Number of SOURCE/SINK JUNCTIONS in containment.
W8-I	INTFLG	Flag to indicate type of ODE integrator to be used in containment calculations. [INTFLG = 1 (explicit integrator) is the only currently available option.]
W9-I	NCOMTB	Number of containment compartments that are connected to primary loop BREAKS and/or FILLS. (Each compartment that is so-connected is counted only once, regardless of the number of BREAK and FILL components to which it is connected.)
W10-I	NCOMTV	Vessel wall heat transfer inclusion flag (see Table 3.4-1).
W11-I	NNLEV	Number of axial levels in vessel (same as NASX if NCOMTV = 0; 0 if NCOMTV = 0).

Table 3.4-1. Explanation of containment parameters and options.

Variable	Explanation (CONTAN)

CONTAN control card

NCOMTV — This parameter suppresses or activates the inclusion of reactor vessel external surface heat transfer in the containment calculation.

If NCOMTV = 0, the option is suppressed.

If NCOMTV ≠ 0, the option is actuated and NCOMTV is the user ID of the compartment in which the vessel is located.

If NCOMTV >0, the code calculates vessel exterior surface heat transfer coefficients based on free-convection correlations only. If NCOMTV <0, the user supplies vessel exterior surface heat transfer coefficients on a separate input card. (See "CONTAN Vessel Heat Transfer Coefficient Card.")

COMPARTMENT parameters/options

ITRKL — If ITRKL = 0, no pool depth is calculated in a compartment.

If ITRKL = 1, the pool depth corresponding to the current liquid mass is computed.

In order to utilize the heat structure level tracking option (ITRKH = 1), ITRKL must be set to 1 in both compartments attached to the heat structure.

ITRKS — If ITRKS = 0, no spilling calculation is done.

If ITRKS ≠ 0, the compartment pool is assumed to begin "spilling" when the liquid volume reaches VMAX. At this point, additional liquid entering the compartment is transferred to the pool region of the compartment whose user ID is specified by ITRKS.

TL — TL is the initial absolute temperature of the pool region.

If TL >0, the code will issue an ERROR message and terminate execution if the pool temperature approaches the saturation temperature corresponding to the compartment vapor region pressure to within 5 K.

If TL <0, the code will continue execution regardless of the pool temperature. (Note, however, that the containment model in TRAC performs no boiling heat or mass transfer calculations).

Table 3.4-1. (continued)

Variable	Explanation (CONTAN)
FRAB	FRAB may be given any value from zero to one, inclusive. If FRAB = 0.0, no heat is transferred between noncondensible gas vented through the pool region and the liquid. If FRAB = 1.0, complete temperature equilibration is assumed between vented noncondensible gas and liquid.
CUCH	A modified UCHIDA condensation heat transfer correlation for a mixture of steam and noncondensible gas may or may not be used. If CUCH < 0, only free convection heat transfer is assumed in the vapor region and the UCHIDA correlation is not used. If $0.0 \le$ CUCH ≤ 1.0, the following heat transfer coefficient (h) is used in the vapor region: $h = h_{TRAC} \times \frac{h_{umod}(r)}{h_{uo}}$ where h_{TRAC} = TRAC-generated HTC using free- and forced-convection correlations in standard TRAC heat transfer package $h_{umod}(r)$ = $h_{uo} + [h_u(r) - h_{uo}] \times$ CUCH prevailing value of r r = density of noncondensible gas/density of water vapor h_{uo} = minimum value of the UCHIDA heat transfer correlation $h_u(r)$ = UCHIDA prediction of h corresponding to r. CUCH = 1.0 is recommended for heat structure surfaces in the drywell region CUCH = -1.0 is recommended for heat structure surfaces in the wetwell region.
DPDT	To smooth the step changes in containment back pressure during containment updates, the TRAC primary loop calculation extrapolates the containment pressure at each time step, based on

Table 3.4-1. (continued)

Variable	Explanation (CONTAN)
	the rate of change during the previous containment update.
	For reasonable containment update intervals (≤2.0 seconds), DPDT may be initialized to zero without difficulty. If instabilities develop after the first containment update, it may be necessary to recommence the calculation, using the results of the first attempt to estimate DPDT.
RML	Every compartment is assumed to contain a pool region, and thus RML must be nonzero.
	During containment initialization, the partial pressure of steam in each compartment is assumed to be the saturation pressure at temperature TV. If RML becomes so large during the transient calculation that the liquid displaces the entire compartment volume, a fatal error will result.
HEAT STRUCTURE Parameters/Options	
	Heat structures are modeled as cylindrical shells with conduction in the radial direction only. The axis of the cylinder is assumed vertical and the inner and outer surfaces of the structure may lie in two separate compartments (e.g., a wall separating two compartments), depending on how the user specifies ICTI and ICTO.
	Radial heat structure noding is used in obtaining the heat structure temperature profile using the TRAC routine CYLHT. The axial noding is used only to define the heat structure levels that lie in vapor and liquid regions of a compartment.
ITRKH	If ITRKH = 0, the entire heat structure remains in the region specified by IREGI and IREGO throughout the containment calculation.
	If ITRKH = 1, the depth of the liquid pool will be used in determining the heat transfer coefficient used for each vertical subdivision (level) of the heat structure.
	If ITRKH = 1, then ITRKL = 1 must also be input for the compartments specified by ICTI and ICTO.
ICTI	Heat structures are treated internally as cylindrical slabs. The user may model a heat structure that is entirely contained in a single compartment by specifying the same value for ICTI and ICTO. A heat structure that is partially in one compartment and

Table 3.4-1. (continued)

Variable	Explanation (CONTAN)
	partially in another (e.g., a wall) may be modelled by specifying appropriate different values for ICTI and ICTO.
	Heat structures that do not have cylindrical geometry may still be modelled by choosing AREAI, AREAO, RADI, and RADO so as to represent the total surface area and characteristic thickness of the heat structure [(AREAI + AREAO) = (TOTAL AREA); (RADO - RADI) = (CHARACTERISTIC THICKNESS)].
PASSIVE JUNCTION Parameters/Options	
ITYPP	ITYPP = 1 specifies a junction between the vapor regions in two compartments. Pressure-induced flow may occur in either direction.
	ITYPP = 2 specifies a one-way valve between the vapor regions in two compartments. Flow occurs in one direction only when the pressure difference between the two compartments reaches a critical minimum value specified by DPCR (e.g., a vacuum breaker valve or a pressure relief valve would be modeled as a passive junction with ITYPP = 2).
	ITYPP = 3 specifies a one-way flow junction between the vapor region of one compartment and the pool region of another. The minimum pressure difference for flow to occur is specified by DPCR (e.g., a vent pipe between the drywell and the pool region of the wetwell would be modeled as a passive junction with ITYPP = 3).
RLEN	In calculating the pressure-induced passive flow between two compartments two junction flow rates are computed: (1) that obtained by treating the junction as if it were a pipe and (2) that obtained by treating the junction as if it were an orifice between the two compartments. The lesser of the two flow rates is then used.
	RLEN is the equivalent pipe length for the junction. The input value must be nonzero.
FR	If the input value of FR is zero, the code will compute an appropriate value of FR.
	If the input value of FR is nonzero, this value will be used in the junction pipe flow calculation.

Table 3.4-1. (continued)

Variable	Explanation (CONTAN)
DPCR	Minimum pressure difference for flow to occur in a Type 2 or Type 3 passive junction. If DPCR < 0, the code interprets DPCR as the elevation of the exit of the junction above the floor of the receiver compartment. It then computes a critical pressure difference equal to the hydrostatic pressure corresponding to the submergence depth of the junction exit in the receiver pool. (The DPCR < 0 option should be used only if ITRKL = 1 in the receiver compartment.)
FORCED JUNCTION Parameters/Options	
IFTYP	IFTYP = 1 specifies a junction that transfers vapor from one compartment to the vapor region of another compartment at the volume flow rate specified by the user-input table for the junction. IFTYP = 2 specifies a junction that transfers liquid from the pool region of one compartment to the pool region of another compartment. IFTYP = 3 specifies a junction that transfers liquid from the pool region of one compartment to the vapor region of another compartment (e.g., a spray cooler).

CONTAN Array Cards, CONTAN00SYCNX

For each component type (COMPARTMENT, HEAT STRUCTURE, etc.), various descriptive parameters and option flags must be specified. The values of a given parameter for a given containment component type are input for all components of that type on a single card using LOAD format. The two-digit integer SY indicates the component type (i.e., SY = 1, 2, 3, 4, 5, 6 indicate, respectively, COMPARTMENT, HEAT STRUCTURE, COOLER, PASSIVE JUNCTION, FORCED JUNCTION, SOURCE/SINK JUNCTION). CN is an alphanumeric or integer identifier for the parameter being input.

The order of the inputs on the card should correspond to the order used to specify user identification numbers for the respective components on the user ID card. For example, to specify initial pressures of 1.E5, 1.1E5, 0.9E5, and 1.5E5, in four containment compartments with user ID's of 1, 2, 3, and 4, respectively, would require the following input cards:

```
CONTAN0001ICTBL1  1  2  3  4  E
```

CONTAN0001P1   1.E5   1.1E5   0.9E5   1.5E5   E

COMPARTMENT Array Cards, CONTAN0001CNX

CN	Variable	Dimension	Description (CONTAN)
41	ITRKL	NCOMT	Flag for compartment pool level tracking option (Integer; see Table 3.4-1).
42	ITRKS	NCOMT	Flag for compartment spill option (integer; see Table 3.4-1).
43	ICTBL	NCOMT	User ID for compartment (integer ≤99; user ID's for all containment and primary loop components should be unique).
44	VOL	NCOMT	Total compartment volume.
45	VMAX	NCOMT	Compartment liquid volume when spilling begins (see Table 3.4-1; Reference ITRKS).
46	P	NCOMT	Initial gas pressure in compartment.
47	TL	NCOMT	Initial liquid temperature in compartment (see Table 3.4-1).
48	TV	NCOMT	Initial vapor temperature in compartment.
49	FRSB	NCOMT	Fraction of steam vented to pool that is not condensed in pool region.
50	FRAB	NCOMT	Effectiveness of heat transfer between noncondensible gas vented through pool region and pool liquid (see Table 3.4-1).
51	CUCH	NCOMT	Uchida condensation heat transfer correlation flag (see Table 3.4-1).
52	DPDT	NCOMT	Initial estimate of time rate of change of pressure in compartment (see Table 3.4-1).
53	APOOL	NCOMT	Area of interface between pool and vapor region (must be ≥1.E-8).
54	PA	NCOMT	Initial partial pressure of air in compartment. (If PA<0.0, the code will compute the saturation pressure [PSAT(TV)] corresponding to TV and assign partial pressures of air (PA) and steam (PS):

CN	Variable	Dimension	Description (CONTAN)
			PS = MIN [PSAT(TV), P] PA = P-PS.
56	RML	NCOMT	Initial mass of liquid in compartment (see Table 3.4-1).

HEAT STRUCTURE Array Cards, CONTAN0002CNX

CN	Variable	Dimension	Description (CONTAN)
41	ITRKH	NHS	Flag for level tracking on heat structure (integer; see Table 3.4-1).
42	ICTI	NHS	User ID of compartment where inner heat structure surface is located (integer; see Table 3.4-1).
43	ICTO	NHS	User ID of compartment where outer heat structure surface is located (integer; see Table 3.4-1; Reference ICTI).
44	NODAX	NHS	Number of vertical nodes in heat structure (integer; must be "1" if ITRKH = 0). For NODAX >1, CPU time may significantly increase.
45	NODRA	NHS	Number of radial nodes in heat structure (integer ≥2).
46	IHSTB	NHS	User ID of heat structure [integer ≤ 99;if IHSTB <0, the user inputs the heat transfer coefficients for the heat structure (see heat structure table cards); user ID's of all containment and primary loop components should be unique.]
47	IREGI	NHS	Flag to indicate region where inner surface of heat structure is located (integer; 1 = liquid region, 0 = vapor region. If ITRKH = 1, input "0".)
48	IREGO	NHS	Flag to indicate region where outer surface of heat structure is located (integer; see "IREGI").
49	RADI	NHS	Radius of curvature of inner surface of heat structure.

CN	Variable	Dimension	Description (CONTAN)
50	RADO	NHS	Radius of curvature of outer surface of heat structure.
51	ROW	NHS	Density of heat structure material.
52	CPW	NHS	Heat capacity of heat structure material.
53	CW	NHS	Thermal conductivity of heat structure material.
54	HLI	NHS	Elevation of lower extremity of heat structure inner surface above floor of compartment ICTI (input 0.0 if ITRKH = 0).
55	HUI	NHS	Elevation of upper extremity of heat structure inner surface above floor of compartment ICTI (input 0.0 if ITRKH = 0).
56	HLO	NHS	Elevation of lower extremity of heat structure outer surface above floor of compartment ICTO (input 0.0 if ITRKH = 0).
57	HUO	NHS	Elevation of upper extremity of heat structure outer surface above floor of compartment ICTO (input 0.0 if ITRKH = 0).
58	HDAVG	NHS	Characteristic length for computation of Grashof number for heat structure.
59	AREAI	NHS	Total heat structure area of inner surface.
60	AREAO	NHS	Total heat structure area of outer surface.

COOLER Array Cards, CONTAN0003CNX

CN	Variable	Dimension	Description (CONTAN)
41	ICLTB	NCOOL	User ID for cooler (integer ≤ 99; user ID's of all containment and primary loop components should be unique).
42	ICTC	NCOOL	User ID of compartment where cooler is located (integer).
43	IREGC	NCOOL	Fluid region cooled by cooler (integer; 0 = vapor region, 1 = liquid region).

CN	Variable	Dimension	Description (CONTAN)
44	ITYPC	NCOOL	Cooler type (integer; 1 = convective heat exchanger for which coolant temperature vs time table and heat transfer coefficients and are required; 2 = heat source for which heating rate vs time table is required).
45	HTC	NCOOL	Heat transfer coefficient times heat transfer area for a Type 1 cooler. (For Type 2 cooler, input 0.0.)

PASSIVE JUNCTION Array Cards, CONTAN0004CNX

CN	Variable	Dimension	Description (CONTAN)
41	ICT1	NJCT	User ID of first compartment connected by junction (integer).
42	ICT2	NJCT	User ID of second compartment connected by junction (integer).
43	IJCTB	NJCT	User ID of passive junction (integer; user ID's of all containment and primary loop components should be unique).
44	ITYPP	NJCT	Passive junction type (integer; see Table 3.4-1).
45	HD	NJCT	Hydraulic diameter for flow in junction.
46	AREA	NJCT	Cross-sectional area for flow in junction.
46	RLEN	NJCT	Equivalent pipe length for flow in junction (see Table 3.4-1).
48	FR	NJCT	Friction factor for junction pipe flow calculation (see Table 3.4-1).
49	DPCR	NJCT	Minimum pressure difference for flow to occur in junction Types 2 and 3 (see Table 3.4-1).

FORCED CONVECTIVE JUNCTION Array Cards, CONTAN0005CNX

CN	Variable	Dimension	Description (CONTAN)
41	ICTF1	NJCTF	User ID of first compartment connected by

CN	Variable	Dimension	Description (CONTAN)
			junction (integer).
42	ICTF2	NJCTF	User ID of second compartment connected by junction (integer).
43	IFTYP	NJCTF	Forced junction type (integer; see Table 3.4-1).
44	IJCTF	NJCTF	User ID of forced junction (integer; user ID's of all containment and primary loop components systems should be unique).

SOURCE/SINK JUNCTION Array Cards, CONTAN0006CNX

CN	Variable	Dimension	Description (CONTAN)
41	ISTYP	NJCTS	Source/sink junction type (integer; 1 = source, 2 = sink).
42	ICTS	NJCTS	User ID of compartment where junction is located (integer).
43	IJCTS	NJCTS	User ID of source/sink junction (integer; user ID's of all containment and primary loop components should be unique).

CONTAN Table Cards, CONTANIDSYCNX

For those containment systems and/or options requiring table inputs, the input format is as follows:

CONTANIDSYCNX NWRD R1, R2 . . . RNWRD

where

ID = User ID for containment compartment to which table applies.

SY = System type (1 = compartment, 2 = heat structure, etc.)

CN = Card number associated with table.

X = Card sequence number for continuation of table data from one card to the next (X = 0, . . . 9).

NWRD = Total number of entries in table. [For x versus y-type tables, NWRD = 2 x (number of x,y pairs in table).]

R1,R3,... = x (independent variable) entries

R2,R4,... = y (dependent variable) entries associated with R1, R3, etc.

COMPARTMENT Table Cards, CONTANID01CNX

CN	Variable	Description (CONTAN)
15	D	Table of pool depth in compartment versus liquid volume (input volume first, then corresponding depth).

HEAT STRUCTURE Table Cards, CONTANID02CNX

CN	Variable	Description (CONTAN)
15	T	Initial temperature profile in heat structure. (Order: Level 1, innermost node to outermost node; Level 2, innermost node to outermost node; . . .; Level NODAX, innermost node to outermost node).
16	HTC	User-input vapor and liquid heat transfer coefficients (HTC's) for heat structure. Input only if IHSTB < 0. (For each heat structure, NODAX*4 HTC's are required in the following order: Level 1, inner surface to liquid HTC, inner surface to vapor HTC, outer surface to liquid HTC, outer surface to vapor HTC; Level 2, . . . etc.)

COOLER Table Cards, CONTANID03CNX

CN	Variable	Description (CONTAN)
15	TC or QC	Table of coolant temperature versus time for a Type 1 cooler, heating rate versus time for a Type 2 cooler. (Order: time(1), TC(1), time(2), TC(2), etc.

FORCED JUNCTION Table Cards, CONTANID05CNX

CN	Variable	Description (CONTAN)
15	Q	Table of volume flow rate versus time for junction. (Order: time(1), Q(1), time(2), Q(2), etc.; positive flow is from compartment ICTF1 to ICTF2).
16	E	Table of spray efficiency (mass fraction of spray that remains in vapor region of receiving compartment) versus time for a Type 3 forced junction; omit for Types 1 and 2. (Order: time(1), E(1), time(2), E(2), etc.)

SOURCE/SINK Table Cards, CONTANID06CNX

CN	Variable	Description (CONTAN)
15	QS	Table of volume flow rate of liquid versus time in junction. (Order: time(1), QS(1), time(2), QS(2), etc.)
16	T	Table of source liquid temperature versus time for a Type 1 source/sink junction, omit for Type 2. (Order: time(1), T(1), time(2), T(2), etc.)

CONTAN Primary Loop-Containment Boundary Card, CONTAN000002X

Word	Variable	Description (CONTAN)
1-I	ICOMT	User ID of first compartment attached to a BREAK or FILL component.
2-I	ICOMT	User ID of second compartment attached to a BREAK or FILL component.
.		
.		
.		
NCOMTB-I	ICOMT	User ID of last compartment attached to a BREAK or FILL compartment.

CONTAN Vessel Heat Transfer Card, CONTAN000003X

Word	Variable	Description (CONTAN)
1-I	MATDS	TRAC material index for vessel wall (see PIPE component).
2-R	VSHT	Elevation of base of vessel above floor of compartment where located.
3-R	TVS	Initial vessel temperature (used to compute initial vessel exterior heat transfer coefficient).

CONTAN Vessel Heat Transfer Coefficient Card, CONTAN000004X

Input only if NCOMTV < 0.

Word	Variable	Description (CONTAN)
1-R	HL(1)	Vessel exterior wall to liquid heat transfer coefficient for Level 1.
2-R	HV(1)	Vessel exterior wall to vapor heat transfer coefficient for Level 1.
"		
"		
"		
(NASX*2-1) -R	HL(NASX)	Vessel exterior wall to liquid heat transfer coefficient for Level NASX.
(NASX*2) -R	HV(NASX)	Vessel exterior wall to vapor heat transfer coefficient for Level NASX.

3.4.4 FILL Component (FILL)

FILL Header Card, FILLID000

NOTE: A FILL cannot be connected directly to a VESSEL through a normal junction. It can be connected directly to a VESSEL through a leak path (see Section 5.1).

Word	Variable	Description (FILL)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

FILL Simple Parameters Card, FILLID01X

The first 11 words are required.

Word	Variable	Description (FILL)
W1-I	JUN1	Junction number at which FILL is located. A junction number of zero indicates a disconnected fill which connects to another component via a leak path. (This junction is omitted from NJUN junction count and VESSEL source count.)
W2-I	IFTY	FILL type option 1 = constant velocity or FILL is controlled by the control system 2 = velocity vs. time 3 = velocity vs. pressure 4 = constant velocity until trip, then velocity vs. time 5 = constant velocity until trip, then velocity vs. pressure (arrange from low to high pressure). 6 = generalized time-dependent fill 7 = generalized time-dependent fill after trip.
W3-I	IFTR	Trip ID number. Must be nonzero if IFTY = 4 or 5.
W4-I	NFTX	Number of FILL table pairs.
W5-I	ICOMT	Flag to indicate connection of FILL to the containment.

FILL Component Data

Word	Variable	Description (FILL)
		ICOMT = 0 implies no connection. ICOMT > 0 implies the FILL draws liquid water from the pool region whose user ID is ICOMT.
W6-R	DXIN	Length of FILL cell (generally taken to be the same as its neighboring cell in the adjacent component).
W7-R	VOLIN	Volume of FILL cell (generally taken to be the same as its neighboring cell in the adjacent component).

(NOTE: DXIN and VOLIN define an area that contributes to the mass flow rate along with velocity and density. Care must be taken to ensure that the geometric data lead to the desired mass flow rate.)

Word	Variable	Description (FILL)
W8-R	ALPIN	Void fraction for entrant mixture.
W9-R	VIN	Entrant mixture velocity.
W10-R	TIN	Entrant mixture temperature.
W11-R	PIN	FILL pressure.

FILL Simple Parameter Card (FILLID02X)

Word	Variable	Description (FILL)
W1-R	BORCIN	Boron concentration (ppm) in FILL (default = 0.0, required if IBORC = 1 and BORCIN not equal to 0.0).

FILL Simple Parameter Card (FILLID03X)

CN	Word	Variable	Description (FILL)
	W1-R	PAIN	Noncondensible gas pressure in FILL (default = 0.0, required if IAIR = 1 and PAIN not equal to 0.0).

FILL Leak Path Data Card, FILLID040

Input this card only if FILL is to be the "From" component of a leak path.

CN	Word	Variable	Description (FILL)
40	W1-R	FALK	Leak path flow area.
	W2-I	NCMPTO	Component number of "To" component.
	W3-I	NCLKTO	Cell number of "To" cell.
	W4-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a vessel. (Default = 0).

FILL Table Cards, FILLID11X-FILLID18X

LOAD format (omit if NFTX = 0).

CN	Variable	Dimension	Description (FILL)
11	VMTB	2*NFTX	FILL table time-velocity or pressure-velocity pairs. (If the FILL is tripped, time is time after the trip activation.)

Include the following cards only if IFTY = 6. (When IFTY = 6, VMTB = Liquid velocity.)

CN	Variable	Dimension	Description (FILL)
12	VRTB	2*NFTX	Vapor velocity table.
13	PTB	2*NFTX	Pressure table.
14	TLTB	2*NFTX	Liquid temperature table.
15	TVTB	2*NFTX	Vapor temperature table.
16	ALPTB	2*NFTX	Void fraction table.
17	BORTB	2*NFTX	Boron concentration table (ppm) (not needed if IBORC = 0).
18	PATB	2*NFTX	Noncondensible gas pressure table. (Optional, used when FILL option uses any other table and IAIR = 1, default = 0.0).

3.4.5 FEEDWATER HEATER Component (HEATR)

FEEDWATER HEATER Header Card, HEATRID000

Word	Variable	Description (HEATR)
W1-I	NUM	Component ID number (must be unique for each component)
W2-I	CTITLE	Optional user description of component. Up to 30 characters enclosed in quotes.

FEEDWATER HEATER Simple Parameters Card 1, HEATRID01X

Word	Variable	Description (HEATR)
W1-I	JUN1	Inlet junction number (for turbine steam) adjacent to cell 1.
W2-I	JUN2	Outlet junction number (from drain cooler) adjacent to cell NCELL1.
W3-I	NCELL1	Number of cells in primary side (≥2)
W4-I	IVERT	Vertical heater flag (=0 for horizontal, 1 for vertical)
W5-I	NTDEEP	Number of layers of tubes in tube bank (>0 for a horizontal heater). Currently not used.
W6-R	DBAFF	Distance between tube bank baffles (>0.0 for a vertical heater)
W7-R	DTUBE	Outer diameter of individual tube bank tubes.

FEEDWATER HEATER Simple Parameters Card 2, HEATRID02X

All words required.

Word	Variable	Description (HEATR)
W1-I	JUN3	Side arm junction number.
W2-R	FA	Side arm flow area.
W3-R	DH	Side arm hydraulic diameter.

Word	Variable	Description (HEATR)
W4-R	VM	Side arm mixture velocity (negative for inflow to shell).
W5-R	LOSK	Additive loss at junction JUN3

FEEDWATER HEATER Simple Parameters Card 3, HEATRID03X

Word	Variable	Description (HEATR)
W1-I	NTABSH	Number of data pairs in shell liquid heat transfer area vs. shell void fraction table (minimum = 2).
W2-I	NTABDC	Number of data pairs in drain cooler liquid heat transfer area vs. drain cooler void fraction table (minimum = 2).
W3-I	NTABLL	Number of data pairs in shell liquid level vs. shell void fraction table (minimum = 2).
W4-R	HDCIN	Height of drain cooler inlet above bottom of heater shell.

FEEDWATER HEATER Simple Parameter Card 4, HEATRID04X

First two words are required.

Word	Variable	Description (HEATR)
W1-I	IHTS	ID number of tube bank pipe component.
W2-I	IWT	Set to zero (no wall heat transfer).

FEEDWATER HEATER Table Cards, HEATRID05X

NTABSH pairs of values required.

Word	Variable	Description (HEATR)
W1-R	TABSH	NTABSH pairs of shell void fraction, liquid heat transfer fraction data.

: "DWATER HEATER Table Cards, HEATRID06X

NTABDC pairs of values required.

Word	Variable	Description (HEATR)
W1-R	TABDC	NTABDC pairs of drain cooler void fraction, liquid heat transfer fraction data.

FEEDWATER HEATER Table Cards, HEATERID07X

NTABLL pairs of values required.

Word	Variable	Description (HEATR)
W1-R	TABLL	NTABLL pairs of shell void fraction, shell liquid level data.

FEEDWATER HEATER Array Cards, HEATRID41X-HEATRID62X

Input one card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (HEATR)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes.
43	FA	NCELL1+1	Cell edge flow areas.
44	FKLOS	NCELLS+1	Additive form loss coefficients for forward mixture mass flow. FKLOS is defined by $\Delta P = 1/2\ FKLOS \cdot \rho \cdot V^2$. (Default = 0.0).
45	GRAV	NCELL1+1	Gravity direction factors (see Section 5.12.5).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELL1+1	Ratio, surface roughness to hydraulic diameter. (Default = 0.0).
51	ALP	NCELL1	Initial void fractions.
52	VL	NCELL1+1	Initial liquid velocity.

CN	Variable	Dimension	Description (HEATR)
53	VV	NCELL1+1	Initial vapor velocity.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures.
57	BORC	NCELL1	Boron concentration (ppm) (default = 0.0 required if IBORC = 1 and BORC not equal to 0.0).
62	RKLOS	NCELLS+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition. (Default = 0.0).
63	PA	NCELLS	Noncondensible gas pressure (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).

3.4.6 Jet Pump Component (JETP)

Figure 3.4-2 shows the noding diagram for the jet pump component (JETP). Input requirements are given below.

JETP Header Card, JETPID000

Word	Variable	Description (JETP)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User-optional description of component. Up to 30 characters may be used. Enclose them in quotes.

JETP Simple Parameter Card, JETPID01X

The first 10 variables are required if NOTES=0; otherwise, the first 12 variables are needed.

Word	Variable	Description (JETP)
W1-I	JCELL	Primary tube cell number where the side tube (secondary tube) connects)
W2-I	NODES	Number of radial heat-transfer nodes in the JETP wall. (0 implies no wall heat transfer).
W3-I	MATID	Material ID of JETP wall (see PIPE input description)
W4-R	COST	Cosine of the angle from the low-numbered side of the primary tube to the secondary tube.
W5-I	ICHF	CHF calculation flag. NEG = No CHF allowed. 0 = use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.
W6-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and

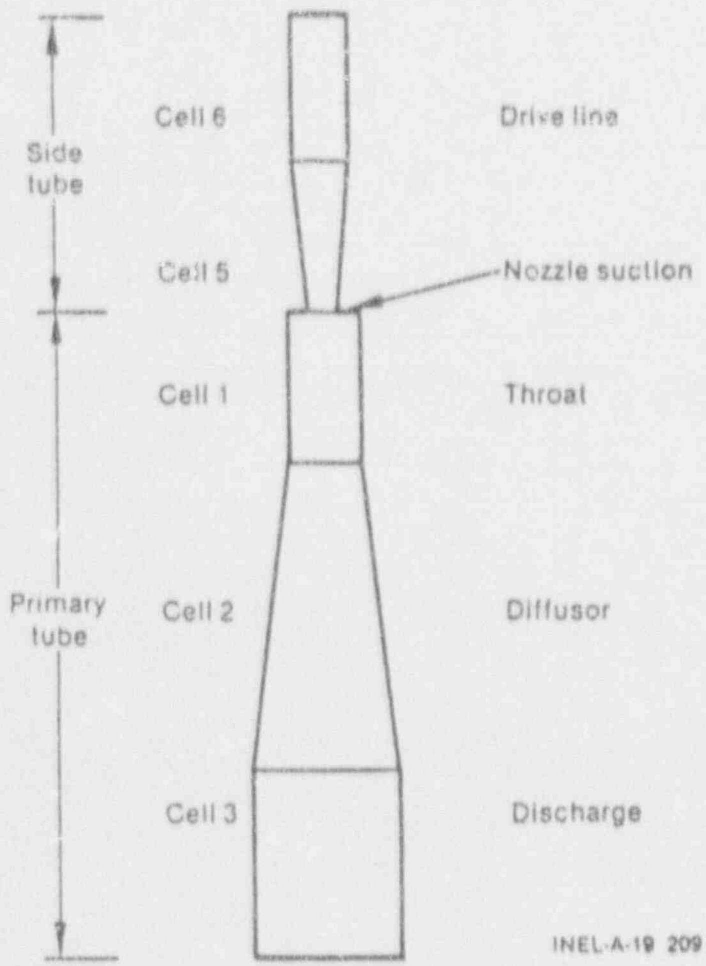


Figure 3.4-2. Noding diagram for jet pump.

Word	Variable	Description (JETP)
		KRVC. IPVHT = 0 means no component-to-component heat transfer.
W7-I	NCELL1	Number of fluid cells in the primary tube.
W8-I	JUN1	Junction number for junction adjacent to cell 1.
W9-I	JUN2	Junction number for junction adjacent to NCELL1.
W10-I	ITRP	Trip number for starting small break.
W11-R	RADIN1	Inner radius of the primary tube wall.
W12-R	TH1	Wall thickness of the primary tube.
W13-R	HOUTL1	Heat transfer coefficient to liquid at the outer boundary of the primary tube wall.
W14-R	HOUTV1	Heat transfer coefficient to vapor at the outer boundary of the primary tube wall.
W15-R	TOUTL1	Temperature of liquid outside primary tube wall.
W16-R	TOUTV1	Temperature of vapor outside primary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

JETP Simple Parameter Card, JETPID02X
(X = 0 through 9)

Only the first two variables are required if NOTES=0; otherwise, the first four variables are needed.

Word	Variable	Description (JETP)
W1-I	NCELL2	Number of fluid cells in the secondary tube.
W2-I	JUN3	Junction number of the free end of the secondary tube (cell NCELL2).
W3-R	RADIN2	Inner radius of the secondary tube wall.
W4-R	TH2	Wall thickness of the secondary tube.
W5-R	HOUTL2	Heat transfer coefficient to liquid at the outer boundary

Word	Variable	Description (JETP)
		of the secondary tube wall.
W6-R	HOUTV2	Heat transfer coefficient to vapor at the outer boundary of the secondary tube wall.
W7-R	TOUTL2	Temperature of liquid outside secondary tube wall.
W8-R	TOUTV2	Temperature of vapor outside secondary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

JETP Simple Parameter Card, JETPID060

Word	Variable	Description (JETP)
W1-I	NJETP	Number of actual jet pumps lumped together. The user inputs the geometry for a single pump.

JETP Simple Parameters Card, JETPID070

This optional card contains the relative form loss coefficients for the jet pump.

Word	Variable	Description (JETP)
W1-R	EPSDFF	Relative form loss coefficient for diffuser forward flow. (Default = 5.5.)
W2-R	EPSDFR	Relative form loss coefficient for diffuser reverse flow. (Default = 0.38.)
W3-R	EPSNZF	Relative form loss coefficient for nozzle forward flow. (Default = 5.5.)
W4-R	EPSNZR	Relative form loss coefficient for nozzle reverse flow. Note: The normal flow direction in the nozzle is reverse. (Default = 0.38.)
W5-R	FINLET	Form loss for positive suction flow. (Default = 0.04.)
W6-R	FOTLET	Form loss for negative discharge flow. (Default = 0.45.)

JETP Leak Path Data Cards, JETPID04X

Input these cards only for the "From" component of a leak path. For leakaye path purposes, JETP cells are counted in a single array--first the primary cells, then one dummy joining cell, then the side arm cells.

X	Variable	Dimension	Description (JETP)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area. (For CHAN component, input value should be for one channel assembly.)
	W3-R	FLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial velocity. (Default = 0.0.)
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell. (Default = 0.0.)
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	MLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL. (Default = 0.)

JETP Simple Parameters Card, JETPID050

This card is needed if the outer walls of any component transfers heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (JETP)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no; 1 = yes; 2 = yes with printout of outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

JETP Primary Tube Array Cards, JETPID41X-JETPID68X

One card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (JETP)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes of a single channel assembly.
43	FA	NCELL1+1	Cell edge flow areas. NOTE: The end cells cannot be tapered; i.e., they may not be conical (see Figure 3.4-2).
44	FKLOS	NCELL1+1	Additive form loss coefficients for forward mixture mass flow (see PIPE input). (Default = 0.0).
45	GRAV	NCELL1+1	Gravity terms (see PIPE input).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELL1+1	Ratio, surface roughness/hydraulic diameter. (Default = 0.0).
48	ICHOKE	NCELL1+1	Choking calculation flag (integer). (0 = no choking, 1 = choking calculation.). (Default = 0).
49	ICCFL	NCELL1+1	CCFL control flag (integer). (0 = no CCFL; 1,2 = CCFL calculation, see PIPE input). (Default = 0.)
50	WETP	NCELL1+1	Wetted perimeter (omit if ICCFL is not equal to 2).
51	ALP	NCELL1	Initial void fractions.
52	VL	NCELL1+1	Initial liquid velocity.
53	VV	NCELL1+1	Initial vapor velocity.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures.

CN	Variable	Dimension	Description (JETP)
57	BORC	N ˈLL1	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELL1	Volumetric heat sources in pipe wall (primary). Eliminate this card set if NODES = 0.)
59	TW	NODES *NCELL1	Initial wall temperatures for primary tube. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELL1+1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not allowed unless IPVHT = the number of a VESSEL (integer).
61	KRVC	NCELL1+1	Cell number in component IPVHT = NUM to which heat is transferred (integer). Omit if IPVHT = 0. If compone˜t IPVHT is a vessel, KVRC(I) is the relative cell number on axial level KLVC(I). (Default = 0.)
62	RKLOS	NCELL1+1	Additive form loss coefficients . reverse mixture mass flow. See FKL ; for definition. (Default = 0.0).
63	PA	NCELL1	Noncondensible gas pressure in JETP primary (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELL1	Two-phase level flag for cell. (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell, (input only if LEV1 = 1; default = -1.) NOTE ILEV1 must be -1 in the primary tube cell that connects to the side arm.
65	ALPA	NCELL1	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELL1	Void fraction below two-phase level (input only if LEV1 = 1, default = 0.0).
67	DZLV1	NCELL1	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0.0).
68	VLEV1	NCELL1	Propagation velocity of two-phase level (input only LEV1 = 1, default = 0.0).

JETP Side Tube Array Cards, JETPID71X-JETPID98X

One card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (JETP)
71	DXS	NCELL2	Cell lengths.
72	VOLS	NCELL2	Cell volumes of a single channel assembly.
73	FAS	NCELL2+1	Cell edge flow areas. NOTE: If the JETP is a jet pump, the end cells cannot be tapered.
74	FKLOSS	NCELL2+1	Additive form loss coefficients for forward mixture mass flow (see PIPE input). (Default = 0.0).
75	GRAVS	NCELL2+1	Gravity terms (see PIPE input).
76	HDS	NCELL2+1	Hydraulic diameters. (If 0.0, HD is calculated assuming FA is circular.)
77	EPSDS	NCELL2+1	Ratio, surface roughness/hydraulic diameter. (Default = 0.0).
78	ICHOKES	NCELL2+1	Choking calculation flag (integer). (0 = no choking, 1 = choking calculation.). (Default = 0).
79	ICCFLS	NCELL2+1	CCFL control flag (integer). (0 = no CCFL; 1,2 = CCFL calculation, see PIPE input). (Default = 0.)
80	WETPS	NCELL2+1	Wetted perimeter (input only if any entry in ICCFL equals 2).
81	ALPS	NCELL2	Initial void fractions.
82	VLS	NCELL2+1	Initial liquid velocity.
83	VVS	NCELL2+1	Initial vapor velocity.
84	TLS	NCELL2	Initial liquid temperatures.
85	TVS	NCELL2	Initial vapor temperatures.
86	PS	NCELL2	Initial pressures.
87	BORCS	NCELL2	Boron concentration (ppm) (default = 0.0,

CN	Variable	Dimension	Description (JETP)
			required if IBORC = 1 and BORC not equal to 0.0).
88	QPPPS	NCELL2	Volumetric heat sources in pipe wall. Eliminate this card set if NODES = 0.
89	TWS	NODES *NCELL2	Initial wall temperatures for side tube. (Eliminate this card set if NODES = 0.)
90	KLVCS	NCELL2+1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not allowed unless IPVHT = the number of a VESSEL (integer).
91	KRVCS	NCELL2+1	Cell number in component IPVHT = NUM to which heat is transferred (integer). Omit if IPVHT = 0. If component IPVHT is a VESSEL, KVRC(I) is the relative cell number on axial level KLVC(I). (Default = 0.)
92	RKLOSS	NCELL2+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition. (Default = 0.0).
93	PAS	NCELL2	Noncondensible gas pressure in JETP primary (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
94	ILEV1S	NCELL2	Two-phase level flag for cell. (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell, (input only if LEV1 = 1; default = -1.) NOTE: ILEV1 must be -1 in the primary tube cell that connects to the side arm.
95	ALPAS	NCELL2	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
96	ALPBS	NCELL2	Void fraction below two-phase level (input only if LEV1 = 1, default = 0.0).
	DZLV1S	NCELL2	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0.0).
98	VLEV1S	NCELL2	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0.0).

3.4.7 PIPE Component (PIPE)

PIPE Header Card, PIPEID000

Word	Variable	Description (PIPE)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

PIPE Simple Parameters Card, PIPEID01X

Only the first five variables are required if NODES = 0; otherwise the first nine variables are needed.

Word	Variable	Description (PIPE)
W1-I	NCELLS	Number of fluid cells in this PIPE.
W2-I	NODES	Number of radial heat transfer nodes in PIPE wall. (0 implies no wall heat transfer.)
W3-I	JUN1	Junction number for junction adjacent to cell 1.
W4-I	JUN2	Junction number for junction adjacent to cell NCELLS.
W5-I	MAT	Material ID of pipe wall. 2 = Zircaloy 6 = SS 304 7 = SS 316 8 = SS 347 9 = Carbon steel A508 10 = INCONEL 718 11 = ZrO_2. 21-99 = Input table.
W6-I	ICHF	CHF calculation flag. Neg = No CHF allowed. 0 = use simplified boiling curve, mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.

Word	Variable	Description (PIPE)
W7-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.
W8-R	RADIN	Inner radius of PIPE wall.
W9-R	TH	PIPE wall thickness.
W10-R	HOUTL	Heat transfer coefficient between outer boundary of PIPE wall and liquid.
W11-R	HOUTV	Heat transfer coefficient between outer boundary of PIPE wall and vapor.
W12-R	TOUTL	Liquid temperature outside PIPE.
W13-R	TOUTV	Vapor temperature outside PIPE.

NOTE: The four parameters HOUTL, HOUTV, TOUTL, and TOUTV are provided to allow flexibility in calculating possible heat losses from the outside of PIPEs. Typically, such heat losses are not important, and HOUTL and HOUTV are set equal to zero. Further, when heat losses are significant, they can often be described by a single heat transfer coefficient (e.g., characteristic of air) and a single external temperature. The above values are not used for cells which transfer heat to another component.

PIPE Simple Parameter Card, PIPEID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (PIPE)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of outer wall heat transfer values.)

Word	Variable	Description (PIPE)
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

PIPE Leak Path Data Cards, PIPEID04X

Input these cards only for the "From" component of a leak path.

X	Variable	Dimension	Description (PIPE)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area (for CHAN component, input value should be for one channel assembly).
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell (default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL (default = 0).

PIPE Array Cards, PIPEID41X-PIPEID68X

Input one card for each of the following variables, using LOAD format. Variables dimensioned NCELLS + 1 need to match the components the PIPE is connected to at the end cells.

CN	Variable	Dimension	Description (PIPE)
41	DX	NCELLS	Cell lengths.
42	VOL	NCELLS	Cell volumes.

CN	Variable	Dimension	Description (PIPE)
43	FA	NCELLS+1	Cell edge flow areas.
44	FKLOS	NCELLS+1	Additive form loss coefficients for forward mixture mass flow. FKLOS is defined by $\Delta P = 1/2\ FKLOS \cdot \rho \cdot V^2$ (default = 0.0).
45	GRAV	NCELLS+1	Gravity direction factors. Cosine of the angle between a vertical (upright) vector and a vector pointing from the center of cell j to the center of cell j+1 (see Section 5.12.5).
46	HD	NCELLS+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELLS+1	Ratio, surface roughness/hydraulic diameter (default = 0.0).
48	ICHOKE	NCELLS+1	Choking calculation flag (integer). (0 = no choking 1 = choking calculation. Optional; default = 0).
49	ICCFL	NCELLS+1	CCFL control flag (integer). 0 = No CCFL 1 = CCFL for pipe flow (same as upper tie plate) 2 = CCFL for side entry orifice. (Default = 0).
50	WETP	NCELLS+1	Wetted perimeter [input only if any entry in ICCFL equals two (2)].
51	ALP	NCELLS	Initial void fraction.
52	VL	NCELLS+1	Initial liquid velocity.
53	VV	NCELLS+1	Initial vapor velocity.
54	TL	NCELLS	Initial liquid temperatures.
55	TV	NCELLS	Initial vapor temperatures.
56	P	NCELLS	Initial pressures.
57	BORC	NCELLS	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC ≠ 0.0).
58	QPPP	NCELLS	Volumetric heat sources in pipe wall

CN	Variable	Dimension	Description (PIPE)
			(Eliminate this card set if NODES = 0).
59	TW	NODES*NCELLS	Initial wall temperatures. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELLS	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELLS	Cell number in component NUM=IPVHT to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELLS+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition (default = 0.0).
63	PA	NCELLS	Noncondensible gas pressure in PIPE (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell, input only if LEV1 = 1, default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0.0).
67	DZLV1	NCELLS	Height of two phase level above bottom of cell (input only if LEV1 = 1, default = 0.0).
68	VLEV1	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0.0).

3.4.8 PUMP Component (PUMP)

PUMP Header Card, PUMPID000

Word	Variable	Description (PUMP)
W1-I	NUM	Component ID number (must be unique for each component).
2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

PUMP Simple Parameter Card, PUMPID01X

Only the first 12 variables are required if NODES = 0; otherwise all 18 variables are needed.

Word	Variable	Description (PUMP)
W1-I	NCELLS	Number of fluid cells in PUMP (must be at least two).
W2-I	NODES	Number of radial heat transfer nodes in wall. (0 implies no wall heat transfer.)
W3-I	JUN1	Junction number for junction adjacent to cell 1.
W4-I	JUN2	Junction number for junction adjacent to cell NCELLS.
W5-I	MAT	Material ID of wall. 2 = Zircaloy 6 = SS 304 7 = SS 316 8 = SS 347 9 = Carbon steel A508 10 = INCONEL 718 11 = ZrO_2 21-99 = Input table
W6-I	ICHF	CHF calculation flag. NEG = No CHF allowed. 0 = Use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi X_c CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE X_c CHF at high flow, Zuber at low flow. (Suggested value = 2).

PUMP Component Data

Word	Variable	Description (PUMP)
W7-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.
W8-I	IPMPTY	PUMP type option 1 = pump speed input by user 2 = constant speed until trip, then speed calculated from equation of motion 3 = pump motor torque controlled by control system.
W9-I	IPFACE	Cell face number of pump impeller.
W10-I	IRP	Reverse speed option (0 = reverse rotation not allowed; 1 = allowed).
W11-I	IPM	Two-phase option (0 = use single-phase curves; 1 = use two-phase curves).
W12-I	IPMPTR	PUMP speed trip number.
W13-I	NPMPTX	Number of pairs of points in the PUMP speed table.
W14-R	RADIN	Inner radius of PUMP wall.
W15-R	TH	PUMP wall thickness.
W16-R	HOUTL	Heat transfer coefficient between outer boundary of pump wall and liquid.
W17-R	HOUTV	Heat transfer coefficient between outer boundary of pump wall and vapor.
W18-R	TOUTL	Liquid temperature outside PUMP wall.
W19-R	TOUTV	Vapor temperature outside PUMP wall.

(See PIPE input description for further comments on these heat transfer parameters.)

PUMP Simple Parameter Card, PUMPID02X

Only the first six variables are required.

Word	Variable	Description (PUMP)
W1-R	RHEAD	Rated head, $\Delta P/\rho$ (m^2/s^2).
W2-R	RTORK	Rated torque (N-m).
W3-R	RFLOW	Rated flow (m^3/s).
W4-R	RRHO	Rated density (kg/m^3).
W5-R	ROMEGA	Rated pump speed (radian/s).
W6-R	EFFMI	Effective moment of inertia (kg-m^2).
W7-R	TFR1	Constant torque due to friction (N-m).
W8-R	TFR2	Bearing and windage torque constant (N-m).
W9-R	OMEGA	Initial pump speed (radian/s).
W10-I	OPTION	Pump curve option number. 0 = User-specified pump, input following. 1 = Use built-in Semiscale pump curves.

PUMP Simple Parameter Card, PUMPID03X

This card and PUMP curve cards are needed only if OPTION = 0. If OPTION = 1, skip to PUMP array cards. The user is referred to the pump component description in Reference 3-2 for a definition of the terminology used below. All 18 variables are required if OPTION = 0.

Word	Variable	Description (PUMP)
W1-I	NDATA(1)	Number of pairs of points on the HSP1 curve.
W2-I	NDATA(2)	Number of pairs of points on the HSP2 curve.
W3-I	NDATA(3)	Number of pairs of points on the HSP3 curve.
W4-I	NDATA(4)	Number of pairs of points on the HSP4 curve.
W5-I	NDATA(5)	Number of pairs of points on the HTP1 curve.
W6-I	NDATA(6)	Number of pairs of points on the HTP2 curve.
W7-I	NDATA(7)	Number of pairs of points on the HTP3 curve.

Word	Variable	Description (PUMP)
W8-I	NDATA(8)	Number of pairs of points on the HTP4 curve.
W9-I	NDATA(9)	Number of pairs of points on the TSP1 curve.
W10-I	NDATA(10)	Number of pairs of points on the TSP2 curve.
W11-I	NDATA(11)	Number of pairs of points on the TSP3 curve.
W12-I	NDATA(12)	Number of pairs of points on the TSP4 curve.
W13-I	NDATA(13)	Number of pairs of points on the TTP1 curve.
W14-I	NDATA(14)	Number of pairs of points on the TTP2 curve.
W15-I	NDATA(15)	Number of pairs of points on the TTP3 curve.
W16-I	NDATA(16)	Number of pairs of points on the TTP4 curve.
W17-I	NHDM	Number of pairs of points on the HDM curve.
W18-I	NTDM	Number of pairs of points on the TDM curve.

PUMP Leak Path Data Cards, PUMPID04X

Input these cards only for the "From" component of a leak path.

X	Variable	Dimension	Description (PUMP)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area.
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell (default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.

X	Variable	Dimension	Description (PUMP)
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL (default = 0).

PUMP Simple Parameter Card, PUMPID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (PUMP)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

PUMP Curve Cards, PUMPID11X-PUMPID28X

Input one set for each curve listed on card PUMPID03X that has nonzero data points, using LOAD format. Data are entered in pairs (e.g., $(x,y)_i$ for i = 1 to NDATA, where x is the independent variable and y is the dependent variable).

CN	Variable	Dimension	Description (PUMP)
11	HSP1	2*NDATA(1)	HSP1 curve.
12	HSP2	2*NDATA(2)	HSP2 curve. Single-phase head curves.
13	HSP3	2*NDATA(3)	HSP3 curve.
14	HSP4	2*NDATA(4)	HSP4 curve.
15	HTP1	2*NDATA(5)	HTP1 curve.
16	HTP2	2*NDATA(6)	HTP2 curve. Fully degraded head curves.
17	HTP3	2*NDATA(7)	HTP3 curve.
18	HTP4	2*NDATA(8)	HTP4 curve.

PUMP COMPONENT DATA

CN	Variable	Dimension	Description (PUMP)
19	TSP1	2*NDATA(9)	TSP1 curve.
20	TSP2	2*NDATA(10)	TSP2 curve. Single-phase torque curves.
21	TSP3	2*NDATA(11)	TSP3 curve.
22	TSP4	2*NDATA(12)	TSP4 curve.
23	TTP1	2*NDATA(13)	TTP1 curve.
24	TTP2	2*NDATA(14)	TTP2 curve. Fully degraded torque curves.
25	TTP3	2*NDATA(15)	TTP3 curve.
26	TTP4	2*NDATA(16)	TTP4 curve.
27	HDM	2*NHDM	HDM curve (head degradation multiplier).
28	TDM	2*NTDM	TDMCURVE (torque degradation multiplier).

PUMP Array Cards, PUMPID29X and PUMPID41X-PUMPID68X

Input one set for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (PUMP)
29	SPTBL	2*NPMPTX	Time since trip vs. pump speed table (omit if NPMPTX = 0).
41	DX	NCELLS	Cell lengths.
42	VOL	NCELLS	Cell volumes.
43	FA	NCELLS+1	Cell edge flow areas.
44	FKLOS	NCELLS+1	Additive form loss coefficients for forward mixture mass flow. FKLOS is defined by $\Delta P = 1/2\ FKLOS \cdot \rho \cdot V^2$ (default = 0.0).
45	GRAV	NCELLS+1	Gravity term (see PIPE input).
46	HD	NCELLS+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELLS+1	Ratio, surface roughness/hydraulic diameter

CN	Variable	Dimension	Description (PUMP)
			(default = 0.0).
48	ICHOKE	NCELLS+1	Choking calculation flag (integer). (0 = no choking, 1 = choking calculation). (Default = 0). NOTE: At cell 1 face 2 I CHOKE must be zero.
49	ICCFL	NCELLS+1	CCFL control flag (integer). (0 = no CCFL, 1, 2 = CCFL calculation, see PIPE Input) (default = 0).
50	WETP	NCELLS+1	Wetted perimeter (omit if ICCFL = 0 or 1).
51	ALP	NCELLS	Initial void fraction.
52	VL	NCELLS+1	Initial liquid velocity.
53	VV	NCELLS+1	Initial vapor velocity.
54	TL	NCELLS+1	Initial liquid temperatures.
55	TV	NCELLS+1	Initial vapor temperatures.
56	P	NCELLS	Initial pressures.
57	BORC	NCELLS	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELLS	Volumetric heat sources in PUMP wall (Eliminate this card set if NODES = 0).
59	TW	NODES*NCELLS	Initial wall temperatures. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELLS	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELLS	Cell number in component NUM=IPVHT to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELLS+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition. (Default = 0.0).

CN	Variable	Dimension	Description (PUMP)
63	PA	NCELLS	Noncondensible gas pressure in PUMP (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell; input only if LEV1 = 1, default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0.0).
67	DZLV1	NCELLS	Height of two phase level above bottom of cell (input only if LEV1 = 1, default = 0.0).
68	VLEV1	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0.0).

3.4.9 Separator/Dryer Component (SEPD)

SEPD Header Card, SEPDID000

Word	Variable	Description (SEPD)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

SEPD Simple Parameter Card, SEPDID01X

The first 10 variables are required if NODES=0; otherwise the first 12 variables are needed.

Word	Variable	Description (SEPD)
W1-I	JCELL	Primary tube cell number where the side tube (secondary tube) connects.
W2-I	NODES	Number of radial heat-transfer nodes in the TEE wall. (0 implies no wall heat transfer.)
W3-I	MATID	Material ID of TEE wall (see PIPE input description).
W4-R	COST	Cosine of the angle from the low-numbered side of the primary tube to the secondary tube.
W5-I	ICHF	CHF calculation flag. NEG = No CHF allowed. 0 = use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.
W6-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component which is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.

Word	Variable	Description (SEPD)
W7-I	NCELL1	Number of fluid cells in the primary tube.
W8-I	JUN1	Junction number for the junction adjacent to cell 1.
W9-I	JUN2	Junction number for the junction adjacent to cell NCELL1.
W10-I	ITRP	TRIP number for starting small break.
W11-R	RADIN1	Inner radius of the primary tube wall.
W12-R	TH1	Wall thickness of the primary tube.
W13-R	HOUTL1	Heat transfer coefficient to liquid at the outer boundary of the primary tube wall.
W14-R	HOUTV1	Heat transfer coefficient to vapor at the outer boundary of the primary tube wall.
W15-R	TOUTL1	Temperature of liquid outside primary tube wall.
W16-R	TOUTV1	Temperature of vapor outside primary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

SEPD Simple Parameter Card, SEPDID02X
(X = 0 through 9)

Only the first two variables are required if NODES=0; otherwise the first four variables are needed.

Word	Variable	Description (SEPD)
W1-I	NCELL2	Number of fluid cells in the secondary tube.
W2-I	JUN3	Junction number of the free end of the secondary tube (cell NCELL2).
W3-R	RADIN2	Inner radius of the secondary tube wall.
W4-R	TH2	Wall thickness of the secondary tube.
W5-R	HOUTL2	Heat transfer coefficient to liquid at the outer boundary of the secondary tube wall.
W6-R	HOUTV2	Heat transfer coefficient to vapor at the outer boundary

Word	Variable	Description (SEPD)
		of the secondary tube wall.
W7-R	TOUTL2	Temperature of liquid outside secondary tube wall.
W8-R	TOUTV2	Temperature of vapor outside secondary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

SEPD Leak Path Cards, SEPDID04X

For leakage path purposes, SEPD cells are counted in a single array--first, the primary cells, then one dummy joining cell, then the side arm cells.

X	Variable	Dimension	Description (SEPD)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area (for CHAN component input value should be for one channel assembly).
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell (default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL (default = 0).

SEPD Simple Parameter Card, SEPDID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (SEPD)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

SEPD Separator/Dryer Cards SEPDID060

Word	Variable	Description (SEPD)
W1-I	NSEPS	Number of separators represented by this component.
W2-I	ISTAGE	Number of stages in separator (allowed values = 0, 2 or 3). Use ISTAGE = 0 if simple separator model is to be used.

The remaining variables on this card depend upon the value of ISTAGE.

If ISTAGE = 0 (simple separator option),

W3-R	XCO	Vapor carryover quality (default = 0.0)
W4-R	XCU	Liquid carryunder quality (default = 0.0)

If ISTAGE = 2 or 3 (mechanistic separator option),

W3-R	AI	Standpipe flow area (default = 0.018637)
W4-R	AN	Separator nozzle exit area (default = 0.01441).
W5-R	RN	Radius of separator hub at inlet (default = 0.0809585).
W6-R	THETA	Angle between swirling vane and horizontal plane (default = 48.0).
W7-R	RR1	Radius of the larger pickoff ring at the first stage of a 2-stage separator (default = 0.0857208).

Mechanistic Separator Stage Data Card SEPDID06X

Input the following eight variables for each separator stage if the mechanistic separator option is specified. X=1 for first stage data, X=2 for second stage data and X=3 for third stage data (if required).

X	Word	Variable	Description (SEPD)
1	W1-R	RWS	Inner radius of the separator wall.
	W2-R	RRS	Inner radius of the pickoff ring.
	W3-R	ADS	Flow area of the discharge passage.
	W4-R	DDS	Hydraulic diameter of the discharge passage.
	W5-R	HBS	Length of the separating barrel.
	W6-R	HSK	Axial distance between the exit of the first discharge passage and the swirler vane.
	W7-R	CKS	Loss coefficient in discharge passage.
	W8-R	EFFLD	Effective L/D coefficient at pickoff ring.
2	Etc., for second stage.		
3	Etc., for third stage (if required).		

The default values for the above variables are summarized in the following:

DEFAULT VALUE

	Two-Stage Separator		Three-Stage Separator		
Variable	First	Second	First	Second	Third
RWS	0.10794	0.06985	0.10794	0.10794	0.10794
RRS	0.069875	0.06032	0.0857208	0.0952453	0.0984201
ADS	0.0415776	0.0029133	0.0095265	0.0096265	0.0096265
DDIS	0.045558	0.0121699	0.025399	0.025399	0.025399
HBS	0.877845	0.16255	1.0699	0.384156	0.384156
HSK	0.2127	0.	0.45083	0.	0.
CKS	10.	0.5	2.5	1.429	2.563
EFFLD	450.0	95.85	53.44	194.64	424.96

Dryer Data Card SEPDID070

This card is needed if this component is to perform the dryer functions.

Word	Variable	Description (SEPD)
W1-R	NDRYR	Number of dryers represented by this component.
W2-R	VDRYL	Vapor velocity in dryer below which dryer capacity is 1.0.
W3-R	VDRYU	Vapor velocity in dryer above which dryer capacity is zero.
W4-R	DELDIM	Range of dryer inlet liquid quality over which dryer capacity degrades from one to zero at fixed inlet vapor velocity.

Separator/Dryer Primary Tube Array Cards, SEPDID41X-SEPDID68X

Input one card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (SEPD)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes.
43	FA	NCELL1+1	Cell edge flow areas. Note: If the TEE is a jet pump, the end cells cannot be tapered.
44	FKLOS	NCELL1+1	Additive form loss coefficients for forward mixture mass flow (see PIPE input) (default = 0.0).
45	GRAV	NCELL1+1	Gravity terms (see PIPE input).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELL1+1	Ratio, surface roughness to hydraulic diameter (default = 0.0).
48	ICHOKE	NCELL1+1	Choking calculation flag (integer) (0 = no choking, 1= choking calculation) (default = 0).
49	ICCFL	NCELL1+1	CCFL control flag Integer

CN	Variable	Dimension	Description (SEPD)
			(0 = no CCFL, 1, 2 = CCFL calculation, see PIPE input) (default = 0).
50	WETP	NCELL1+1	Wetted perimeter (omit if ICCFL not equal 2).
51	ALP	NCELL1	Initial void fractions.
52	VL	NCELL1+1	Initial liquid velocity.
53	VV	NCELL1+1	Initial vapor velocity.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures.
57	BORC	NCELL1	Boron concentration (ppm) (default = 0.0, required IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELL1	Volumetric heat sources in pipe wall (primary). (Eliminate this card set if NODES = 0.)
59	TW	NODES* NCELL1	Initial wall temperatures for primary tube. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELL1+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition (default = 0.0).
63	PA	NCELL1	Noncondensible gas pressure in SEPD primary (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase

CN	Variable	Dimension	Description (SEPD)
			level not present in cell; +1 implies two-phase level present in cell; input only if LEV1 = 1, default = 0).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0).
67	DZLV1	NCELLS	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0).
68	VLEV	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0).

SEPD Side Tube Array Cards, SEPDID71X-SEPDID98X

CN	Variable	Dimension	Description (SEPD)
71	DXS	NCELL2	Cell lengths.
72	VOLS	NCELL2	Cell volumes.
73	FAS	NCELL2+1	Cell edge flow areas. Note: If the TEE is a jet pump, the end cells cannot be tapered.
74	FKLOSS	NCELL2+1	Additive form loss coefficients for forward mixture mass flow (default = 0.0).
75	GRAVS	NCELL2+1	Gravity terms (see PIPE).
76	HDS	NCELL2+1	Hydraulic diameters. (If 0.0, HD is calculated assuming FA is circular.)
77	EPSD	NCELL2+1	Ratio surface roughness/hydraulic diameter (default = 0.0).
78	ICHOKES	NCELL2+1	Choking calculation flag (integer) (0 = no choking, 1 = choking) (default = 0).
79	ICCFLS	NCELL2+1	CCFL control flag (integer) (0 = no CCFL, 1,2 = calculation, see PIPE input) (default = 0).
80	WETPS	NCELL2+1	Wetted perimeter [input only if any entry in ICCFL equals two (2)].

CN	Variable	Dimension	Description (SEPD)
81	ALPS	NCELL2	Initial void fractions.
82	VLS	NCELL2+1	Initial liquid velocity.
83	VVS	NCELL2+1	Initial liquid temperatures.
84	TLS	NCELL2	Initial liquid temperatures.
85	TVS	NCELL2	Initial vapor temperatures.
86	PS	NCELL2	Initial pressures.
87	BORCS	NCELL2	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC ≠ 0.0).
88	QPPPS	NCELL2	Volumetric heat sources in pipe wall. (Eliminate this card set if NODES = 0.)
89	TWS	NODES* NCELL2	Initial wall temperatures for side tube. (Eliminate this card set if NODES = 0.).
90	KLVCS	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
91	KRVCS	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
92	RKLOSS	NCELL2+1	Additive form loss coefficients for reverse mixture mass flow (default = 0.0).
93	PAS	NCELL2	Noncondensible gas pressure in TEE secondary, (default = 0.0, required if IAIR = 1 and PAS not equal to 0.0).
94	ILEVIS	NCELL2	(Same as ILEV).
95	ALPAS	NCELL2	(Same as ALPA).
96	ALPBS	NCELL2	(Same as ALPB).
97	DZLVIS	NCELL2	(Same as DZLEV).
98	VLEVIS	NCELL2	(Same as VLEV).

3.4.10 TEE Component (TEE)

TEE Header Card, TEEID000

Word	Variable	Description (TEE)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose then in quotes.

TEE Simple Parameter Card, TEEID01X

The first 10 variables are required if NODES=0; otherwise the first 12 variables are needed.

Word	Variable	Description (TEE)
W1-I	JCELL	Primary tube cell number where the side tube (secondary tube) connects.
W2-I	NODES	Number of radial heat-transfer nodes in the TEE wall. (0 implies no wall heat transfer.)
W3-I	MATID	Material ID of TEE wall (see PIPE input description).
W4-R	COST	Cosine of the angle from the low-numbered side of the primary tube to the secondary tube.
W5-I	ICHF	CHF calculation flag. NEG = No CHF allowed. 0 = use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.
W6-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.

Word	Variable	Description (TEE)
W7-I	NCELL1	Number of fluid cells in the primary tube.
W8-I	JUN1	Junction number for the junction adjacent to cell 1.
W9-I	JUN2	Junction number for the junction adjacent to cell NCELL1.
W10-I	ITRP	TRIP number for starting small break.
W11-R	RADIN1	Inner radius of the primary tube wall.
W12-R	TH1	Wall thickness of the primary tube.
W13-R	HOUTL1	Heat transfer coefficient to liquid at the outer boundary of the primary tube wall.
W14-R	HOUTV1	Heat transfer coefficient to vapor at the outer boundary of the primary tube wall.
W15-R	TOUTL1	Temperature of liquid outside primary tube wall.
W16-R	TOUTV1	Temperature of vapor outside primary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

TEE Simple Parameter Card, TEEID02X
(X = 0 through 9)

Only the first two variables are required if NODES=0; otherwise, the first four variables are needed.

Word	Variable	Description (TEE)
W1-I	NCELL2	Number of fluid cells in the secondary tube.
W2-I	JUN3	Junction number of the free end of the secondary tube (cell NCELL2).
W3-R	RADIN2	Inner radius of the secondary tube wall.
W4-R	TH2	Wall thickness of the secondary tube.
W5-R	HOUTL2	Heat transfer coefficient to liquid at the outer boundary of the secondary tube wall.
W6-R	HOUTV2	Heat transfer coefficient to vapor at the outer boundary

Word	Variable	Description (TEE)
		of the secondary tube wall.
W7-R	TOUTL2	Temperature of liquid outside secondary tube wall.
W8-R	TOUTV2	Temperature of vapor outside secondary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

TEE Leak Path Data Cards, TEEID04X

Input these cards only for the "From" component of a leak path. For leakage path purposes, TEE cells are counted in a single array: first the primary cells, then one dummy joining cell, then the side arm cells.

X	Variable	Dimension	Description (TEE)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area.
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell (default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL (default = 0).

TEE Simple Parameter Card, TEEID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (TEE)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

TEE Primary Tube Array Cards, TEEID41X-TEEID68X

Input one card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (TEE)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes.
43	FA	NCELL1+1	Cell edge flow areas. Note: If the TEE is a jet pump, the end cells cannot be tapered.
44	FKLOS	NCELL1+1	Additive form loss coefficients for forward mixture mass flow (see PIPE input) (default = 0.0).
45	GRAV	NCELL1+1	Gravity terms (see PIPE input).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EFSD	NCELL1+1	Ratio, surface roughness to hydraulic diameter (default = 0.0).
48	ICHOKE	NCELL1+1	Choking calculation flag (integer) (0 = no choking, 1= choking calculation) (default = 0).
49	ICCFL	NCELL1+1	CCFL control flag Integer (0 = no CCFL, 1, 2 = CCFL calculation, see PIPE input) (default = 0).
50	WETP	NCELL1+1	Wetted perimeter (omit if ICCFL not equal 2).
51	ALP	NCELL1	Initial void fractions.

CN	Variable	Dimension	Description (TEE)
52	VL	NCELL1+1	Initial liquid velocity.
53	VV	NCELL1+1	Initial vapor velocity.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures.
57	BORC	NCELL1	Boron concentration (ppm) (default = 0.0, required IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELL1	Volumetric heat sources in pipe wall (primary). (Eliminate this card set if NODES = 0.)
59	TW	NODES* NCELL1	Initial wall temperatures for primary tube. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELL1+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition (default = 0.0).
63	PA	NCELL1	Noncondensible gas pressure in TEE primary (default = 0.0, required if IAIR = . and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell; input only if LEV1 = 1, default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).

CN	Variable	Dimension	Description (TEE)
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0).
67	DZLV1	NCELLS	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0).
68	VLEV	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0).

TEE Side Tube Array Cards, TEEID71X-TEEID98X

CN	Variable	Dimension	Description (TEE)
71	DXS	NCELL2	Cell lengths.
72	VOLS	NCELL2	Cell volumes.
73	FAS	NCELL2+1	Cell edge flow areas. Note: If the TEE is a jet pump, the end cells cannot be tapered.
74	FKLOSS	NCELL2+1	Additive form loss coefficients for forward mixture mass flow (default = 0.0).
75	GRAVS	NCELL2+1	Gravity terms (see PIPE).
76	HDS	NCELL2+1	Hydraulic diameters. (If 0.0, HD is calculated assuming FA is circular.)
77	EPSDS	NCELL2+1	Ratio surface roughness/hydraulic diameter (default = 0.0).
78	ICHOKES	NCELL2+1	Choking calculation flag (integer) (0 = no choking, 1 = choking calculation) (default = 0).
79	ICCFLS	NCELL2+1	CCFL control flag (integer) (0 = no CCFL, 1,2 = calculation, see PIPE input) (default = 0)
80	WETPS	NCELL2+1	Wetted perimeter [input only if any entry in ICCFL equals two (2)].
81	ALPS	NCELL2	Initial void fractions.
82	VLS	NCELL2+1	Initial liquid velocity.
83	VVS	NCELL2+1	Initial liquid temperatures.

CN	Variable	Dimension	Description (TEE)
84	TLS	NCELL2	Initial liquid temperatures.
85	TVS	NCELL2	Initial vapor temperatures.
86	PS	NCELL2	Initial pressures.
87	BORCS	NCELL2	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC not equal to 0.0).
88	QPPPS	NCELL2	Volumetric heat sources in pipe wall. (Eliminate this card set if NODES = 0.)
89	TWS	NODES* NCELL2	Initial wall temperatures for side tube. (Eliminate this card set if NODES = 0.).
90	KLVCS	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
91	KRVCS	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
92	RKLOSS	NCELL2+1	Additive form loss coefficients for reverse mixture mass flow (default = 0.0).
93	PAS	NCELL2	Noncondensible gas pressure in TEE secondary, (default = 0.0, required if IAIR = 1 and PAS not equal to 0.0).
94	ILEVIS	NCELL2	(Same as ILEV).
95	ALPAS	NCELL2	(Same as ALPA).
96	ALPBS	NCELL2	(Same as ALPB).
97	DZLVIS	NCELL2	(Same as DZLEV).
98	VLEVIS	NCELL2	(Same as VLEV).

3.4.11 Turbine Component (TURB)

TURB Header Card, TURBID000

Word	Variable	Description (TURB)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose then in quotes.

TURB Simple Parameter Card, TURBID01X

The first 10 variables are required if NODES=0; otherwise the first 12 variables are needed.

Word	Variable	Description (TURB)
W1-I	JCELL	Primary tube cell number where the side tube (secondary tube) connects.
W2-I	NODES	Number of radial heat-transfer nodes in the TURB wall. (0 implies no wall heat transfer.)
W3-I	MATID	Material ID of TURB wall (see PIPE input description).
W4-R	COST	Cosine of the angle from the low-numbered side of the primary tube to the secondary tube.
W5-I	ICHF	CHF calculation flag. NEG = No CHF allowed. 0 = use simplified boiling curve, Mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.
W6-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.

TURB Component Data

Word	Variable	Description (TURB)
W7-I	NCELL1	Number of fluid cells in the primary tube (must be 2).
W8-I	JUN1	Junction number for the junction adjacent to cell 1.
W9-I	JUN2	Junction number for the junction adjacent to cell NCELL1.
W10-I	ITRP	TRIP number for starting small break.
W11-R	RADIN1	Inner radius of the primary tube wall.
W12-R	TH1	Wall thickness of the primary tube.
W13-R	HOUTL1	Heat transfer coefficient to liquid at the outer boundary of the primary tube wall.
W14-R	HOUTV1	Heat transfer coefficient to vapor at the outer boundary of the primary tube wall.
W15-R	TOUTL1	Temperature of liquid outside primary tube wall.
W16-R	TOUTV1	Temperature of vapor outside primary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

TURB Simple Parameter Card, TURBID02X
(X = 0 through 9)

Only the first two variables are required if NODES=0; otherwise, the first four variables are needed.

Word	Variable	Description (TURB)
W1-I	NCELL2	Number of fluid cells in the secondary tube.
W2-I	JUN3	Junction number of the free end of the secondary tube (cell NCELL2).
W3-R	RADIN2	Inner radius of the secondary tube wall.
W4-R	TH2	Wall thickness of the secondary tube.
W5-R	HOUTL2	Heat transfer coefficient to liquid at the outer boundary of the secondary tube wall.
W6-R	HOUTV2	Heat transfer coefficient to vapor at the outer boundary

Word	Variable	Description (TURB)
		of the secondary tube wall.
W7-R	TOUTL2	Temperature of liquid outside secondary tube wall.
W8-R	TOUTV2	Temperature of vapor outside secondary tube wall.

(See PIPE component description for further comments on these heat transfer parameters.)

TURB Simple Parameter Card, TURBID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (TURB)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

TURB Stage Data Card TURBID06X

Word	Variable	Description (TURB)
W1-I	NSTAGE	Number of stages in TURB component (default = 1).
W2-I	ITSEP	Moisture separator flag 0 = no moisture separator 1 = sidearm is moisture separator.
W3-R	RMDOT	Turbine rated mass flow rate.
W4-R	EFISHR	Turbine rated efficiency.
W5-R	SEPEF	Moisture separator efficiency. Used only if ITSEP = 1. For perfect separation, use SEPEF = 1.0 (default = 1.0).

TURB Rotor Data Card, TURBID07X

The first four words are required.

Word	Variable	Description (TURB)
W1-I	JROT	Turbine rotor number. More than one TURB component may use the same rotor number. If several TURB components are connected to the same rotor, the rotor parameters will be taken only from the first TURB encountered that connects to that rotor.
W2-I	ITURTR	Turbine trip number for rotor number JROT. Rotor speed will remain constant until trip has occurred. Rotor speed will be calculated from equation of motion after trip has occurred.
W3-R	OMEGT	Rotor initial angular velocity (rad/s).
W4-R	INERT	Rotor moment of inertia (kg/m^2).
W5-R	OMEGTR	Rated rotor angular velocity (default = OMEGT).
W6-R	CTROTB	Rotor bearing and windage torque constant (default = 0).
W7-R	TORQTR	Rotor frictional torque (N-m) (default = 0).

TURB Primary Tube Array Cards, TURBID41X-TURBID68X

Input one card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (TURB)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes.
43	FA	NCELL1+1	Cell edge flow areas. [For cell edge 2, a non-zero input value is assumed to be the user-specified turbine nozzle flow area for the first turbine stage. A zero value for cell edge 2 causes the code to compute the nozzle flow area. This calculation assumes that the rated mass flow rate (RMDOT; see below) is achieved with the initial pressure profile input by the user. NOTE: Following

CN	Variable	Dimension	Description (TURB)
			initialization, the nozzle flow area is stored in the TEE VLTAR common block, and the flow area at cell edge 2 is set equal to that at cell edge 1.]
44	FKLOS	NCELL1+1	Additive form loss coefficients for forward mixture mass flow (see PIPE input) (default = 0.0).
45	GRAV	NCELL1+1	Gravity terms (see PIPE input).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELL1+1	Ratio, surface roughness to hydraulic diameter (default = 0.0).
48	ICHOKE	NCELL1+1	Choking calculation flag (integer) (0 = no choking, 1= choking calculation) (default = 0).
49	ICCFL	NCELL1+1	CCFL control flag Integer (0 = no CCFL, 1, 2 = CCFL calculation, see PIPE input) (default = 0).
50	WETP	NCELL1+1	Wetted perimeter (omit if ICCFL not equal 2).
51	ALP	NCELL1	Initial void fractions.
52	VL	NCELL1+1	Initial liquid velocity.
53	VV	NCELL1+1	Initial vapor velocity. [The user-input value at cell edge 2 is assumed to be the initial mixture velocity at the exit of the first stage nozzle. If the user-input value of FA(2) is 0.0, then VV(2) must be specified but is not used. In this case, the initial mixture velocity is set to the steady-state value corresponding to the initial pressure profile in the TURB.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures. [If the user-input value of FA(2) is 0.0, then P(2) must be less than P(1).

CN	Variable	Dimension	Description (TURB)
57	BORC	NCELL1	Boron concentration (ppm) (default = 0.0, required IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELL1	Volumetric heat sources in pipe wall (primary). (Eliminate this card set if NODES = 0.)
59	TW	NODES* NCELL1	Initial wall temperatures for primary tube. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELL1+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition (default = 0.0).
63	PA	NCELL1	Noncondensible gas pressure in TURB primary (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies two-phase level present in cell; input only if LEV1 = 1, default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0).
67	DZLV1	NCELLS	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0).
68	VLEV	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0).

TURB Side Tube Array Cards, TURBID71X-TURBID98X

CN	Variable	Dimension	Description (TURB)
71	DXS	NCELL2	Cell lengths.
72	VOLS	NCELL2	Cell volumes.
73	FAS	NCELL2+1	Cell edge flow areas. Note: If the TEE is a jet pump, the end cells cannot be tapered.
74	FKLOSS	NCELL2+1	Additive form loss coefficients for forward mixture mass flow (default = 0.0).
75	GRAVS	NCELL2+1	Gravity terms (see PIPE).
76	HDS	NCELL2+1	Hydraulic diameters. (If 0.0, HD is calculated assuming FA is circular.)
77	EPSDS	NCELL2+1	Ratio surface roughness/hydraulic diameter (default = 0.0).
78	ICHOKES	NCELL2+1	Choking calculation flag (integer) (0 = no choking, 1 = choking calculation) (default = 0).
79	ICCFLS	NCELL2+1	CCFL control flag (integer) (0 = no CCFL, 1,2 = calculation, see PIPE input) (default = 0).
80	WETPS	NCELL2+1	Wetted perimeter [input only if any entry in ICCFL equals two (2)].
81	ALPS	NCELL2	Initial void fractions.
82	VLS	NCELL2+1	Initial liquid velocity.
83	VVS	NCELL2+1	Initial liquid temperatures.
84	TLS	NCELL2	Initial liquid temperatures.
85	TVS	NCELL2	Initial vapor temperatures.
86	PS	NCELL2	Initial pressures.
87	BORCS	NCELL2	Boron concentration (ppm) (default = 0.0, required if IBORC = 1 and BORC ≠ 0.0).
88	QPPPS	NCELL2	Volumetric heat sources in pipe wall. (Eliminate this card set if NODES = 0.)

CN	Variable	Dimension	Description (TURB)
89	TWS	NODES* NCELL2	Initial wall temperatures for side tube. (Eliminate this card set if NODES = 0.).
90	KLVCS	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
91	KRVCS	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
92	RKLOSS	NCELL2+1	Additive form loss coefficients for reverse mixture mass flow (default = 0.0).
93	PAS	NCELL2	Noncondensible gas pressure in TURB secondary, (default = 0.0, required if IAIR = 1 and PAS not equal to 0.0).
94	ILEV1S	NCELL2	(Same as ILEV).
95	ALPAS	NCELL2	(Same as ALPA).
96	ALPBS	NCELL2	(Same as ALPB).
97	DZLV1S	NCELL2	(Same as DZLEV).
98	VLEV1S	NCELL2	(Same as VLEV).

3.4.12 VALVE Component (VALVE)

VALVE Header Card, VALVEID000

Word	Variable	Description (VALVE)
W1-I	NUM	Component ID number (must be unique for each component).
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose then in quotes.

VALVE Simple Parameters Card, VALVEID01X

Only the first five variables are required if NODES = 0; otherwise the first nine variables are needed.

Word	Variable	Description (VALVE)
W1-I	NCELLS	Number of fluid cells in this VALVE.
W2-I	NODES	Number of radial heat transfer nodes in VALVE wall. (0 implies no wall heat transfer.)
W3-I	JUN1	Junction number for junction adjacent to cell 1.
W4-I	JUN2	Junction number for junction adjacent to cell NCELLS.
W5-I	MAT	Material ID of pipe wall. 2 = Zircaloy 6 = SS 304 7 = SS 316 8 = SS 347 9 = Carbon steel A508 10 = INCONEL 718 11 = ZrO_2. 21-99 = Input table.
W6-I	ICHF	CHF calculation flag. Neg = No CHF allowed. 0 = use simplified boiling curve, mode 7. 1 = Zuber/Biasi CHF. 2 = Biasi or Biasi Xc CHF at high flow, Zuber at low flow. 3 = Biasi or CISE-GE Xc CHF at high flow, Zuber at low flow.

Word	Variable	Description (VALVE)
W7-I	IPVHT	Component-to-component heat transfer indicator. If IPVHT = the NUM of some other component that is not a BREAK or a FILL, then the outer wall of at least one cell in this component transfers heat to the fluid in at least one cell of component NUM, as specified in input arrays KLVC and KRVC. IPVHT = 0 means no component-to-component heat transfer.
W8-R	RADIN	Inner radius of VALVE wall.
W9-R	TH	VALVE wall thickness.
W10-R	HOUTL	Heat transfer coefficient between outer boundary of VALVE wall and liquid.
W11-R	HOUTV	Heat transfer coefficient between outer boundary of VALVE wall and vapor.
W12-R	TOUTL	Liquid temperature outside VALVE.
W13-R	TOUTV	Vapor temperature outside VALVE.

(See PIPE component description for further comments on these heat transfer parameters.)

VALVE Simple Parameter Card, VALVEID02X

All 11 variables are required.

Word	Variable	Description (VALVE)
W1-I	IVTY	VALVE type option.
	-1	VALVE area controlled by control system. (Initial area is specified by FA on VALVE array cards.)
	1	VALVE normally open--trip closes it instantaneously.
	2	VALVE normally closed--trip opens it instantaneously.
	3	VALVE normally open--trip-initiated closing specified by time-dependent table.
	4	VALVE normally closed--trip initiated opening specified by time-dependent table.
	5	Check valve controlled by static pressure gradient.

Word	Variable	Description (VALVE)
		IVPG = 1, DP = P(1)-P(2) = 2, DP = P(2)-P(1) DP + PVC1 $\geq$ 0, valve opens DP + PVC2 $\leq$ 0, valve closes. NOTE: PVC1 and PVC2 defined on W8 and W9.
	6	Motor control valve. Opens and closes based on the pressure in cell ISENS. A minimum flow area ALEAK may be specified to simulate leakage. MODE indicates valve operation (opening, closing, or stationary), and XPOS is the relative position of the valve stem. BCSP, ECSP, BOSP, and EOSP are pressure setpoints controlling valve motion. IVPG controls the manner in which valve area is related to stem position. IVPG = 1, Valve area is directly proportional to stem position. IVPG = 2, Valve area is S-shaped function of stem position. (Guillotine cut of circular cross section.) IVPG = 3, Valve area is user-specified function of stem position. Function will be specified by Table VLTB. NOTE: ISENS, ALEAK, MODE, YPOS, BCSP, ECSP, BOSP, and EOSP are defined on later VALVE cards.
	7	Multiple bank safety relief valve with ADS trip. Each valve bank opens and closes independently based on its own opening and closing pressure set points. Valve opens and closes based on the pressure in cell (IVPS-IVPG-1). Use IVPG = 0 if valve is to be controlled by pressure immediately upstream of valve seat position. Activation of valve trip results in immediate opening of valve area to AVLVE (word 6 on this card) to simulate ADS operation. Valve bank areas, pressure set points, and activation status must be specified in VALVE Table VLTB (VALVE array cards). When trip number IVTR is activated, relief valve will open completely. Trip number IVTP must be defined even if trip control of relief valve is not required.

Word	Variable	Description (VALVE)
W2-I	IVTR	VALVE trip ID. (Input value will be ignored for IVTY = 5,6).
W3-I	NVTX	Number of VALVE table entry sets (used only if IVTY = 3, 4, 6, or 7).
W4-I	IVPG	VALVE pressure gradient option (used only if IVTY = 5, 6, or 7.)
W5-I	IVPS	VALVE orifice location (must be greater than 1 and less than NCELLS + 1).
W6-R	AVLVE	VALVE open area.
W7-R	HVLVE	VALVE open hydraulic diameter.
W8-R	PVC1	Check VALVE pressure set point for opening (use only if IVTY = 5).
W9-R	PVC2	Check VALVE pressure set point for closing, greater than or equal to PVC1.
W10-R	ALEAK	Minimum valve flow area for leakage (IVTY = 6).
W11-R	DELSTP	Valve area change smoothing time constant. Valve area changes take place exponentially with time constant DELSTP (default = 0.0).

VALVE Simple Parameter Card, VALVEID03X
(Input this card only if IVTY = 6).

All 9 variables are required.

Word	Variable	Description (VALVE)
W1-R	BOSP	Pressure above which valve begins to open.
W2-R	EOSP	Pressure below which valve stops opening.
W3-R	BCSP	Pressure below which valve begins to close.
W4-R	ECSP	Pressure above which valve stops closing.

NOTE: It is required that BCSP $\leq$ ECSP $\leq$ EOSP $\leq$ BOSP.

Word	Variable	Description (VALVE)
W5-R	ROPEN	Rate at which valve opens (fraction of total valve stem

Word	Variable	Description (VALVE)
		travel per second). ROPEN ≥ 0.
W6-R	RCLOS	Rate at which valve closes (fraction of total valve stem travel per second). RCLOS ≥ 0.
W7-I	MODE	Defines attempted valve operation (0 = no movement, +1 = opening movement, -1 = closing movement).
W8-R	XPOS	Fraction valve stem withdrawn (0.0 = closed; 1.0 = full open).
W9-I	ISENS	Number of cell for which pressure is checked against pressure set points in words 1 through 4.

VALVE Leak Path Data Cards, VALVEID04X

Input these cards only for the "From" component of a leak path.

X	Variable	Dimension	Description (VALVE)
0	W1-R	NCLK	"From" cell number of leak path.
	W2-R	FALK	Leak path flow area.
	W3-R	CLOS	Leak path loss coefficient.
	W4-R	VMLK	Leak path initial mixture velocity (default = 0.0).
	W5-R	DELZLK	Elevation difference between center of "From" cell and center of "To" cell. A positive value for DELZLK means that the center of the "From" cell is higher than the center of the "To" cell (default = 0.0).
1	W1-I	NCMPTO	Component number of "To" component.
	W2-I	NCLKTO	Cell number of "To" cell.
	W3-I	NLEVTO	Axial level number of "To" cell. Used only when "To" component is a VESSEL (default = 0).

VALVE Simple Parameter Card, VALVEID050

This card is needed if the outer walls of any component transfer heat to the fluid of this component (i.e., if some IPVHT = the NUM of this component). This card can also be used to get major edit printout of wall node temperatures. The default value for both variables below is 0.

Word	Variable	Description (VALVE)
W1-I	IHTS	Indicator for heat transfer to the fluid of this component from the outer wall of one or more other components. (0 = no, 1 = yes, 2 = yes with printout of those outer wall heat transfer values).
W2-I	IWT	Write flag for major edit of wall node temperatures. (1 = yes, 0 = no).

VAL‹ ‹‹imary Tube Array Cards, VALVEID41X-VALVEID68X

Input one card for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (VALVE)
41	DX	NCELL1	Cell lengths.
42	VOL	NCELL1	Cell volumes.
43	FA	NCELL1+1	Cell edge flow areas.
44	FKLOS	NCELL1+1	Additive form los‹ coefficients for forward mixture mass flow FKLOS is defined by $\Delta P = 1/2\ FKLOS \cdot \rho \cdot V^2$ (de‹ ‹ult = 0.0).
45	GRAV	NCELL1+1	Gravity terms (see PIPE input).
46	HD	NCELL1+1	Hydraulic diameters. (If absent or 0.0, HD is calculated assuming FA is circular.)
47	EPSD	NCELL1+1	Ratio, surface roughness to hydraulic diameter (default = 0.0).
48	ICHOKE	NCELL1+1	Choking calculation flag (integer) (0 = no choking, 1= choking calculation) (default = 0).
49	ICCFL	NCELL1+1	CCFL control flag Integer (0 = no CCFL, 1, 2 = CCFL calculation, see

CN	Variable	Dimension	Description (VALVE)
			PIPE input) (default = 0).
50	WETP	NCELL1+1	Wetted perimeter (omit if ICCFL not equal 2).
51	ALP	NCELL1	Initial void fractions.
52	VL	NCELL1+1	Initial liquid velocity.
53	VV	NCELL1+1	Initial vapor velocity.
54	TL	NCELL1	Initial liquid temperatures.
55	TV	NCELL1	Initial vapor temperatures.
56	P	NCELL1	Initial pressures.
57	BORC	NCELL1	Boron concentration (ppm) (default = 0.0, required IBORC = 1 and BORC not equal to 0.0).
58	QPPP	NCELL1	Volumetric heat sources in pipe wall (primary). (Eliminate this card set if NODES = 0.)
59	TW	NODES* NCELL1	Initial wall temperatures for primary tube. (Eliminate this card set if NODES = 0.)
60	KLVC	NCELL1	Axial level of associated VESSEL cell for 1-D component-to-VESSEL heat transfer. This card is not needed unless IPVHT = the NUM of a VESSEL (integer).
61	KRVC	NCELL1	Cell number in component IPVHT = NUM to which heat is transferred. If NUM is a VESSEL, then KRVC(I) is the relative cell number on axial level KLVC(I). This card is not needed if IPVHT = 0 (integer).
62	RKLOS	NCELL1+1	Additive form loss coefficients for reverse mixture mass flow. See FKLOS for definition (default = 0.0).
63	PA	NCELL1	Noncondensible gas pressure in VALVE primary (default = 0.0, required if IAIR = 1 and PA not equal to 0.0).
64	ILEV1	NCELLS	Two-phase level flag for cell (-1 implies no level tracking in cell; 0 implies two-phase level not present in cell; +1 implies

CN	Variable	Dimension	Description (VALVE)
			two-phase level present in cell; input only if LEV1 = 1, default = -1).
65	ALPA	NCELLS	Void fraction above two-phase level (input only if LEV1 = 1, default = 1.0).
66	ALPB	NCELLS	Void fraction below two-phase level (input only if LEV1 = 1, default = 0).
67	DZLV1	NCELLS	Height of two-phase level above bottom of cell (input only if LEV1 = 1, default = 0).
68	VLEV1	NCELLS	Propagation velocity of two-phase level (input only if LEV1 = 1, default = 0).
71	VLTB	NVTX	VALVE table data. Interpretation of table entries depends on value of IVTY and IVPG. NVTX pairs are required.

Option	Table Entries
IVTY = 3,4	Time, valve area fraction pairs.
TY = 6 and also IVPG = 3	Fractional valve stem position, valve area fraction pairs. (Both values must be between 0.0 and 1.0, inclusive.)
IVTY = 7	Input one set of the following five values for each valve bank: 1. Valve bank fractional area relative to AVLVE 2. Valve bank opening pressure. 3. Valve bank closing pressure. 4. Valve bank activation flag. 5. Valve bank fractional hydraulic diameter relative to HVLVE. The activation flag should normally be input as 0.0 unless the valve is to be initialized in an open state which case the activation flag should be 1.0. The valve bank fractional areas need not sum to 1.0.

3.4.13 VESSEL Component (VESSEL)

VESSEL Header Card, VESSELID00000

Word	Variable	Description (VESSEL)
W1-A	NUM	Component ID number.
W2-A	CTITLE	User optional description of component. Up to 30 characters may be used. Enclose them in quotes.

VESSEL Simple Parameter Card, VESSELID0001X

The first 17 variables are required.

Word	Variable	Description (VESSEL)
W1-I	NASX	Number of axial (z) segments (levels).
W2-I	NRSX	Number of radial (r) segments (rings).
W3-I	NTSX	Number of azimuthal (θ) segments (sectors). 0 Slab geometry is assumed. The input variable "TH" is used for the slab thickness. Wall friction is calculated on theta cell faces and the R = 0 face. >1 Cylindrical geometry with NTSX cells per ring.
W4-I	NCSR	Number of cell sources (connections to 1-D components). NCSR must be greater than zero.
W5-I	IDCU	Downcomer upper level number. It ends at top of this level.
W6-I	IDCL	Downcomer lower level number. It begins at top of this level. IDCL is used in the level trip logic.
W7-I	IDCR	Downcomer ring number. It begins on outer face of this ring.
W8-I	ICRU	Core upper level number. It ends at top of this level. Must be greater than zero if model contains CHAN components.
W9-I	ICRL	Core lower level number. It begins at top of this

Word	Variable	Description (VESSEL)
		level. Must be greater than zero if model contains CHAN components.
W10-I	ICRR	Core ring number. It ends on outer face of this ring. Must be greater than zero if model contains CHAN component.
W11-R	ROHS	Density of lumped parameter heat slab material.
W12-R	CPHS	Specific heat of lumped parameter heat slab material.
W13-R	CHS	Conductivity of lumped parameter heat slab material
W14-R	EMHS	Emissivity of lumped parameter heat slab wall.
W15-I	ISDU	Perfect separator-dryer upper level number. It ends at top of this level (may be 0.0).
W16-I	ISDL	Perfect separator-dryer lower level number. It begins at bottom of this level (may be 0.0).
W17-I	ISDR	Perfect separator-dryer ring number. It ends at outer face of this ring (may be 0.0).
W18-R	CZSDL	Axial liquid friction factor in perfect separator-dryer. (Defaults to 1.0E26 if 0.0 or blank is input.)
W19-R	CRSDV	Radial vapor friction factor in perfect separator-dryer. (Defaults to 1.0E26 if 0.0 or blank is input.)

The following five values for bidirectional conduction are used for all double-sided slabs. DHOUTL, DHOUTLV, DTOUTL, and DTOUTV are used only for double slabs lying on the outside surface of the vessel.

Word	Variable	Description (VESSEL)
W20-R	NODESD	Number of conduction heat transfer nodes in double slabs.
W21-R	DHOUTL	Heat transfer coefficient to liquid on vessel outside surface.
W22-R	DHOUTV	Heat transfer coefficient to vapor on vessel outside surface.
W23-R	DTOUTL	Liquid temperature outside vessel.
W24-R	DTOUTV	Vapor temperature outside vessel.

Word	Variable	Description (VESSEL)
W25-I	LEYOPT	Two-phase lev tracking option indicator. (0 = no level tracking 1 = level tracking performed). (Default = 0). If LEVOPT = 1, card 70 is required and cards 71-74 are optional.

VESSEL Simple Parameter Card, VESSELID00050

This card is optional.

Word	Variable	Description (VESSEL)
W1-I	IHTS	Write flag for major edit of heat transfer values of any 1-D component walls transferring heat to VESSEL. (0 or 1 = no, 2 = yes).

VESSEL Geometry Cards, VESSELID0011X-VESSELID0013X

One set for each of the following variables, using LOAD format.

CN	Variable	Dimension	Description (VESSEL)
11	z	NASX	Upper elevations of axial levels. (Referenced to zero elevation at bottom of vessel.)
12	RAD	NRSX	Outer radii of rings if NTSX >0, or right-hand side face position of cells face segments (referenced to left-hand side face of first cell if NTSX = 0).
13	TH	NTSX or 1	Theta angles at azimuthal segment ends (radians) if NTSX >0, or width of slab if NTSX = 0.

VESSEL Source Cards, VESSELID0014X

6*NCSR variables are required.

Word	Variable	Description (VESSEL)
W1-I	ISRL	Axial level number associated with source 1.

Word	Variable	Description (VESSEL)
W2-I	ISRC	Relative cell number associated with source 1.
W3-I	ISRF	Face number associated with source 1. (1 = azimuthal direction, 2 = axial direction, and 3 = radial direction (see note below if LEVOPT = 1). Both positive and negative values of ISRF are allowed. ISRF for CHAN: JUN1 must be +2, for JUN2, ISRF must be -2.
W4-I	JUNS	Junction number associated with source 1.
W5-R	ZJN	Axial position of source junction expressed as fraction of cell height. Must be input but only used when level tracking option is selected (see note below).
W6-I	ISRL	Axial level number associated with source 2.
W7-I		etc.

NOTE: The mass and energy flux terms for flow from a vessel cell to an attached 1-D source is computed according to the donor void fraction, ALPV, for the vessel-source connection. ALPV is determined from the vessel cell geometry, level position, and user-input values of ISRF, ZJN, and HD for the source as follows:

Case 1. (ILEV(j) ≠ 1):

ALPV = ALP(J)

Case 2. (ILEV(j) = 1):

2a. (ZJN > 0.0 or |ISRF| ≠ 2):

ALPV = ALPM(j), when DZL > DZSP
ALPP(j), when DZL < DZSM
(Interpolated valve between ALPM(J) and ALPP(j), when DZSM ≤ DZL ≤ DZSP)

2b. (ZJN ≤ 0.0 and |ISRF| = 2):

ALPY = ALPM, if ISRF < 0
ALPP, if ISRF > 0,

where

DZL = (height of two-phase level above bottom of vessel cell
DZSM = MAX 0.0, (DZ(j)·|ZJN| - RDP)
DZSP = MIN DZ(j), (DZ(j)·|ZJN| + RDP)
RDP = HD/2

Word	Variable	Description (VESSEL)

DZ(j) = Axial height of cell j
ALPM(j) = Below level void fraction in cell j
ALPP(j = Above level void fraction in cell j
ALP(j) = Cell average void fraction in cell j
ILEV(j) = Two-phase level flag in cell j.

VESSEL Level Cards, VESSELIDLV17X-VESSELIDLV28X and VESSELIDLV42X-VESSELIDLV74X

Input one set for each of the following variables for each level using LOAD format.

NOTE: The following parameters (dimensioned NTSX*NRSX or NRSX if NTSX = 0) are read in for each (r, θ) mesh position at each axial level. In this case, they extend over the entire vessel cross section. Since a separate data set is read for each level, these parameters are supplied for every mesh cell in the VESSEL.

CN	Variable	Dimension	Description (VESSEL)
17	HSA	NTSX*NRSX	Lumped parameter heat slab area.
18	HSM	NTSX*NRSX	Mass of lumped parameter heat slab. Must be input but not used for cells in which HSA = 0.
19	DSA	NTSX*NRSX	Double slab inside surface area. (One slab per vessel cell is allowed).

NOTE: The following two cards must be input but will not be used for cells in which DSA = 0.

CN	Variable	Dimension	Description (VESSEL)
20	DSTH	NTSX*NRSX	Double slab thickness.
21	MATDS	NTSX*NRSX	Double slab material type.
22	DST	NODESD *NTSX *NRSX	Double slab nodal temperature. (omit if NODESD = 0).
23	FKLOS-T	NTSX*NRSX	Additive form loss coefficients for forward mixture mass flow (θ direction) (default = 0.0).
24	FKLOS-Z	NTSX*NPSX	Additive form loss coefficients for forward mixture mass flow (Z direction) (default = 0.0).
25	FKLOS-R	NTSX*NPSX	Additive form loss coefficients for forward mixture mass flow (R direction) (default = 0.0).

CN	Variable	Dimension	Description (VESSEL)
26	RKLOS-T	NTSX*NRSX	Additive form loss coefficients for reverse mixture mass flow (θ direction) (default = 0.0).
27	RKLOS-Z	NTSX*NPSX	Additive form loss coefficients for reverse mixture mass flow (Z direction) (default = 0.0).
28	RKLOS-R	NTSX*NPSX	Additive form loss coefficients for reverse mixture mass flow (R direction) (default = 0.0).
42	VOL	NTSX*NRSX	Cell fluid volume fractions.
43	FA-T	NTSX*NRSX	Average cell fluid edge area fractions in θ direction.
44	FA-Z	NTSX*NRSX	Average cell fluid edge area fractions in Z direction.
45	FA-R	NTSX*NRSX	Average cell fluid edge area fractions in R direction.
46	HD-T	NTSX*NRSX	Hydraulic diameters in θ direction. (If 0.0, HD-T is calculated.)
47	HD-Z	NTSX*NRSX	Hydraulic diameters in Z direction. (If 0.0, HD-Z is calculated.)
48	HD-R	NTSX*NRSX	Hydraulic diameters in R direction. (If 0.0, HD-R is calculated.)
49	EPSD-T	NTSX*NRSX	Ratio of surface roughness to hydraulic diameter in θ direction (default = 0.0).
50	EPSD-Z	NTSX*NRSX	Ratio of surface roughness to hydraulic diameter in Z direction (default = 0.0).
51	EPSD-R	NTSX*NRSX	Ratio of surface roughness to hydraulic diameter in R direction (default = 0.0).
52	HSTN	NTSX*NRSX	Heat slab temperatures (not used but must be input if HSA = 0).
53	ALPN	NTSX*NRSX	Vapor fraction.
54	VVN-T	NTSX*NRSX	Vapor velocity in θ direction.
55	VVN-Z	NTSX*NRSX	Vapor velocity in Z direction.
55	VVN-R	NTSX*NRSX	Vapor velocity in R direction.

CN	Variable	Dimension	Description (VESSEL)
57	VLN-T	NTSX*NRSX	Liquid velocity in θ direction.
58	VLN-Z	NTSX*NRSX	Liquid velocity in Z direction.
59	VLN-R	NTSX*NRSX	Liquid velocity in R direction.
60	TVN	NTSX*NRSX	Vapor temperature.
61	TLN	NTSX*NRSX	Liquid temperature.
62	PN	NTSX*NRSX	Pressure.
63	BORC	NTSX*NRSX	Boron concentration (ppm) (default = 0.0, required IBORC = 1 and BORC not equal to 0.0).
64	ICCFL	NTSX*NRSX	CCFL control flag 0 = Turn off CCFL model 1 = CCFL upper tip plate constants 2 = CCFL side entry orifice constants (default = 0).
65	WETP	NTSX*NRSX	Wetted perimeter (needed only if any entry in ICCFL equals 2).
66	PA	NCRX	Noncondensible gas pressure in VESSEL (default = 0.0, required, if IAIR = 1 and PA not equal to 0.0).

NOTE: Omit the next five variables if LEVOPT = 0.

CN	Variable	Dimension	Description (VESSEL)
70	ILEV	NTSX*NRSX	Cell two-phase level indicator. 0 = no level in cell 1 = level exists in cell -1 = bypass level calculations for this cell.
71	DZLEV	NTSX*NRSX	Two-phase level position expressed as distance from bottom of the cell (default = 0).
72	VLEV	NTSX*NRSX	Two-phase level velocity (default = 0.0).
73	ALPP	NTSX*NRSX	Void fraction above two-phase level (default = 1.0).
74	ALPM	NTSX*NRSX	Void fraction below two-phase level (default = 0.0).

3.4.14 References

3.4-1. R. W. Shumway et al., *TRAC-BD1/MOD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Transient Analysis, Volume 2: Users Guide*, NUREG/CR-3633, EGG-2294, April 1984.

3.4-2. D. D. Taylor et al., *TRAC-BD1/MOD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Transient Analysis, Volume 1: Model Description*, NUREG/CR-3633, EGG-2294, April 1984.

3.5 REACTOR POWER DATA

This set of input data controls the power input to simulated fuel rods. No reactor power data are required when there is no reactor core (i.e., NAXN = 0). When the constant power option is desired, only the initial reactor power RPOWRI needs to be input. For the power options (IRPOP) 2, 3, 4, 5, 6, or 7, a power or reactivity table must be input if the first card is input. No decay heat option may be changed. Omit all power cards for an EXTRACT run. For a restart calculation, power cards are optional, but if POWER0001X is input and NPWX is not zero, the PTAB cards must be input.

3.5.1 General Power Data Card, POWER0001X

This card is required if NAXN >0, except for a restart run.

Word	Variable	Description (POWER)
W1-R	RPOWRI	Initial reactor power (W). RPOWRI ≥ 0.0. On restart, if IRPOP = 1, the new value of RPOWRI will be used for the constant power, even if 0.0; if IRPOP ≠ 1, then RPOWRI is not used, and must be input as 0.0.
W2-1	IRPOP	Reactor power option. On restart, IRPOP must = original value. 1 = Constant power. This set to RPOWRI. 2 = Table lookup of power. 3 = Trip-initiated table lookup of power. 4 = Point reactor kinetics with table lookup of reactivity. 5 = Point reactor kinetics with trip-initiated table lookup of reactivity. 6 = Same as 4, but with reactivity feedback 7 = Same as 5, but with trip-initiated reactivity feedback and trip-initiated scram reactivity insertion.

Word	Variable	Description (POWER)
		8 = 1-D kinetics model.
W3-I	NDG	Number of delayed neutron groups (default = 6). For IRPOP = 1 - 3, NDG = 0. For IRPOP = 4 - 8, NDG ≥ 1 and ≤ 6. On restart, NDG must equal original value.
W4-I	NPWX	Number of data pairs for power/reactivity table (default = 0). For IRPOP = 1 or 8, NPWX = 0. For IRPOP = 2 through 6, NPWX > 0. For IRPOP = 7, NPWX > 0 if ICRTR > 0, and NPWX ≥ 0 if ICRTR = 0. On restart, NPWX = 0 means to keep the original value and the original table; NPWX > 0 means use the new value and read a new table with NPWX points.
W5-I	IRPTR	Reactivity power/kinetics trip ID (default = 0). For RPOP = 3, 5, or 7, IRPTR > 0; otherwise, IRPTR = 0. On restart, IRPTR = 0 means keep the original value; IRPTR > 0 means use the new value and print a warning message if it is not the same as the original value.
W6-I	ICRTR	Scram reactivity table trip ID (default = 0). For IRPOP = 7, ICRTR > 0, or 0 (use 0 if no scram reactivity trip); otherwise, ICRTR = 0. On restart, ICRTR = 0 means keep the original value; ICRTR > 0 means use the new value and print a warning message if it is not the same as the original value.

3.5.2 Power vs. Time Table Cards, POWEROCNXX

NOTE: Only one zero before array name PTAB.

CN	Variable	Dimension	Description (POWER)
31	PTAB	2*NPWX	Table of power (W) vs time. NPWX pairs of (time, power). This input may be used for IRPOP = 2 or 3.

NOTE: None of the remaining power input is allowed on a restart run, except for POWPTKINORT ABXX, the point kinetics table of reactivity vs. time.

3.5.3 Axial Power Distribution Cards, POWEROOCNX

CN	Variable	Dimension	Description (POWER)
11	ZPOWR	NAXN	Relative axial power density at each level in the core. This is the linear power density (W/m) at each core level divided by the average linear power density (W/m) for all NAXN core levels. (The DX at a given core level is the same for all CHANS.) The input values of this array are multiplied by [sum of DX(J)/sum of ZPOWR(J)*DX(J)I, J = 1, NAXN, and replaced by these new values. For 1-D kinetics (IRPOP = 8), this input array is used for initialization only. After that, the array is calculated each time step.

3.5.4 Direct Moderator Heating Card, POWER00020

These variables are used for all values of IRPOP. (This is a change--formerly used only if IRPOP = 6 or 7.)

Word	Variable	Description (POWER)
W1-R	DMHFIS	Fraction of prompt (fission) power for direct moderator heating (default = 0.0).
W2-R	DMHDH	Fraction of decay heat power for direct moderator heating (default = 0.0).

3.5.5 Reacti ity Weighting Option Card POWER00030

This card may be present only if IRPOP is 6, 7, or 8, or IRPOP is 1 and STDYST is 1.

Word	Variable	Description (POWER)
W1-I	ITFW	Flag for fuel temperature reactivity weighting within

Word	Variable	Description (POWER)
		bundle (default = 0). 0 = Volume weighting. 1 = Power-squared weighting.
W2-I	ITMW	Flag for CHAN to CHAN reactivity weighting (default = 0). -1 = Input weighting (CHAN array RCTWF) 0 = Volume weighting. 1 = Power-squared weighting.
W3-R	WTBYP	The weight of bypass water reactivity relative to channel water (default = 0.0).

3.5.6 Decay Heat Model Cards, POWDECAY00CNX and POWDECAY0CNXX

These cards are input for the decay heat model. They may be used with either point kinetics or 1-D kinetics (IRPOP = 4 through 8).

Decay Heat Simple Parameter Card, POWDECAY0001X

Word	Variable	Description (POWDECAY)
W1-I	IPOWH	Number of reactor operation periods described in fission power history table on cards POWDECAY031XX. (Default = 0, which assumes one year of operation at RPOWRI.)
W2-I	NFI	Number of fissile isotopes in decay heat model on card POWDECAY0012X (default = 3). 1 = U-235 decay heat products. 2 = U-235 + Pu-239 decay heat products. 3 = U-235 + Pu-239 + U-238 decay heat products.
W3-I	INEUTC	Flag for including effect of neutron capture by fission products (default = 1). 1 = Include 0 = Do not include.
W4-I	IHEDH	Flag for including effect of heavy element (U-239, Np-239) decay heat (default = 1). 1 = Include. 0 = Do not include.

Decay Heat Simple Parameter Card, POWDECAY0002X

Word	Variable	Description (POWDECAY)
W1-R	DHMUL	Arbitrary constant multiplier for decay heat (default = 1.0.)
W2-R	RPRO	Atoms of U-239 produced per fission (default = 1.0.)
W3-R	FISSAT	Number of fissile atoms in core (see PSIDH below). (Suggested value = RPOWRI * 9.849E+23.)
W4-R	PSIDH	Burnup ratio of core, fissions per fissile atom. If input value is not 0, input of FISSAT is not used. If input value is 0, PSIDH is internally computed from FISSAT (default = 3.0).

Decay Heat Fission Power Fraction Card, POWDECAY00C14X

CN	Variable	Dimension	Description (POWDECAY)
12	PFRAC	NFI	Fraction of fission power at time = 0.0, due to thermal fission of: NFI = 1 U-235 [PFRAC(1), default = 1.0] Pu-239 [PFRAC(2), default = 0.0] U-238 [PFRAC(3), default = 0.0] NFI = 3 U-235 [PFRAC(1), default = 0.71] Pu-239 [PFRAC(2), default = 0.21] U-238 [PFRAC(3), default = 0.08].

Decay Heat Fission Card, POWDECAY00CNX

CN	Variable	Dimension	Description (POWDECAY)
13	QVAL		MeV per fission U-235 [QVAL(1), default = 200.0] Pu-39 [QVAL(2), default = 200.0] U-238 [QVAL(3), default = 200.0].

Decay Heat Power History Table Cards, POWDECAYOCNXX

NOTE: Only one zero before card number.

CN	Variable	Dimension	Description (POWDECAY)
31	PHIST	IPOWH* (NFI+1)	Power history table. There are IPOWH sets of values, or one for each reactor operation period. Each set has (NFI+1) values of the form: DELRT Duration of period (S). RMW(1) Fission power (W) of U-235. If NFI > 1, RMW(2) Fission power (W) of PU-39. If NFI > 2, RMW(3) Fission power (W) of U-238.

3.5.7 Point Kinetics Model Cards, POWPTKINOOCNX and POWPTKINOCNXX

These cards may be input for the point kinetics model. (IRPOP = 4, 5, 6, or 7.)

Point Kinetics Neutron Generation Time Card, POWPTKIN00010

Word	Variable	Description (POWPTKIN)
W1-R	TNEUT	Neutron generation time (s) (default = 4.754E-5).

Point Kinetics Delayed Neutron Fractions Cards, POWPTKINOOCNX

CN	Variable	Dimension	Description (POWPTKIN)
15	BETA	NDG	Delayed neutron fractions. (Defaults = 2.74E-4, 1.38E-3, 1.22E-3, 2.64E-3, 8.32E-4, 1.69E-4).

Point Kinetics Reactivity vs. Time Table Cards, POWPTKINOCNXX

NOTE: Only one zero before card number.

CN	Variable	Dimension	Description (POWPTKIN)
31	RTAB	2*NPWX	Table of reactivity (ΔK/K) vs. time. NPWX pairs of (time, reactivity). If IRPOP = 4 or 5, total reactivity. if IRPOP = 6 or 7, rod insertion reactivity, starting with ΔK/K = 0.0.

Point Kinetics Reactivity Feedback Coefficients Cards, POWPTKIN0021X-POWPTKIN0024X

These cards may be present only if IRPOP = 6 or 7.

CN	Variable	Dimension	Description (POWPTKIN)
21	CTF	3	Coefficients for calculating the void dependent Doppler coefficient (defaults = -8.44 E-4, -3.95 E-4, (0.0).

NOTE: Doppler coefficient = CTF(1) + CTF(2)*ALPH + CTF(3)*ALPH**2, where ALPH is the void fraction.

CN	Variable	Dimension	Description (POWPTKIN)
22	CTM	3	Coefficients for calculating the temperature-dependent moderator temperature reactivity coefficient (defaults = -1.15802E-4, 4.63039E-7, -9.6878E-10).

NOTE: Moderator temperature coefficient = CTM(1) + CTM(2)*temp + CTM(3)*temp**2, where temp is the water temperature.

CN	Variable	Dimension	Description (POWPTKIN)
23	CVOID	3	Coefficients for calculating the void-dependent void reactivity coefficient (defaults = -0.0478, -0.2748, 0.1911).

NOTE: Void coefficient = CVOID(1) + CVOID(2)*ALPH + CVOID(3)*ALPH**2, where ALPH is the void fraction.

CN	Variable	Dimension	Description (POWPTKIN)
24	CBOR	3	Coefficients for calculating the water density dependent boron reactivity coefficient (defaults = 3.6E-5, -2.23E-7, 0.0).

NOTE: Boron coefficient = CBOR(1) + CBOR(2)*DENS + CBOR(3)*DENS**2, where DENS is the water density.

3.5.8 One-Dimensional Neutron Kinetics Cards, POWONKIN00CNX and POWONKINOCNSS

These cards are new input for the 1-D reactor kinetics model, used if and only if IRPOP = 8. All cards are required unless otherwise indicated.

1-D Kinetics Simple Parameter Card, POWONKIN00010

Word	Variable	Description (POWONKIN)
W1-I	NCORE	Number of levels in neutronic core region. NCORE ≥ NAXN.
W2-I	NXSS	Number of cross-section sets.
W3-I	JTSC	Time step control flag. 0 = No time step control--advance over DT in 1 step. 1 = Automatic time step control--use K infinity data to initialize subintervals. 2 = Automatic time step control--use kinetics equation to initialize subintervals.
W4-I	IPRT	Kinetics print control flag. (see all rel. subs) 0 = No printing from 1-D kinetics routines 1 = Print cross sections, fluxes, and powers on major edit. 2 = Print cross sections, fluxes, and powers with lengthy edit of coefficient matrices at each kinetics time subinterval. CAUTION: Option 2 produces an enormous amount of printout and is intended only for debug use.
W5-I	NCRGP	Number of control rod groups.
W6-I	IRL	Flag for left boundary condition (default = 1). 0 = Zero flux. 1 = General matrix albedo.
W7-I	IBR	Flag for right boundary condition (default = 1). 0 = Zero flux. 1 = General matrix albedo.
W8-I	JCOP	Integration option (default = 1). 0 = THETA method.

Word	Variable	Description (POWONKIN)
		1 = Exponential method.
W9-I	IMODE	Steady-state mode selection flag (default = 0). 0 = Do eigenvalue calculation only. 1 = Adjust thermal bucklings in the RS02 arrays such that the target relative power distribution (input array PTAPG) and the target global eigenvalue (TEGV) will be produced. Then calculate eigenvalue.

1-D Kinetics Simple Parameter Card, POWONKIN00020

Word 4 is required when IMODE = 1; all other values are optional.

Word	Variable	Description (POWONKIN)
W1-R	THETA	Time differencing parameter, 0.5 (Crank-Nicholson) to 1.0 (fully implicit). Note that oscillatory solutions may result if THETA <1.0. Also, if JTSC >0, THETA is automatically set to 1.0 (default = 1.)
W2-R	FMAX	Approximate maximum fractional nodal flux change allowed per time subinterval when running under automatic time step control (ITSC >0) (default = 0.1). (0.0 ≤FMAX ≤1.0.)
W3-R	EPS	The convergence criterion used in all steady-state calculations (both for the source iterations and for the buckling adjustment, if requested) (default = 1.0E-8).
W4-R	TEGV	Target eigenvalue used when IMODE = 1. (0.0 ≤TEGV ≤2.0)
W5-I	NEXT	An integer flag to indicate the type of steady state source convergence acceleration desired. 1 = No acceleration (debugging only) 2 = Two-point linear extrapolation using the factor THTSS (specialized applications only) 3 = Three-point Chebyshev semi-iterative polynomial extrapolation (previous versions always used this option) 4 = Wielandt eigenvalue shift acceleration (recommended option except as noted under FW below) (default = 4).

Word	Variable	Description (POWONKIN)
W6-R	THTSS	Linear extrapolation factor used if NEXT = 2 (recommended value = 0.5 to start with, then optimize for the particular application) (default = 0.5).
W7-R	FW	The eigenvalue shift factor used with Wielandt acceleration. Recommended value is FW = 0.01, but this may have to be increased for some problems if the solution appears to be converging to one of the higher harmonics rather than the fundamental. The user can also switch to Chebyshev (NEXT = 3) extrapolation in such cases. All problems tested so far have correctly converged using FW = 0.01 (default = 0.01).

1-D Kinetics Neutron Velocity Card, POWONKIN00030

NOTE: Many of the parameters below use cm units rather than m.

Word	Variable	Description (POWONKIN)
W1-R	VN1	Neutron velocity for Group 1 (cm/s).
W2-R	VN2	Neutron velocity for Group 2 (cm/s).

1-D Kinetics Control Rod Cards POWONKIN0005X-POWONKIN0008X

CN	Variable	Dimension	Description (POWONKIN)
05	NCRDG	TICRGP	Number of control rods in each control rod group.
06	VCROD	NCRGP	Velocity of control rod in control rod group (cm/s).
07	RCRDI	NCRGP	Initial group relative control rod insertion (0.0 = bottom of core, 1.0 = top of core).
08	NCRTP	NCRGP	Trip number for each control rod group.

1-D Kinetics Array Cards POWONKIN0013X-POWONKIN0018X

CN	Variable	Dimension	Description (POWONKIN)
13	ALBT	4	Top albedo matrix. Optional (default = 0.0's).

CN	Variable	Dimension	Description (POWONKIN)
14	ALBB	4	Bottom albedo matrix. Optional (default = 0.0's)
15	BETA	NDG	Delayed neutron fractions (defaults = 2.74E-4, 1.38E-3, 1.22E-3, 2.64E-3, 8.32E-4, 1.69E-4).
16	PTARG	NCORE	Target NODAL relative power distribution used when IMODE = 1. 0.0 ≤PTARG ≤10-0.
17	IXSS	NCORE	Cross-section set index.
18	IAXN	NCORE	Index to hydraulic level within the CHAN core region. 0.<IAXN(I) ≤NAXN. IAXN(I+I) ≥IAXN(I).

1-D Kinetics Cross Section Cards

NXSS sets of these cards are required. XS indicates the cross-section set.

1-D Kinetics Cross-Section Simple Parameters Card, POWONKINXS01X

Word	Variable	Description (POWONKIN)
WI-R	NU1	Number of neutrons per fission for Group 1.
W2-R	NU2	Number of neutrons per fission for Group 2.
W3-R	TMODRF	Reference temperature for moderator dependence.
W4-R	TFULRF	Reference temperature for fuel dependence.
W5-I	ITUNTS	Temperature units flag (1 = Kelvin, 2 = Celsius, 3 = Rankine, 4 = Fahrenheit).

1-D Kinetics Cross Section Coefficients Cards, POWONKINXS21X-POWONKINXS29X

Coefficient in neutron cross-section polynomial function, nine coefficients per neutron cross-section.

CN	Variable	Dimension	Description (POWONKIN)
21	DIFC1	9	Coefficients for Group 1 diffusion coefficient.
22	DIFC2	9	Coefficients for Group 2 diffusion coefficient.
23	SIGA1	9	Coefficients for Group 1 macroscopic absorption cross section.
24	SIGA2	9	Coefficients for Group 2 macroscopic absorption cross section.
25	SIGR1	9	Coefficients for Group 1 macroscopic downscatter cross section. (NOTE: The total removal cross section for Group 1 is the sum of SIGA1 and SIGR1.)
26	NSGF1	9	Coefficients for Group 1 macroscopic NU*fission cross section.
27	NSGF2	9	Coefficients for Group 2 macroscopic NU*fission cross section.
28	BSQ1	9	Coefficients for Group 1 transverse buckling squared data. Optional (default = 0.0's).
29	BSQ2	9	Coefficients for Group 2 transverse buckling squared data. Optional (default = 0.0's) Cannot be present if IMODE = 1.

3.6 Control System Data

This set of input data specifies the control system. (Omit if ICTR = 0). All control system data, except for Restart Change Cards (CNTRL90XXX), should he omitted for restart runs. Control cards cannot be added on restart to decks that did not originally have a control system.

3.6.1 Control System Simple Parameters Card, CNTRL01000

If the last n variables on this card are 0, only the first 4-n variables need to he entered. If all variables are 0, the card may be eliminated. The NTRCR control blocks with the lowest control block numbers are treated as transient control blocks; all other control blocks are assumed to be steady-state blocks.

Word	Variable	Description (CNTRL)
W1-I	NUIOD	Number of user-supplied I/O sets
W2-I	NTRCB	Number of transient control blocks in problem
W3-I	NFT	Number of control function tables
W4-I	NUSSCB	Number of user-supplied steady-state control blocks.

3.6.2 Control System I/O Data Cards, CNTRL10XXX

One card is required for each I/O Description Set. XXX is the I/O Description Set Number. It must be unique but need not be sequential.

Word	Variable	Description (CNTRL)
W1-A	IOVAR	I/O variable type (see Table 3.6-1).
W2-I	IOCMP	I/O variable component number.
W3-I	IOLEV	I/O variable level number (used in VESSEL only).
W4-I	IOCEL	I/O variable cell number.

Table 3.6-1. Control system input/output variables.

Variable Symbolic Name	Description	Input Components (Variable may be input to control system from these components)	Output Components (Variable may be adjusted by control system output for these components)	Comments
TIME	Reactor Time (s)	TIME	None	
POWR	Total Reactor Power (W)	NEUTRON KINETICS	NEUTRON KINETICS	
TRIP	Trip Condition	TRIP	TRIP	Input variable IUCMP is Trip Number
ALFA	Vapor Fraction	CHAN,FILL,PIPE,PUMP,TEE,VALVE,VESSEL	FILL	
PRES	Pressure (Pa)	BREAK,CHAN,PIPE,PUMP,TEE,VALVE,VESSEL	BREAK	
TLIQ	Liquid Temperature (K)	CHAN,FILL,PIPE,PUMP,TEE,VALVE,VESSEL	FILL	
TVAP	Vapor Temperature (K)	CHAN,FILL,PIPE,PUMP,TEE,VALVE,VESSEL	FILL	
MDOT	Mass Flow Rate (kg/s)	CHAN,FILL,PIPE,PUMP,TEE,VALVE	FILL	For MDOT and ENTH: IOCEL=1 gives inlet quantity
ENTH	Mixture Enthalpy (J/kg)	CHAN,PIPE,PUMP,TEE,VALVE	None	IOCEL=2 gives outlet quantity IOCEL=3 gives TEE side arm quantity
TORQ	Torque (N-M)	PUMP, TURB	PUMP	Value is dimensionless (fraction of rated torque) for PUMP
OMEG	Angular Speed (rad/s)	PUMP, TURB	None	
AREA	Valve Area (fraction of fully open area)	VALVE	VALVE, TEE	Controls area of face NCELL1 in TEE used as feedwater heater.
LLEV	Downcomer Liquid Level (m)	VESSEL, PIPE, TEE	None	IOCEL is VESSEL Theta Zone Number. Measured from bottom end of component for PIPE and TEE.
RHOC	Control Rod Reactivity ($\Delta k/k$)	KINETICS	None	

Table 3.6-1. (continued).

Variable Symbolic Name	Description	Input Components (Variable may be input to control system from these components)	Output Components (Variable may be adjusted by control system output for these components)	Comments
RHOA	Additive Control Reactivity ($\Delta k/k$)	None	KINETICS	
BORC	Core Average Boron Concentration (ppm)	KINETICS	NONE	
CROD	Control rod group position	KINETICS	KINETICS	IOCEL is control rod group number

3.6.3 Control Block Data Cards, CNTRL20XXX

One card is required for each control block. XXX is the Control Block Number and need not be consecutive. Control blocks will be executed in order of their logical relations regardless of the numbering sequence. The logical relations will be established automatically in TRAC-BF1.

Word	Variable	Description (CNTRL)
W1-A	ICBTYP	Control block Type (see Table 3.6-2).
W2-I	NCBI1	Control block first input identifier (default = 0).
W3-I	NCBI2	Control block second input identifier (default = 0).
W4-I	NCBI3	Control block third input identifier (default = 0).

NOTE: For the above three control block input identifiers, if:

NCBIN = 0, the control block does not require an nth input.
NCBIN > 0, the nth input comes from the output of control block number NCBIN.
NCBIN < 0, the nth input comes from the TRAC component variable defined on the I/O description set number = NCBIN.

Word	Variable	Description (CNTRL)
W5-I	NCBOUT	Control block output identifier (default = 0). If NCBOUT = 0, the control block is not used to adjust TRAC component data. If NCBOUT < 0, the control block is used to adjust the TRAC component variable defined on I/O description set number = NCBOUT.
W6-A	CBNAM	Control block Name. Use up to 10 alphanumeric characters enclosed in quotes (default = blanks).

3.6.4 Control Block Data Cards, CNTRL21XXX

One card is supplied for each control block. XXX is the control block number. If a card is blank, all default values will be used.

Word	Variable	Description (CNTRL)
W1-R	CBIV	Control block initial value (default = 0.0).
W2-R	CON1	Control block first constant (default = 0.0).

Table 3.6-2. Description of control block operations.

Type	Block Type[a]	Block Input 1[b]	Block Input 2	Block Input 3	Block Const 1	Block Const 2[c]	Gain Factor[c]	Upper Limit[c]	Lower Limit[d]	Initial Value	Control Block Name	Control Block Mathematical Operation[e]
1	ABSV	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Absolute Value	XOUT = G*ABS(X1)
2	ACOS	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Arcosine	XOUT = G*ACOS(X1), XOUT in Radians
3	ADD	X1	X2	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Add	XOUT = G*(X1+X2)
4	AINT[f]	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Integral value	XOUT = G*FLOAT[IFIX(X1)]
5	AND[f]	L1	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical And	LOUT = 1.0 IF[(L1.EQ.1.0).AND.(L2.EQ.1.0)] = 0.0 Otherwise.
6	ASIN	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Arcosine	XOUT = G*ASIN(X1), XOUT in Radians
7	ATAN	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Arctangent	XOUT = G*ATAN(X1), XOUT in Radians
8	ATN2	X1	X2	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Arctangent	XOUT = G*ATAN2(X1/X2), XOUT in Radians
9	CONS	N/A	N/A	N/A	C1	N/A	N/A	N/A	N/A	XIV	Constant	XOUT = C1
10	COS	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Cosine	XOUT = G*COS(X1), X1 in Radians
11	DEAD	X1	N/A	N/A	C1	C2	G	XMAX	XMIN	XIV	Dead Band, Dead Zone, or Dead Space	XOUT = G*(X1-C2) IF(X1.GT.C2) = G*(X1-C1) IF(X1.LT.C1) = 0.0 Otherwise.
12	DER	X1	(X2)	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Derivative	XOUT = G*(dX1/dt)
13	DINL	X1	(X2)	(X3)	N/A	N/A	G	[illegible]	[illegible]	[illegible]	[illegible] Limited	[illegible]
14	DIV	X1	X2	[illegible]	[illegible]	N/A	G	XMAX	XMIN	XIV	Divide	XOUT = G*X1/X2
15	EOR[f]	L1	[illegible]	[illegible]	N/A	N/A	N/A	N/A	N/A	LIV	Logical Exclusive Or	LOUT = 1.0 IF[(L1 + L2).EQ.1.0] = 0.0 Otherwise.
16	EQU[f]	[illegible]	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical Equivalent	LOUT = 1.0 IF(L1.EQ.L2) = 0.0 Otherwise.
17	[illegible]	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Exponential	XOUT = G*EXP(X1)

Table 3.6-2. (continued).

Type	Block[a] Type	Block[b] Input 1	Block Input 2	Block Input 3	Block Const 1	Block[c] Const 2	Gain[c] Factor	Upper[c] Limit	Lower[d] Limit	Initial Value	Control Block Name	Control Block Mathematical Operation[e]
18	FLFP[f]	L1	(L2)	L3	N/A	N/A	N/A	N/A	N/A	LIV	Logical Flip-flop	LOUT = Flip-flop output which changes state whenever L1 changes state (only if L3 = 1.0).
19	GATE[f]	X1	L2	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Gate	XOUT = X1 IF(L2.EQ.1.0) = 0.0 IF(L2.EQ.0.0)
20	GREQ[f]	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Greater than or equal to	LOUT = 1.0 IF([illegible].GE.X2) = 0.0 Otherwise.
21	GRTH[f]	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Greater than	LOUT = 1.0 IF(X1.GT.X2) = 0.0 Otherwise
22	INSW[f]	X1	X2	L3	N/A	N/A	N/A	N/A	N/A	XIV	Input Switch	XOUT = X1 IF(L3.EQ.1.0) = X2 IF(L3.EQ.0.0)
23	INT	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Integrate	See Section 1.2.3.6
24	INTM	X1	L2	L3	N/A	N/A	G	XMAX	XMIN	XIV	Integrate with mode control	See Section 1.2.3.6
25	IOR[f]	L1	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical Inclusive Or	LOUT = 0.0 IF[(L1 + L2).EQ.0.0) = 1.0 Otherwise
26	LAG	X1	N/A	N/A	C1	N/A	G	XMAX	XMIN	XIV	First Order Lag	XOUT = G*X1/(1.0 + C1*s), s is Laplace Operator
27	LDLY[f]	L1	(L2)	N/A	C1	(C2)	N/A	N/A	N/A	LIV	Logic Delay	LOUT = 0.0 IF[(L1.EQ.0.0).OR. (TIMET.GT.(C1 + C2))] = 1.0 IF[(L1.EQ.1.0).AND. (TIMET.LE.(C1 + C2))] where (C2) is the TIMET when L1 Switches from 0.0 to 1.0
28	LGPC[f]	L1	(L2)	L3	N/A	N/A	N/A	N/A	N/A	LIV	Logic General Purpose Counter	LOUT = 0.0 IF(L3.EQ.0.0), Reset Mode = Number of times L1 has changed state since enabled (when L3 = 1.0), count mode
29	LISW[f]	L1	L2	L3	N/A	N/A	N/A	N/A	N/A	LIV	Logic Input Switch	LOUT = L1 IF(L3.EQ.1.0) = L2 IF(L3.EQ.0.0)
30	LLAG	X1	(X2)	(X3)	C1	C2	G	XMAX	XMIN	XIV	Lead-lag Transfer Function	XOUT = G*X1*(1.0 + C1*S)/(1.0 + C2*S) ,S is Laplace Transform Operator

Table 3.6-2. (continued).

Type	Block Type[a]	Block Input 1[b]	Block Input 2	Block Input 3	Block Const 1	Block Const 2[c]	Gain Factor[c]	Upper Limit[c]	Lower Limit[d]	Initial Value	Control Block Name	Control Block Mathematical Operation[e]
31	LINT	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Limited Integrator	XOUT = G* X1*dt + XIV, X1 is set to 0.0 if XOUT is against a limit and the sign of X1 does not change
32	LOGN	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Natural Logarithm	XOUT = G*ALOG(X1)
33	LSEQ[f]	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Less than or Equal to	LOUT = 1.0 IF(X1.LE.X2) = 0.0 Otherwise.
34	LSTH[f]	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Less than	LOUT = 1.0 IF(X1.LT.X2) = 0.0 Otherwise.
35	MAXS	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Maximum of 2 signals	XOUT = AMAX1(X1,X2)
36	MAXT	X1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Maximum during transient	XOUT = AMAX1(X1,XOUT)
37	MINS	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Minimum of 2 signals	XOUT = AMIN1(X1,X2)
38	MINT	X1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Minimum during transient	XOUT = AMIN1(X1,XOUT)
39	MULT	X1	X2	N/A	N/A	N/A	N/A	G	XMAX	XIV	Multiply	XOUT = G*X1*X2
40	NAND[f]	L1	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical "Not And"	LOUT = 0.0 IF[(L1 + L2).EQ.2.0] = 1.0 Otherwise.
41	NEQ[f]	L1	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical "Not Equal"	LOUT = 1.0 IF(L1.NE.L2) = 0.0 Otherwise.
42	NOR[f]	L1	L2	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical "Not Inclusive Or"	LOUT = 1.0 IF[(L1 + L2).EQ.0.0] = 0.0 Otherwise.
43	NOT[f]	L1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Logical "Not" or Negation	LOUT = 1.0 IF(L1.EQ.0.0) = 0.0 IF(L1.EQ.1.0)
[illegible]	PDIF	X1	X2	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Positive Difference	XOUT = G*(X1 - X2) IF(X1.GT.X2) = 0.0 Otherwise.

Table 3.6-2. (continued).

Type	Block Type[a]	Block Input 1[b]	Block Input 2	Block Input 3	Block Const 1	Block Const 2[c]	Gain Factor[c]	Upper Limit[c]	Lower Limit[d]	Initial Value	Control Block Name	Control Block Mathematical Operation[e]
45	QUAN[f]	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Quantizer	XOUT = G*FLOAT[IFIX(Z1+0.5)] IF(X1.GE.0.0) = G*FLOAT[IFIX(X1 - 0.5)] IF(X1.LT.0.0)
46	RAMP	N/A	N/A	N/A	C1	N/A	G	XMAX	XMIN	XIV	Ramp	XOUT = G*TIMET-C1) IF(TIMET.GT.C1) = 0.0 Otherwise.
47	RAND[f]	N/A	N/A	N/A	C1	N/A	G	XMAX	XMIN	XIV	Random Number Generator	XOUT = G*RANF(DUMY) IF(TIMET.GE.C1) = 0.0 Otherwise.
48	SIGN	X1	X2	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Sign Function	XOUT = |X1| IF(X2.GE.0.0) = |X1| IF(X2.LT.0.0)
49	SIN	X1	N/A	N/A	N/A	N/A	N/A	XMAX	XMIN	XIV	Sine	XOUT = G*SIN(X1), X1 in Radians
50	SINV	X1	N/A	N/A	N/A	N/A	G	XMAZ	XMIN	XIV	Sign Inversion	XOUT = -G*X1
51	SOTF	X1	(X2)	(X3)	C1	C2	G	XMAX	XMIN	XIV	Second Order Transfer Function	XOUT = G*X1/(1.0 + C1*s + C2*s**2), s is Laplace Transform Operator
52	SQRT	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Square Root	XOUT = G*SQRT(X1)
53	STEP	N/A	N/A	N/A	C1	N/A	G	XMAX	XMIN	XIV	Step	XOUT = GIF(TIMET.GE.C1) = 0.0 Otherwise.
54	SUBT	X1	X2	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Subtract	XOUT = G*(X1 - X2)
55	TAN	X1	N/A	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Tangent	XOUT = G*TAN(X1), X1 in Radians
56	TIME	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Time	XOUT = TIMET
57	TRIP[f]	L1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	LIV	Trip Status	LOUT = L1 = 1.0 if Trip + Delay time has elapsed = L1 = 0.0 Otherwise.
58	VLIM	X1	X2	X3	N/A	N/A	G	N/A	N/A	XIV	Variable Limiter	XOUT = X2 IF[(G*X1).GT.X2], at upper limit = X3 IF[(G*X1).LT.X3], at lower limit = G*X1 Otherwise, between limits

Table 3.6-2. (continued).

Type	Block Type[a]	Block Input 1[b]	Block Input 2	Block Input 3	Block Const 1	Block Const 2[c]	Gain Factor[c]	Upper Limit[c]	Lower Limit[d]	Initial Value	Control Block Name	Control Block Mathematical Operation[e]
59	WSUM	X1	X2	N/A	C1	C2	G	XMAX	XMIN	XIV	Weighted Summer	XOUT = G*(C1*X1 + C2*X2)
60	XPO	X1	X2	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Exponentiate	XOUT = G*(X1**X2)
61	ZOH[f]	X1	L2	N/A	N/A	N/A	N/A	N/A	N/A	XIV	Zero Order Hold	XOUT = X1 IF(L2.EQ.1.0) = XOUT Otherwise.
100	DLAY	X1	n	N/A	C1	N/A	G	XMAX	XMIN	XIV	Time Delay	XOUT = XIV IF(TIMET.LE.C1) = G*X1(TIMET-C1) Otherwise Where n is number of delay table time intervals.
101	FNG1	X1	n	N/A	N/A	N/A	G	XMAX	XMIN	XIV	Function of one independent variable	XOUT = G*f_n(X1); where n is function table number.

a. An "^" parameter indicates a continuous variable; and "L" parameter indicates a logical (or discrete) parameter having a value of 0.0 or 1.0 only.

b. Variables enclosed in ( ) are not input variables but are used internally by the control block for data storage.

c. If G, XMAX, and XMIN are required for a control block, a constant gain factor and constant upper and lower limits will be applied at the values given. Default values for the limits are +1.0E+50 and -1.0E+50. If XOUT.GT.XMAX, XOUT is set equal to XMAX. If XOUT.LT.XMIN, XOUT is set equal to XMIN.

d. An initial value (XIV or LIV) is loaded into a control block output (XOUT or LOUT) at TIMET = 0.0 s.

e. XOUT appearing on the right-hand side of a defining equation indicates a previous time step value.

f. These blocks may not be included in a control system implicit loop.

Word	Variable	Description (CNTRL)
W3-R	CON2	Control block second constant (default = 0.0).
W4-R	CBGAIN	Control block gain (default = 1.0).
W5-R	CBMAX	Control block maximum value (default = 1.0E50).
W6-R	CBMIN	Control block minimum value (default = -1.0E50).

3.6.5 Control System Function Table Length Cards, CNTRL4000Y

Word	Variable	Description (CNTRL)
W1-I	NFTP(L)	Number of pairs of data in first function table.
.		
.		
.		
WNFT-I	NFTP(NFT)	Number of pairs of data in NFTth function table. (NFTP ≤50).

3.6.6 Control System Function Table Data Cards, CNTRL41XXY

One card (set) must be input for each Function Table. XX is the function table number and must be consecutive in ascending order.

Word	Variable	Description (CNTRL)
W1-R	CBFUN(L)	First table value of independent variable.
W2-R	CBFUN(2)	First table value of dependent variable.
W3-R	CBFUN(3)	Second table value of independent variable.
W4-R	CBFUN(4)	Second table value of dependent variable.
.		
.		
.		
WNFPT-R	CBFUN(NFPT)	NFPTth table value of dependent variable.

3.6.7 Control System Restart Change Data Card, CNTRL90XXX

One card is required for each control block to be changed. XXX is the control block number. The default for each variable is to leave the variable unchanged from the restart dump value. This card may also be used to change constant values used in the default steady-state control system (see Section 3.4.15).

Word	Variable	Description (CNTRL)
W1-R	CON1	New value of control block first constant.
W2-R	CON2	New value of control block second constant.
W3-R	CBGAIN	New value of control block gain.
W4-R	CBMAX	New value of control block maximum value.
W5-R	CBMIN	New value of control block minimum value.
W6-R	CBIV	New value of control block initial value.

Zero output values from a control block after restart may be obtained by setting CBGAIN, CBMAX, CBMIN, and CBIV to 0.0. This will only work for those continuously varying control blocks that actually use CBGAIN or CBMAX and CBMIN. See Table 3.6-2 for details.

3.7 STEADY-STATE CONTROL DATA

3.7.1 Steady State Control Cards, STEADYSTCNX

These cards request built-in control systems for use in steady-state runs. Input one card for each built-in control system required. CN is the card number. More than one control system of each type may be used; for example, separate flow control systems may be used for broken and intact recirculation loops. ICTR on card MAINXX must not be 0 if any built-in control system cards are input. The contents of these cards are described below for each of the three types of built-in control systems. Omit these cards on restart runs.

Word	Description (STEADYST)

Water Level Control System Description:

W1-A	Control system type. Input value = WLEVC.
W2-R	Water level setpoint measured from bottom of downcomer (m).
W3-R	Initial feedwater flow rate (kg/s).
W4-I	Number of component in which water level is to be detected.
W5-I	Vessel θ zone in which water level is to be detected. (Not used if downcomer is not part of a VESSEL component).
W6-I	Number of component in which steam line mass flow rate is to be detected.
W7-I	Location at which steam line mass flow rate is to be detected. Input value should be 1 for component inlet flow, 2 for component outlet flow, or 3 for side arm flow.
W8-I	Number of component in which feedwater mass flow rate is to be detected.
W9-I	Location at which feedwater mass flow rate is to be detected. This entry is not used if component W7 is a FILL. Input value should be 1 for component inlet flow, 2 for component outlet flow, or 3 for side arm flow.
W10-I	Number of FILL component in which feedwater flow rate is to be controlled. IFTY (Fill card FILLID01X) for this FILL should be 1.

Word	Description	(STEADYST)

Flow Control System Input Description:

W1-A	Control system type. Input value = FLOWC.
W2-R	Mass flow rate setpoint (kg/s).
W3-R	Initial recirculation pump motor torque (rated torque).
W4-I	Number of component in which mass flow rate is to he detected. This component will normally be a JETP or a CHAN.
W5-I	Location at which mass flow rate is to be detected. Input value should be 1 for component inlet flow, 2 for component outlet flow, or 3 for side arm flow.
W6-I	Number of PUMP component in which the motor torque is to he controlled. IPMPTY (pump card PUMPID01X) for this PTIMP should be 3.

Pressure Control System Input Description:

WI-A	Control system type. Input value = PRESR.
W2-R	Pressure setpoint (Pa).
W3-R	Time zero valve area fraction open.
W4-I	Numher of component in which steam line pressure is to be detected.
W5-I	Cell number at which pressure is to be detected.
W6-I	Number of VALVE component in which the value area is to be controlled. IVTY (valve card VALVEID02X) for this VALVE should be -1.

3.8 EXTRACT DATA

This set of input data determines which components are to be extracted from the TRCRST file and recreated in card image form on the TAPE3 file. This data set is input only if the variable NEXTR in the main control data is nonzero.

3.8.1 EXTRACT Data Cards, EXTRACTXX

All noncomponent cards except control system, reactor power, and time step cards are required, as usual. Power cards should be deleted from the deck. EXTRACT runs may be made either from an original input deck or from a restart tape. The card deck output from EXTRACT will be written on File TAPE3. If EXTRACT should fail due to bad input, TAPE5 will contain either partial EXTRACT output or, since TAPE5 is used for temporary input processing, a copy of the user's original input deck.

Since the card identifier number for fixed field input is arbitrary and not even required, EXTRACT uses the component number to create card identifiers for the free field decks it produces. And since the card identifiers are limited to two characters, the numbers produced are calculated module 100. Thus unless the user uses the recommended procedure of using the same numbers, less than 100, for the component number and the component identifier portion of the card identifier, EXTRACT will not reproduce the same card identifiers as used on the EXTRACT input deck.

NEXTR (from card OPTIONS) entries are required.

Word	Variable	Description	(EXTRACT)
W1-I	IEXTR(L)	Number of first component to he extracted.	
W2-I	IEXTR(2)	Number of second component to be extracted.	
.			
.			
.			
etc.	IEXTR (NEXTR).		

3.9 OPTIONAL INPUT DATA

The input data described below for counter-current flow and material properties are optional input data.

3.9.1 Counter-Current Flow (CCFL) Data

Up to 10 sets of CCFL constants may be input by the user. Each data set is given a data set identifier which is identical to the data card sequence number. The data set identifier is input as variable ICCFL in the component data to specify which set of CCFL constants is to be used at each location in the component. Two default sets of CCFL coefficients are provided. Default set 1 is for upper tie plates, and default set 2 is for side entry orifices.

CCFL Constant Card CCFLXX

The data on this card are optional. The card sequence number XX is used as the data set identifier.

Word	Variable	Description (CCFL)
W1-R	CCFLM	Multiplier on liquid Kutateladze number in CCFL correlation (see Volume I).
W2-R	CCFLK1	First constant in expression for the square root of the constant on the right-hand side of the CCFL correlation (see Volume I).
WR-3	CCFLK2	Second constant in expression for the square root of the constant on the right-hand side of the CCFL correlation (see Volume I).

3.9.2 Material Property Data

Material Property First Card, MPROPID00

ID is a 2-digit identifier for the material. ID may be any integer between 21 and 99 inclusive. Material types 1 through 20 are reserved for built-in material tables.

Word	Variable	Description (MPROP)
W1-R	EMIS	Emissivity of material.
W2-A	NAME	Optional name or description of material. Up to 30 characters may be used; enclose them in quotes.

Material Property Table Cards, MPROPIDXX

This ID must be the same as the ID on the corresponding 00 card above. XX is a sequence number between 01 and 99 inclusive.

This is a table of from 1 to 25 points. Each point consists of a temperature and three dependent variables, as shown below for the first point. Temperatures must be in increasing order.

If the ID on the new cards is the same as the identifier of a table on the restart file, the table from cards replaces the table from restart. If ID is not the same as the identifier of a table on the restart file, then the table from cards is added to the tables from restart.

Word	Variable	Description (MPROP)
W1-R	TEMP	Temperature (K).
W2-R	COND	Thermal conductivity (W/m-K).
W3-R	CP	Specific heat capacity (J/kg-K).
W4-R	RHO	Density (kg/m^3).

4. OUTPUT DESCRIPTION

In addition to the plot file, two other output files are generated by TRAC-BF1/MOD1--the edit file and the message file.

4.1 EDIT FILE

The edit file is written directly to the job OUTPUT file. The edit file contains lists of input data card images, including comments as input by the user, a list of input data values as processed by TRAC input routines, a list describing user-selected options, and major and minor time edits that are produced at intervals specified on the time step cards.

Major time edits contain a detailed description of the thermal-hydraulic state of the modeled system at the time of the edit. Time-integrated values of variables relating to mass and energy inventories in the system are also included in these edits, along with statistical information regarding convergence of the numerical solution scheme.

Minor time edits consist primarily of numerical scheme convergence information.

The edit file also contains error messages regarding abnormal conditions encountered during input processing and during steady-state or transient calculations.

4.2 MESSAGE FILE

The message file is an auxiliary output file written on file TRCMSG. This file contains error messages that are often of a highly repetitive nature, such that their inclusion in the edit file might be cumbersome. This file is created during every TRAC run, but it must be specifically requested and catalogued if its contents are to be used at the conclusion of the TRAC run.

5. USER GUIDELINES

This section contains information that will be helpful to the user in setting up and executing a TRAC-BF1/MOD1 analysis. Most of this information has come from the experience gained in running TRAC-BD1 and TRAC-BF1 at the INEL.

5.1 Leak Path Model

The leak path concept is used in TRAC-BF1/MOD1 as a means of transferring a small mass and energy flow between components through an explicit flow path separate from the normal TRAC-BF1/MOD1 junction. The use of such a fully explicit flow is helpful, since it reduces the complexity of a TRAC-BF1/MOD1 network and requires less execution time than the implicit coupling in a normal TRAC-BF1/MOD1 junction. The leak path concept is useful in situations where momentum transfer is not important and where flow instabilities due to the explicit nature of the leak path are not likely to occur. Both of these criteria are satisfied for the small, transverse flow from a channel assembly into the surrounding core bypass region, feedwater flow between a FILL and the VESSEL downcomer, and for the liquid discharge flow from a separator-dryer into the downcomer.

Each leak path connects two components, one designated the FROM component and the other designated the TO component. These designations refer to a conventional flow direction and do not change if the actual flow direction reverses. Positive leak path flow implies flow from the From component to the To component. All leak path geometric data and connection data are input and stored as part of the FROM component data base. The geometric data include the leak path flow area, loss coefficient, and elevation difference, while the connection data include the FROM cell number, the TO component number, the TO cell number, and the TO level number (used only if the TO component is a VESSEL). All components except VESSEL and BREAK may be used as FROM components, and all components except BREAK and FILL may be used as TO components. A given component may be used as the FROM component for only one leak path, but no restriction is placed on the number of leaks to a given component or cell within that component.

The concept of a *disconnected* FILL component facilitates the use of a FILL component as the FROM component of a leak path. A disconnected FILL is specified by an input junction number of zero and is not connected to any other component through a conventional TRAC-BF1/MOD1 junction. Flow from a disconnected FILL to a component takes place only through a leak path. The use of a disconnected FILL and associated leak path permit a reduction in the number of components in a TRAC-BF1/MOD1 model, since FILL components may be connected directly to a VESSEL cell or 1-D component cell through a leak path without the use of an intervening PIPE or TEE.

5.2 IRREVERSIBLE LOSSES

Irreversible pressure losses in TRAC-BF1/MOD1 are of three types: wall friction, form losses, and fictitious losses due to the TRAC-BF1/MOD1 numeric scheme. An understanding of the differences between these three types of losses is helpful in correctly modeling pressure drops in a TRAC-BF1/MOD1 system model. Figure 5-1 is used to illustrate some of these differences and shows a one-dimensional TRAC-BF1/MOD1 model of a converging-diverging PIPE section.

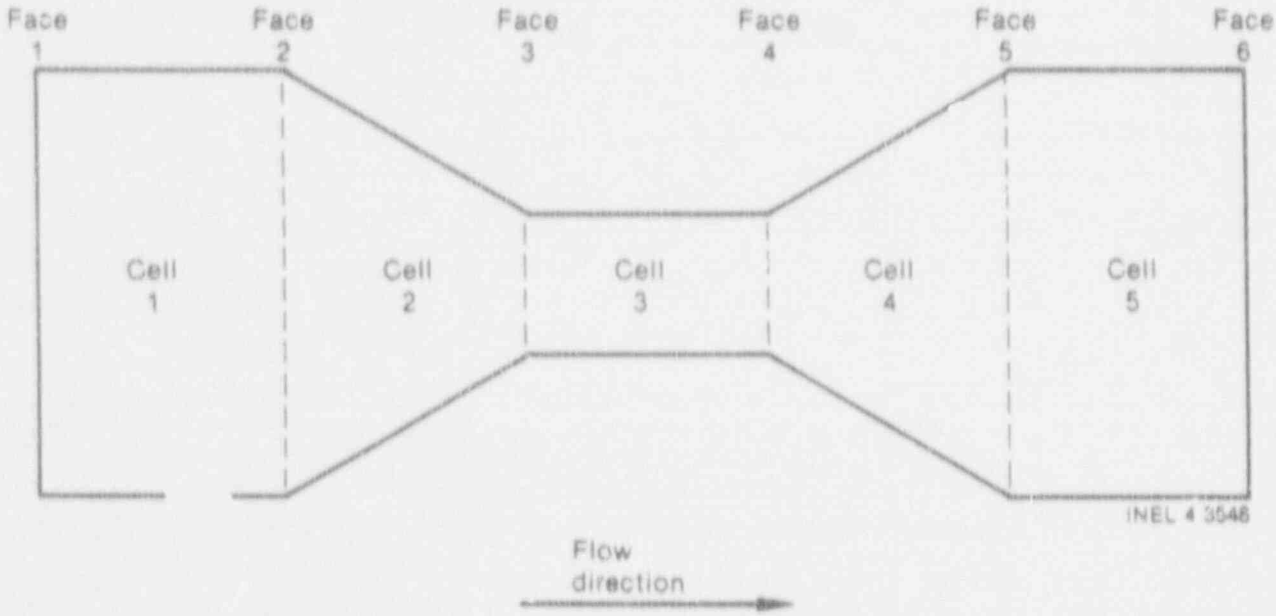


Figure 5-1. A converging-diverging PIPE section.

5.2.1 Wall Friction

Wall friction is calculated internally in TRAC-BF1/MOD1 as described in Volume I. The wall friction loss for flow between cell centers is calculated using phasic mass fluxes and the user-supplied hydraulic diameter at the face between the cells. For example, the wall friction loss between Cells 1 and 2 in Figure 5-1 is calculated using mass fluxes and hydraulic diameter at Face 2. A two-phase friction multiplier is automatically applied in this calculation. The most direct control that the user may exert on the wall friction calculation is through the specification of hydraulic diameters at cell faces. Wall friction pressure drops will vary approximately in inverse proportion to the hydraulic diameter. Wall friction pressure drops are experienced even in a straight section of pipe containing no area changes between cells.

5.2.2 User-Input Form Losses

If a TRAC-BF1/MOD1 system model contains structures such as flow area changes, bends, or grids, the user may choose to input form loss coefficients to account for the extra pressure drop encountered at such structures. Form loss pressure drops are calculated in TRAC-BF1/MOD1 by

$$\Delta p = 1/2\ k\rho v^2 \tag{5-1}$$

where

Δp = the cell center-to-cell center form loss pressure drop

k = the form loss coefficient at the face between cells

v = the mixture velocity at the face between cells

ρ = the mixture density in the upstream cell.

Form loss coefficients must be supplied by the user at the appropriate cell faces, since the code does not calculate any form loss coefficients internally. Two loss coefficients may be input at each cell face for forward (plus) and negative (minus) flow directions. If these two loss coefficients differ in magnitude by more than 10^3, flow instabilities may occur during flow reversals.

5.2.3 Fictitious Losses

In the absence of wall friction and user-supplied form loss friction, the pressure profile for incompressible flow in a pipe section such as that shown in Figure 5-1 should ideally be given by Bernoulli's equation. The pressure should decrease from Cell 1 to Cell 3 as the flow area decreases (and velocity increases), then should increase again to its original value at Cell 5, provided the flow areas of Faces 2 and 5 are equal.

However, because of nonconservation errors inherent in the backward differencing numerical scheme used in TRAC-BF1/MOD1, this ideal pressure profile is not realized. The pressure drop from Cell 1 to Cell 3 as predicted by TRAC-BF1/MOD1 is greater than the Bernoulli predicted value, and the TRAC-BF1/MOD1-predicted pressure rise from Cell 3 to Cell 5 is less than the Bernoulli value. For both flow contractions and expansions, TRAC-BF1/MOD1 calculates pressure changes irreversibly, as though form losses were present.

It can be shown that these fictitious form losses are equivalent to an effective form loss coefficient given by

$$k' = (1 - r)^2 \tag{5-2}$$

where r is the area ratio (smaller area/larger area) for the contraction or expansion. For the contraction from Cell 1 to Cell 3, the fictitious loss coefficient would appear to be applied at Face 3 with $r = A_2/A_1$; and for the expansion from Cell 3 to Cell 5, the fictitious coefficient would appear to be applied at Face 5, with $r = A_4/A_5$.

Although erroneous in origin, these fictitious coefficients are often of the correct magnitude to account for the genuine form loss effects that would be found in converging or diverging PIPE sections. Thus, the pressure changes observed in the TRAC-BF1/MOD1 model of such a section are often quite accurate, even though no form loss coefficients have been input by the user to account for the area change.

The user should include the effect of this fictitious loss when inputting a form loss coefficient for use at an area change. Generally, the input loss coefficient should equal the desired total loss coefficient minus the fictitious loss coefficient.

When modeling high-velocity regions between the VESSEL and one-dimensional components, a large face area should be used on the first cell face because there is no momentum source consideration on this type of connection. For instance, when VESSEL fluid flows into a ruptured suction PIPE, the pressure in the PIPE and the break flow from the PIPE will be too low if a large face area is not used.

5.3 Level Tracking Model

The TRAC-BF1/MOD1 level tracking model (see Volume 1) should be used in situations where accurate representation of the liquid level within a single TRAC cell is essential to the accurate modeling of system behavior. Such a situation occurs in the uncovering of a BWR jet pump suction inlet during a small-break LOCA transient. In such a transient, only liquid should enter the jet pump suction until the liquid level in the downcomer above the jet pump suction (the donor cell) falls to the elevation of the suction inlet. Thereafter, the mass entering the suction inlet should be mostly steam. If this situation is analyzed with TRAC-BF1/MOD1 without the level tracking model, the fluid entering the jet pump will have the average vapor fraction of the donor cell. Vapor will enter the jet pump inlet the moment that vapor first appears in the donor cell, producing premature uncovering of the jet pump suction. Proper use of the TRAC-BF1/MOD1 level tracking model can eliminate this problem, since this model does not allow vapor to be fluxed into the jet pump inlet until the liquid level in the donor cell actually reaches the elevation of the jet pump inlet. It is suggested that the level tracking model be used in all downcomer cells for modeling this situation. Other suggested locations for use of the level tracking model would be in BWR lower plenum cells, for accurate modeling of steam venting around the core skirt, and in lower downcomer cells, for modeling uncovering of the recirculation pump suction during a LOCA transient. Because of the extra computation time required for this model, it should not be used except in cells where it is needed.

Level tracking is not performed in the mixing cell of a TEE component. If the user sets the flag to track a level here, it will be turned off internally and a warning message will be issued. To minimize numerical diffusion of void in TEE mixing cells, the size of the cells should be minimized (subject to Courant limit restrictions on time step size).

Liquid levels will be tracked only in vertically oriented cells, that is, cells for which GRAV = 1.0 at both cell faces or GRAV = -1.0 at both cell faces.

Default values of parameters used to define level detection criteria (EPSALPL, ALPLVT, DALPC, DALPCI) are generally acceptable and should not be changed without compelling reasons.

5.4 BWR Fuel Bundle Modeling

Contained in this section are suggestions for modeling fuel bundle assemblies using the CHAN component. The CHAN component is used to model various fuel bundle configurations surrounded by a channel wall or flow shroud. The assumption of a rod grid on square centers is made by the code when setting up view factors for the thermal radiation calculation, hence the most accurate radiation heat transfer calculation available is for rods on a square grid only. Non-square grids (such as those encountered in some test facilities) may be modeled, but the view factors used will be on the basis of a square grid and will only approximate the actual view factors in the bundle. Though the rod grid is assumed to be on square centers, the overall dimensions of the rod array are not assumed to be square. Rods on the corners or periphery of an array may be removed from the view factor calculation by setting their group number equal to zero in the IROD array (see CHAN input).

5.4.1 Rod Group Modeling

Rods in a fuel bundle may be divided into as many rod groups as desired. An 8 x 8 fuel rod array could be modeled by as many as 64 different rod groups; however, computer time and storage limitations normally require that the rods be lumped together into a smaller number of groups containing nearly identical rods. The code considers all rods within a group to be identical, having the same geometry, temperatures, materials, power, and view factors to rods in other groups. Hence, only one rod within each group is described by input data. A typical grouping for an 8 x 8 fuel rod array is shown in Figure 5-2. The four corner rods are lumped into a single group (Group 1), since they have an especially large radiation view factor to the cool channel wall. The four innermost rods are broken into two groups (5 and 6), one to represent unpowered water rods and one to represent high power rods. The remaining rods in the array are divided into three more groups, giving a total of six rod groups. This grouping was determined on the basis of bundle symmetry and radial power profile. Other considerations, such as skewed radial power profiles, may lead to other groupings.

It has been found that no more than five or six rod groups are usually needed to adequately represent the distribution of fuel rod characteristics within the bundle. The outside radius of rods in Group 1 is used for calculation all rod-to-rod radiation view factors in the bundle, hence the rods in Group 1 must have a radius typical of most rods in the bundle. Atypical rods such as water rods should not be assigned to Group 1.

The IROD array in the CHAN input data is used to designate the rod grouping. It is important to remember that, for the purposes of rod grouping, the channel wall is also considered to be a separate group and must be input as the last entry in the IROD array. The channel wall is Group 7 in the sample array of Figure 5-2.

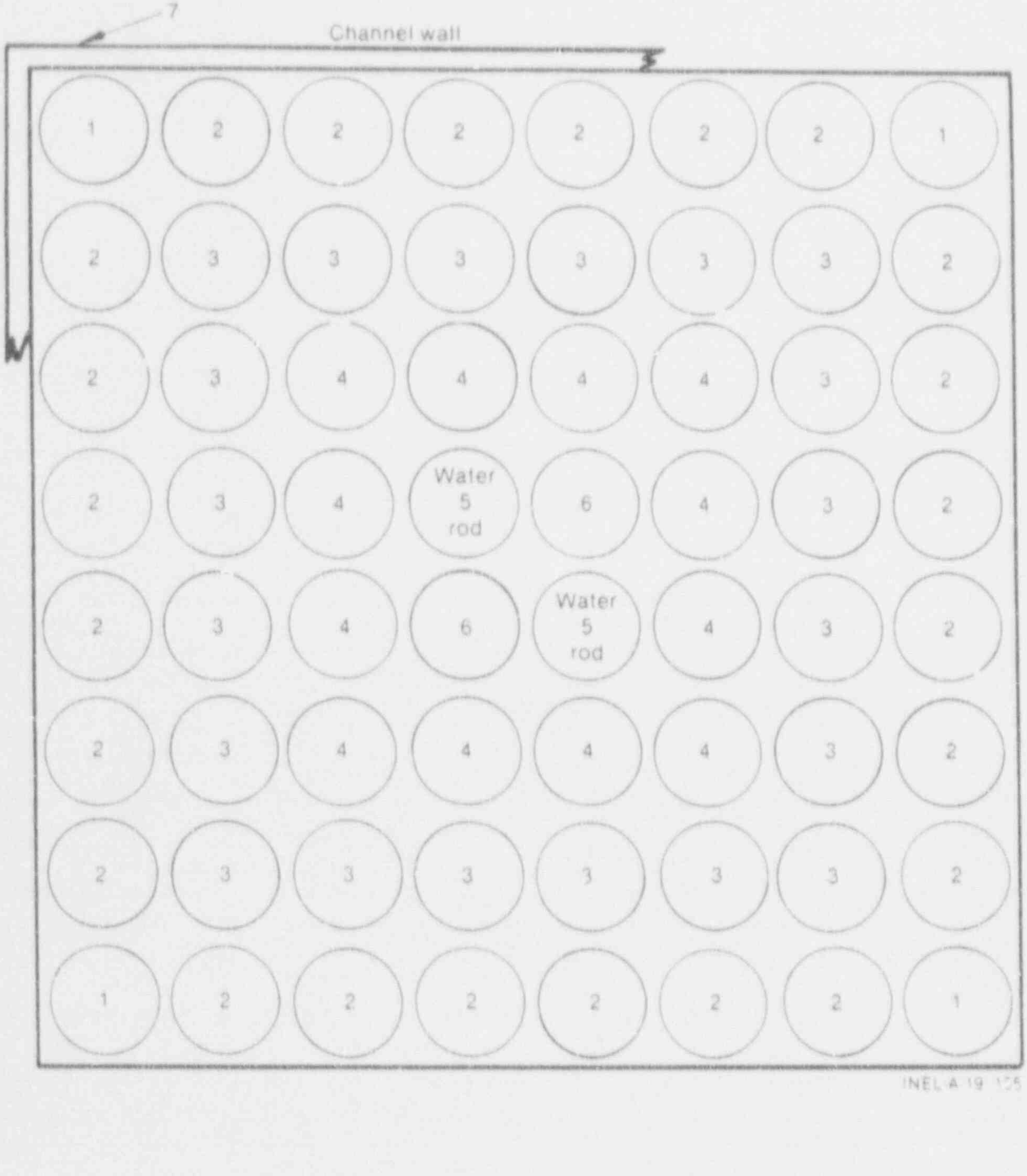


Figure 5-2. Sample fuel bundle grouping.

For the calculation of fuel rod thermal behavior, the code treats each rod group as a single rod having the geometry and power distribution of one rod within the group. For the calculation of fuel rod-to-fluid heat transfer, the surface area of the single fuel rod representing each group is automatically scaled up by the factor RDX (CHAN array data) to represent the total group heat transfer area to fluid. Thus, fuel rod properties should always be input using the actual properties of a single fuel rod. Any scaling required to represent total group properties is performed automatically by the code.

In the same manner, a single CHAN component is typically used to represent many actual BWR fuel bundle assemblies lying within a single vessel (r, θ) zone. The properties of CHAN (channel wall geometry and leakage path flow area) are to be input for a single channel assembly. TRAC automatically multiplies a single channel quantity by the scale factor NCHANS (CHAN Card CHANID0002X) if a total quantity for all channel assemblies in a vessel (r, θ) zone is required.

5.4.2 Axial Level Modeling

The number of axial levels in a fuel bundle model depends on such factors as the bundle length and the degree of peaking in the axial power profile. Typical bundle models use from 6 to 12 axial levels. Each fuel rod axial level occupies one CHAN fluid cell, but fluid cells at the top and bottom of CHAN need not contain fuel rods. This allows simulation of unheated sections at the fuel bundle entrance and exit. The location of the unheated sections is determined by the variables ICRLH and MCRZ on CHAN Card CHANDID0003X.

The number of cells or axial levels in a CHAN component is not determined by the number of axial levels in the VESSEL core region containing the CHAN. Normally, for economical use of computer time, the VESSEL core region will contain only two or three axial levels, while the CHAN components will typically contain four times that many cells. It is normally desirable that the total length of the CHAN component and the VESSEL core region be nearly equal, but the code will execute (with the printing of a warning message) even if these quantities differ.

5.4.3 Moving Mesh Reflood Model

The moving mesh reflood model is used to calculate detailed CHAN heat transfer information in the region of a reflood quench front. Because of the relatively large computational expense associated with this model, it is recommended that it be used only during the reflood portion of a reactor transient.

During the moving mesh calculation, both data storage requirements and calculation time become large if several rod groups are modeled and if NZMAX (the maximum number of rod axial conduction modes) and NXMAXW (the maximum number of channel wall axial conduction modes) are large. It is recommended that the DZNHT and DZNHTW parameters (minimum row spacing of rods and channel mass respectively) be used to limit the number of rows of nodes per cell. In general, these parameters should not be less than 0.02 m to avoid instability due to the explicit axial conduction solution used in the moving mesh calculation.

5.4.4 Power Distribution

Four separate variables or arrays must be supplied as part of the CHAN data to specify the reactor power distribution. The first of these, RADPOW, represents the fraction of total reactor power generated by a single bundle in the CHAN component.

The second distribution, CPOWR (CHAN array cards), represents the group-to group power distribution within a CHAN. The values in this array are entered for each rod group in the CHAN. The value entered for each rod group is the fraction of bundle power generated by a single rod within the group.

The third distribution, ZPOWR (CHAN array cards), represents the axial power distribution in a CHAN. One value is required for each cell edge (axial mode) in the heated region of the CHAN, including the top and bottom boundaries of the heated region. The values in the array represent the linear power density (W/m) at the axial node divided by the average linear power density for the entire fuel rod.

The fourth distribution, RDPWR (CHAN array cards), represents the centerline-to-rod surface radial power density distribution within each fuel rod. This array contains a value for each radial conduction node. Radial conduction nodes lie on the boundaries between radial conduction rings in the rod. The first node lies on the rod centerline, and the last node lies on the rod surface. The values in this array represent the power density (W/m^3) at the radial conduction node divided by the average power density for the entire fuel pellet region. The values in this array will commonly be 1.0 in the fuel pellet region and 0.0 in the gap and cladding regions. The node lying at the fuel pellet surface should be considered a powered node.

Rod groups simulating unpowered water rods can be modeled by setting CPOWR equal to zero for the group and by specifying a very small value for the gap heat-transfer coefficient, HGAP (CHAN array data), for all axial levels in the group. This has the effect of thermally isolating the fuel region of the rod from the cladding and surrounding fluid. The cladding thickness may be specified differently for the water rod groups than for the fuel rod groups, since radial node spacing is supplied independently for each group.

5.4.5 Isolated CHAN Modeling

The CHAN may be used as an isolated component without being placed in a VESSEL. This method of using the CHAN is convenient and economical if the inlet and outlet boundary conditions for the channel assembly are known functions of time. The CHAN inlet and outlet may be connected to FILL or BREAK components to supply the required fluid boundary conditions. The initial channel wall outside heat transfer coefficients (HOUTL and HOUTV) and fluid temperatures (TOUTL and TOUTV) supplied on CHAN Card CHANID0001X will be used as constant channel wall boundary conditions.

5.4.6 CHAN Leak Paths

The use of a leak path component connection allows the user to model leakage mass flow between the CHAN and its bypass region, usually a VESSEL. Physically, this leakage may represent the inexactness of the fit when the channel box is mounted to the tie plate. Leakage communication with the bypass may change (either positively or negatively) the mass flow rate in the heated section of the CHAN, thereby changing the channel pressure drop and void distribution. These effects may be particularly important under natural circulation conditions.

5.5 VESSEL MODELING

The following guidelines are directed toward features in a BWR TRAC-BF1/MOD1 model that are normally included in the VESSEL component and its connections. Figure 5-3 illustrates a simple BWR VESSEL model with seven axial levels and three radial zones. FILL and PIPE components are used to represent the main steam line, the ECCS core spray, and the feedwater supply. A more complete model might require additional FILL and PIPE combinations to represent other plant-dependent ECCS systems.

5.5.1 One-Dimensional Component Connectors

The three-dimensional momentum equation does not account for dynamic pressure at source connections to VESSEL cells. Thus, the VESSEL views one-dimensional components as sources of mass and thermal energy only. This means that dynamic pressure at the junction between any one-dimensional component and a VESSEL cell is not conserved. For this reason, in order to minimize errors due to nonconservation of momentum, it is desirable to include in the TRAC-BF1/MOD1 model an area expansion at any junction between a one-dimensional component and the VESSEL where the dynamic pressure gradient is significant in comparison with the static pressure gradient.

5.5.2 Core Spray

Core spray modeling in the mixing plenum is achieved in a simplified manner with TRAC-BF1/MOD1. Though the actual coolant in a BWR is sprayed across the top of the upper core support plate, it has been found that good results are obtained by modeling the core spray with a PIPE and FILL injecting subcooled water directly into the outer ring of the mixing plenum. It is our experience that this scheme yields a sufficiently uniform distribution of coolant water directly into the inner rings of the mixing plenum if a distributed spray is desired. For a more detailed discussion of core spray modeling, see Volume 1.

5.5.3 Separator-Dryer

The perfect VESSEL separator-dryer model achieves separation by using a large liquid friction factor in the axial direction, and a large vapor friction factor in the radial direction. If the default values of these friction factors (CZSDL and CRSDV) are used, complete separation of steam and water is achieved.

A perfect separator-dryer may be effectively modeled with a single VESSEL axial level. It is recommended that the separator liquid discharge be

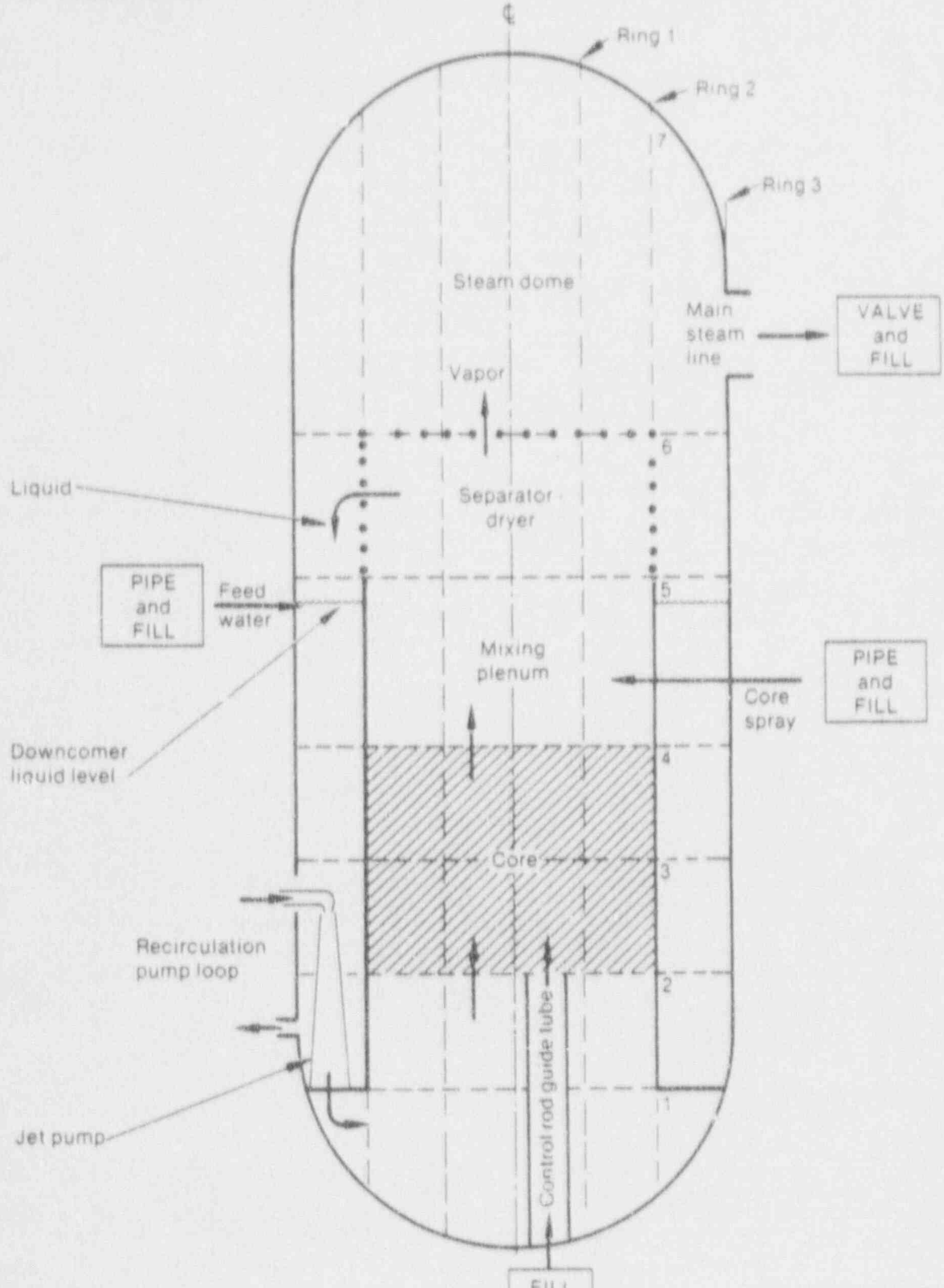


Figure 5-3. BWR-TRAC VESSEL nodalization diagram.

connected to a liquid-filled cell in the downcomer. This will reduce the downward numerical diffusion of vapor in the downcomer during steady-state runs.

The large loss coefficients used to achieve perfect separation effectively impose walls to vapor in the radial direction and to liquid in the axial direction. Care should be taken so that the placement of the separation surfaces does not block off physical flow paths or introduce unphysical pressure drops.

If a simple, or mechanisticc separator calculation with more realistic values for water carry-over and steam carry-under is required, the separator-dryer may be modeled by using the SEPD component. In this case, a SEPD component would be connected to VESSEL sources attached to the upper face of the mixing plenum, the bottom face of the steam dome, and the inner radial face of the downcomer.

5.5.4 Main Steam Line

The reactor vessel main steam line may be modeled as a multi-celled VALVE component connected from the VESSEL steam dome to a low-pressure BREAK. The forward loss coefficient (FKLOS) for the valve seat cell face should be set to the value required to obtain the desired steady-state flow rate. Alternately, a control system may be used to control the VALVE flow area to yield the desired steam line mass flow rate and steam dome pressure. A built-in controller is available for this purpose (see Section 3.6).

5.5.5 Control Rod Guide Tubes

During the reflood portion of a BWR LOCA, the stored thermal energy in the control rod guide tubes plays an important role in generating steam in the lower plenum. The guide tubes can be modeled by a PIPE component connected thermally to the VESSEL lower plenum region by use of the generalized pipe heat transfer option (see Volume 1). A single PIPE connected hydraulically to a VESSEL source on the bottom face of the core region and connected thermally to the fluid cells in one of the inner rings of the lower plenum gives an adequate representation of lower plenum steam generation. Additional PIPE components may be used in other rings if the user desires steam generation throughout the entire lower plenum.

The control rod guide tube PIPE may be connected to a FILL at its lower end. The FILL may be used to simulate control rod coolant flow, or to seal off the end of the guide tube. The fluid flow area and volume of the PIPE should equal the total fluid flow area and volume of all control guide tubes, while the hydraulic diameter should be that of one guide tube. The PIPE wall thickness should be the wall thickness of one guide tube, while the inside radius of the PIPE wall should equal the sum of the inside radii of all the guide tubes. This will ensure that the wall heat transfer area of the PIPE is the same as the total wall heat transfer area of the guide tubes. The PIPE wall metal volume will also be nearly the same as the total wall heat transfer area of the guide tubes, assuming that the guide tube wall thickness is small compared to its inner radius. Several cells may be used in a guide tube PIPE component to allow simulation of the water level in the guide tube during blowdown.

If the flow resistance between the guide tube and lower plenum is <10 times the resistance from the tube to the core bypass, the guide tube should be modeled with a TEE component. This ensures that when tube water flashes during a blowdown, some of the generated steam will go to the lower plenum.

5.5.6 Vessel Structural Stored Energy

Three methods are available in TRAC-BF1/MOD1 for modeling stored thermal energy in passive vessel structures. First, the lumped parameter heat slab model treats vessel structures as perfect conductors, allowing instant transfer of heat from the interior of the structure to the surface. Each point in such a structure is at the same temperature. This model is useful for modeling structures whose thermal relaxation time is short compared to the duration of the thermal-hydraulic transient being modeled. Examples of such structures would be thin-walled tubes in a rapid blowdown transient or thick girders during a slower, small-break transient.

The user supplies the surface area and mass of the heat slab in each vessel cell for this model. If the surface area equals zero for a cell, no lumped parameter heat slab is calculated for that cell. A single set of material properties (density, specific heat, thermal conductivity, and emissivity) input on VESSEL Card VESSELID0001X is used for all lumped parameter heat slabs. The thermal conductivity and emissivity values are used in determining the heat-transfer coefficient at the heat slab surface.

The second method is modeling stored energy in the double-sided heat slab or double slab. The double slab is designed to model stored energy in structures lying on cylindrical vessel boundaries, as described in Volume 1. The double slab also models conductive heat transfer between fluid regions on both sides of the slab. The double-slab model solves the heat conduction equation in the cylindrical slab, allowing the accurate modeling of stored energy removal from thick structures, such as downcomer walls or reactor pressure vessel walls. In the case of the downcomer wall, heat transfer from fluid in the core region to fluid in the downcomer region through the double slab is also calculated. For a model of the reactor pressure vessel, heat is transferred from the fluid in the vessel to an outside heat sink whose thermal properties are designated on VESSEL Card VESSELID0001X.

Third, modeling stored energy in vessel structures is provided by the generalized pipe heat transfer option described in Volume 1. This option permits the wall of a PIPE, TEE, or JETP component to be thermally connected to the fluid in specified vessel cells. A conduction solution is performed in the PIPE wall, permitting accurate calculation of the stored energy removal rate. This option is useful for modeling such structures as jet pumps, jet pump drive tubes, and control rod guide tubes.

5.5.7 Vessel Modeling With One-Dimensional Components

If three-dimensional effects are not required in a vessel model, the vessel may be modeled by using only one-dimensional TRAC component. A vessel model of this type may result in significant savings in computer time when compared to a model using the VESSEL component. A component diagram of such a one-dimensional vessel model is shown in Figure 5-4. A SEPD component must be used to achieve steam-water separation. It is recommended that the separator liquid discharge be connected to a liquid filled cell in the downcomer component to reduce the downward numerical diffusion of vapor in the downcomer.

Heat transfer between the outside wall of the CHAN and the fluid in the core bypass region is accomplished by using the generalized component-to-component heat transfer option. This option allows the outer wall of each CHAN cell to be in thermal contact with a user-specified cell in the bypass component. Appropriate values of IPVHT, KLVC and KRVC must be input for the CHAN component and core bypass component to specify the heat transfer path.

Leak paths (see Subsection 5.1) are used for modeling leakage flow from the CHAN to the core bypass, discharge flow from the separator to the downcomer, and feedwater flow from the FILL to the downcomer. The use of leak paths eliminates the need for extra TEE components for connecting these flows to the reactor system.

A collapsed liquid level is calculated in PIPE and TEE components so that these components can be used for modeling a vessel downcomer. This level is calculated with respect to the bottom end of the component; hence, the level in the downcomer TEE shown in Figure 5-4 would be measured from the junction connected to the recirculation pump. Fluid in the TEE sidearm is not included in this calculation. This level is available to the control system (variable name LLEV) and to graphics output (variable name LLEVL).

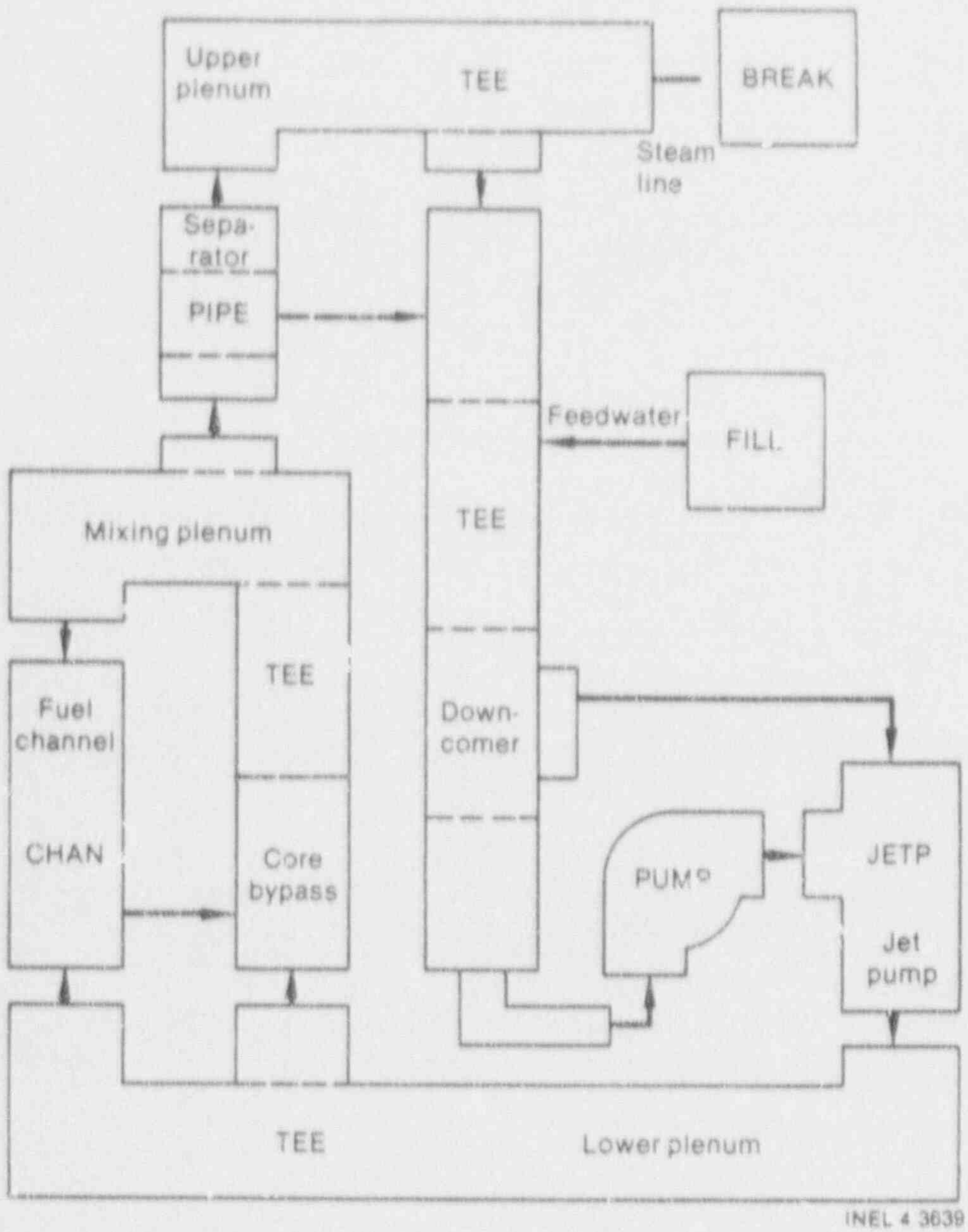


Figure 5-4. One-dimensional vessel model.

5.6 Control System Modeling

The BWR TRAC-BF1/MOD1 control system model can be used to simulate actual reactor control systems, to simulate the approximate behavior of plant system components such as motor generators, pumps, or turbines, or to assist in driving a reactor plant model to a specified steady-state condition. The built-in steady-state controllers available in TRAC-BF1/MOD1 (see Section 2.4.2) are designed to assist in the last of these operations. A thorough discussion of control system operation and modeling is beyond the scope of this manual, but an effort will be made to introduce the reader to some of the basics of control system operation by means of a simple example.

5.6.1 Simple Proportional-integral Controller

Though the details of individual of individual control systems vary widely from system to system, there is a simple control system called proportional-integral (PI) controller that often serves as a building block in more complex control systems and whose operation serves to illustrate some of the central features of control system behavior. The combination of TRAC-BF1/MOD1 control blocks comprising a simple PI controller is shown in Figure 5-5. The subtracter (SUBT 4) generates an error signal by subtracting a set point generated by constant block CONS 3 from the current value of the measured variable. For this example, the measured variable will be the reactor steam dome pressure.

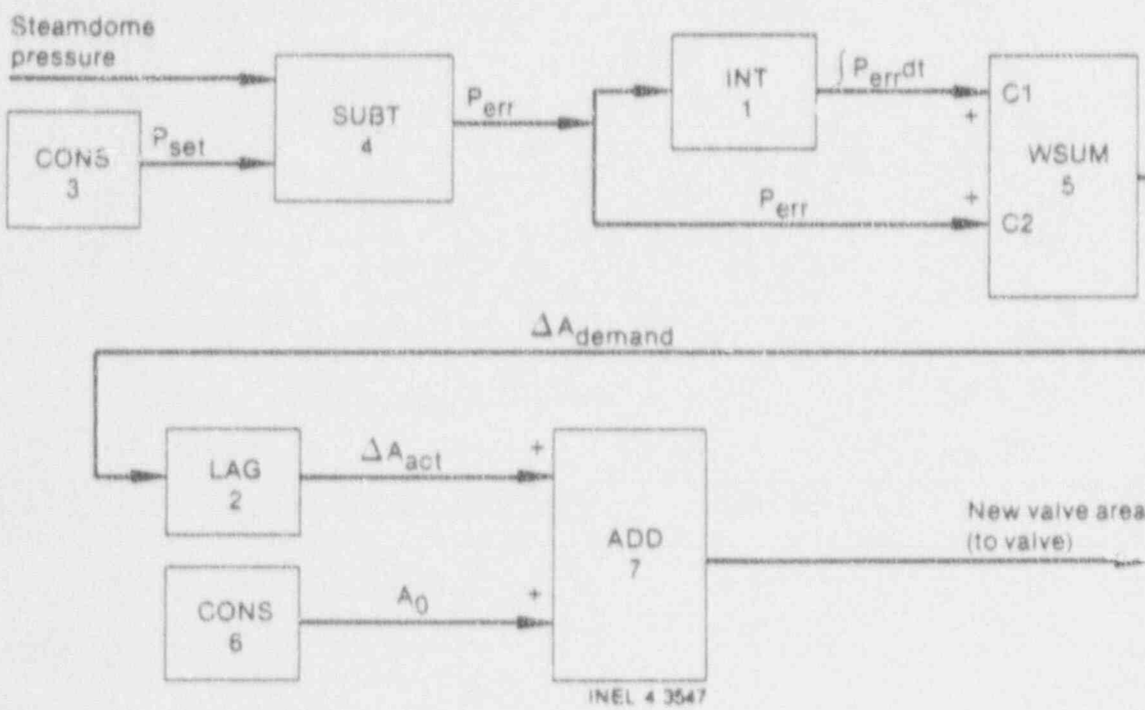


Figure 5-5. Simplified pressure control system.

The integrator (INT 1) integrates the error signal with respect to time to create an integrated error signal. Both the integrated error signal and the direct error signal are passed into the weighted summer (WSUM 5). Constant C1 is called the integral gain and serves as the multiplier on the integrated error signal in the weighted summer. Constant C2 is called the proportional gain and serves as the multiplier on the error signal in the weighted summer. The output of the weighted summer is a demanded change to the controlled variable (the pressure control valve area in this example). The first order lag block (LAG 2) serves to smooth out abrupt variations in the demanded area change. The constant block (CON 6) generates a nominal value for the control valve area that is added to the lagged area change by the adder (ADD 7) to produce a new value for the controlled variable or control valve area. This simple control system will adjust the control valve area in response to changes in the steam dome pressure, as it attempts to drive the steam dome pressure to the set point value.

Other possible applications of such a controller would be a core flow controller, where the measured variable is the reactor core mass flow rate and the controlled variable is the recirculation pump speed, or a level controller, where the measured variable is the reactor downcomer water level and the controlled variable is the feedwater flow rate.

5.6.2 Analysis of Controller Behavior

One of the most difficult problems posed in the design of a PI controller model is the choice of values for proportional and integral gains (C2 and C1 for WSUM 5). Optional values for these constants can be obtained by theoretical analysis of system behavior for linear systems; but for the nonlinear systems presented in a TRAC-BF1/MOD1 thermal-hydraulic model, values for these constants must normally be estimated by experience or intuition. The choice of values for these constants may result in a variety of possible controller responses.

A sampling of these possible responses is shown in Figure 5-6, along with a description of the gain values producing these responses. It is hoped that these examples will be useful to the user in diagnosing and correcting abnormal controller behavior. In these examples, the controller is attempting to bring the measured variable from a nonsteady initial value to a steady state value specified by a setpoint.

5.6.3 Computational Sequencing of Control Blocks

The current control system model does not automatically determine the computational order used to execute the control blocks in a control system. It is the user's responsibility to determine the correct computational order and to assign control block numbers in accordance with the desired computational order. This section contains guidelines to assist the user in

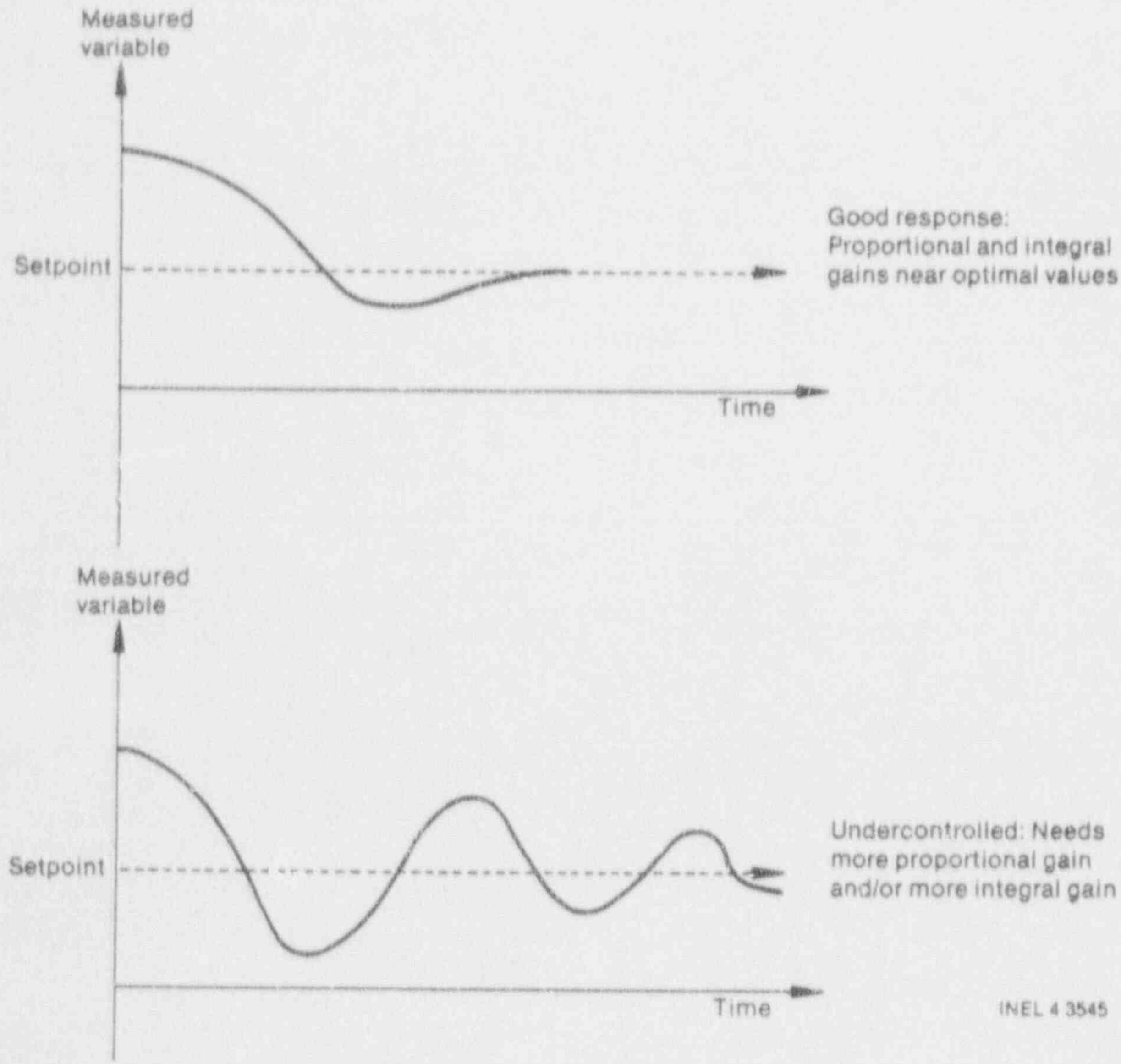
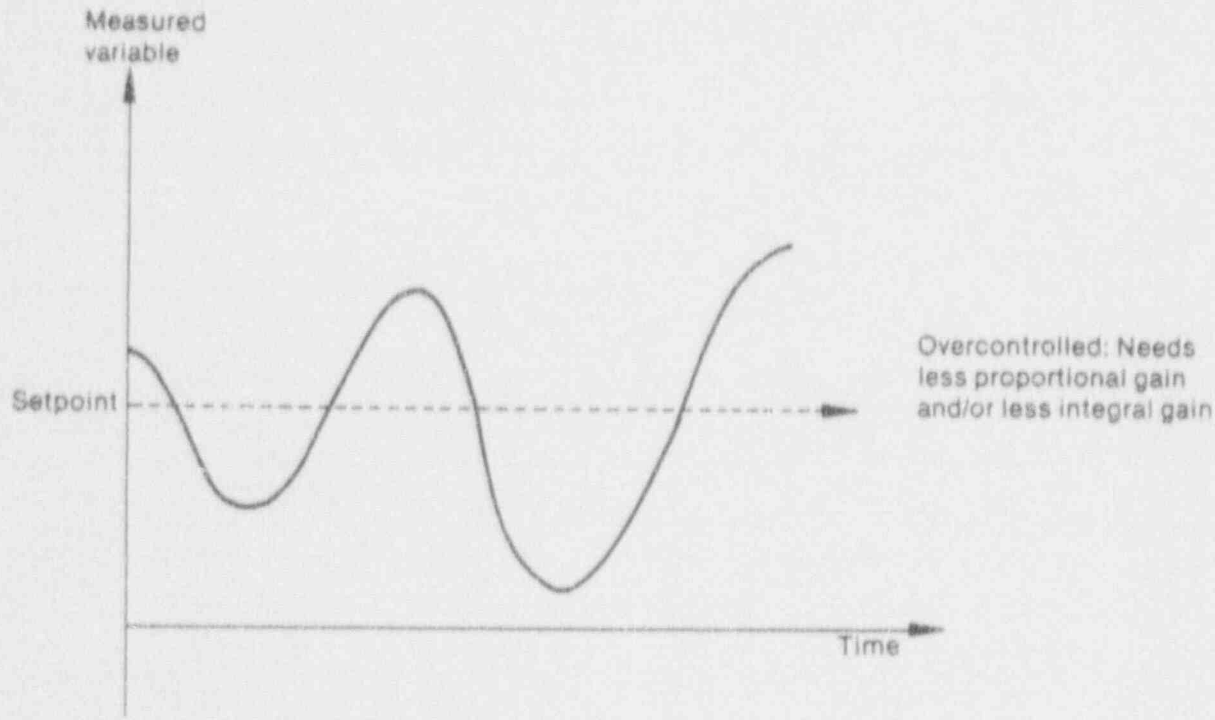


Figure 5-6. PI controller response curves.



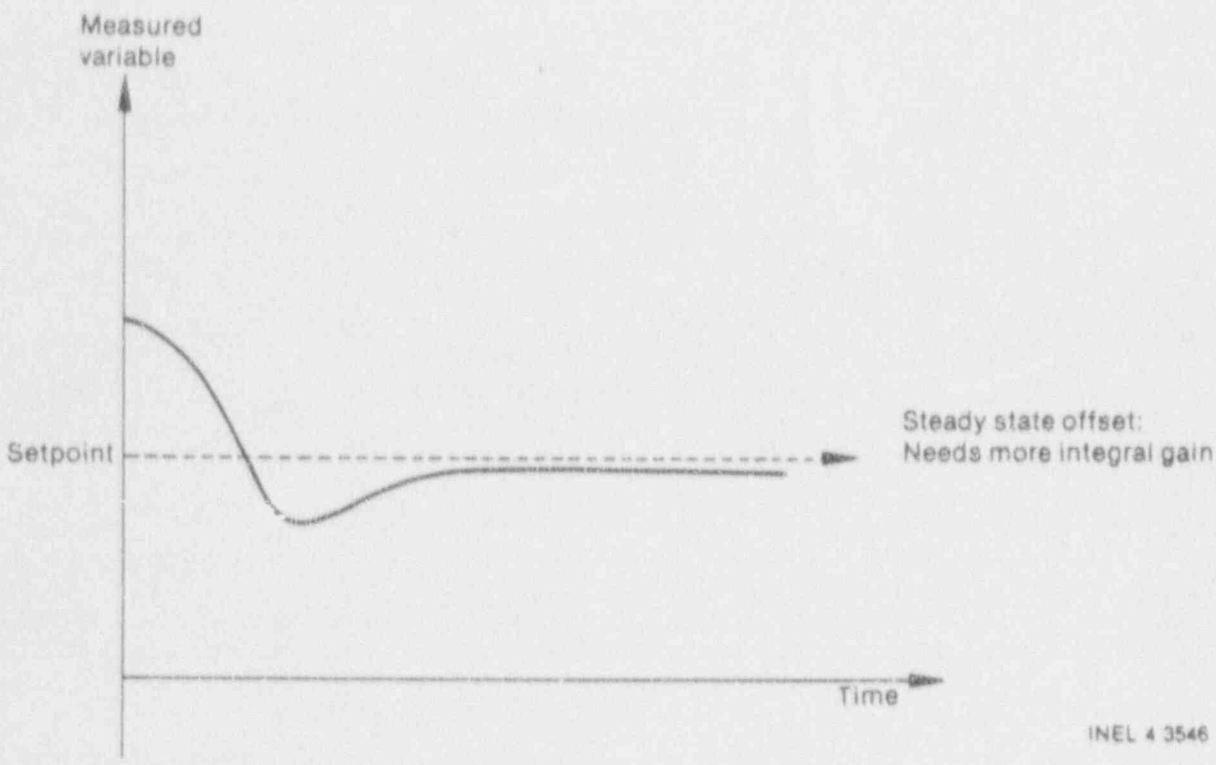


Figure 5-6. (continued)

determining the proper control block computational order.

In addition to the control block number (xxx on Input Card CNTRL20xxx) the second number--a computational sequence number--is associated with each control block. This sequence number describes the order in which the control blocks are executed. The control block number and sequence number of a given control block need not be the same, although the control block number is currently used to determine the sequence number. The subroutine CHKCIO assigns consecutive sequence numbers to control blocks by order of ascending control block number. Thus, a set of control blocks with control block numbers 10, 20, 15, 30, 40 would have the respective sequence numbers 1, 3, 2, 4, 5. The lowest-numbered control block is calculated first, followed by the next number in sequence, and so on until the control block with the highest number is calculated. This process is repeated during the next controller time step and continues until the desired transient solution is complete. Future plans call for the automatic sorting of the control blocks into proper computational order, thus relieving the user of the burden of numerically sequencing the numbering of the control blocks. The stability (as well as accuracy) of the simulation may well depend upon the correct ordering of all the control blocks to ensure that all inputs to control blocks are calculated prior to their use. The control block data input must therefore be in sorted order.

Every system (not containing algebraically implicit loops) can be so arranged. First of all, the state variable type blocks (DINL, INT, INTM, LAG, LINT,and SOTF) must be calculated after all their inputs have been determined. Since all thermal-hydraulic calculations are completed before the control system calculations, all thermal-hydraulic data base values are available as inputs to any control block requiring them. Constant block (CONS) values should also be generated before they are used as input, even though they themselves have no inputs from other blocks.

[A state variable type block is defined as one containing one or more mathematical integration operations.

An initial output value (XIV or LIV) is user-supplied as a part of the input data for each control block. These specified initial values are printed out at each major edit of the control system data so the user can easily determine how much each control block output has changed from the user-specified initial value. During the zeroth pass (at TIMET = 0.0), all control block output values are computed. Since the controller time step (DTCON) is 0.0, the state variable blocks properly retain the values input as initial conditions. However, the algebraic variables may have their initial values changed during the zeroth pass computation so as to be exactly consistent with the given state variable and thermal-hydraulic initial values. Consequently, the user is not actually required to input init al output values for algebraic variables.

The only exception is that if an algebraically implicit loop exists, there currently exists no way of iteratively solving for a solution for each time step. The user would have to specify an accurate initial value given for the output of the first one of the control blocks in the algebraic loop. As an example, consider the following implicit loop:

$Z = Y + \sin(Z)$.

According to Figure 5-7, the user would have to specify the initial value for either the SIN block or the ADD block, whichever he chooses to sequence first. It is assumed that the value of the variable Y has been previously calculated. As can be seen, this procedure has the distinct disadvantage of first requiring an accurate guess for the initial value of Z. Second, the solution proceeds with the input to either the SIN or ADD block lagging by one controller time step. This can result in an inaccurate or even unstable solution. So the user should avoid such loops if at all possible. Future plans will rectify this situation by the inclusion of a new control block named IMPL, which will iteratively solve noncoupled algebraic loops implicitly for each time step.]

Once calculated, the output of any control block may be used as input to as many control blocks as necessary. In the case where the output from a control block is being used to change the thermal-hydraulic data base, only one such control block should modify that particular parameter. If more than one control block were inadvertently used to adjust a specific thermal-hydraulic variable, only the last one in sequence would ultimately affect the simulation. However, if desired, a value from the thermal-hydraulic data base may be used as input to more than one control block. If such is the case, one should consider that any thermal-hydraulic input/output data transfer is a relatively time-consuming process. Consequently, it is more efficient to avoid having multiple transfers of the same parameter from the thermal-hydraulic data base. A trick to accomplish this is to define a *dummy* algebraic control block that has the desired thermal-hydraulic parameter as an input. Setting the DEAD control block constants (C1 and C2) to 0.0 results in its output equaling the desired thermal-hydraulic input. Then, the DEAD block may be efficiently used as input subsequently to as many other blocks as required.

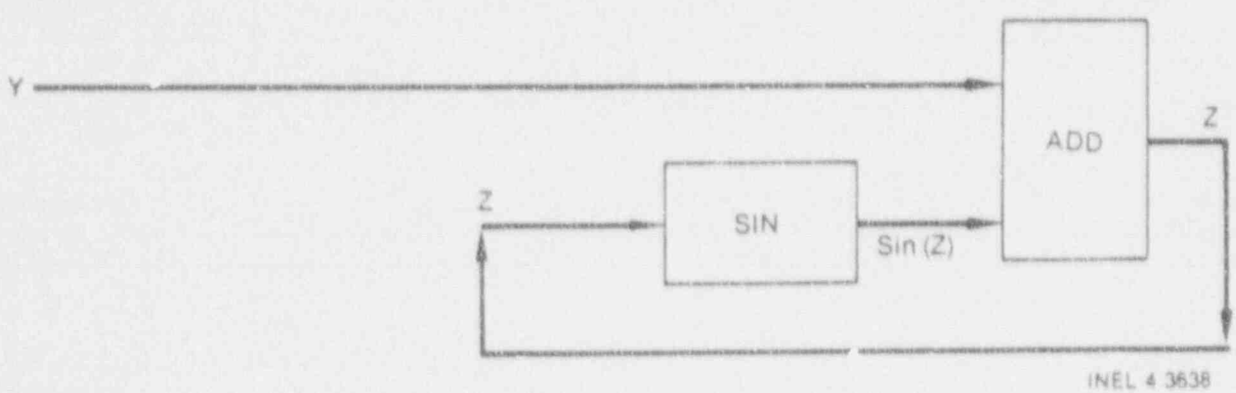


Figure 5-7. Implicit loop example.

In the infrequent event where it is desired that a thermal-hydraulic parameter be input directly to a state variable block, a similar artifice must be employed. The reason is that state variables have to be updated from past time step derivative values according to the following rectangular (first-order Euler) integration algorithm:

$$X_n = X_{n-1} + X_{n-1} * DTCON_N \quad (5\text{-}3)$$

where

X = state variable

X = derivative of the state variable

n = current time step number

DTCON = controller time step size.

It can be seen that since the thermal-hydraulic parameter is at the current time step (n), a means of storing the past time step value is necessary. This can be illustrated in Figure 5-8, where it is desired to integrate the feedwater flow rate (m_{FW}) to get the total mass (m_{FW}) of feedwater supplied.

The minus preceding the Number 1 in the circle denotes that it is a T/HI/O variable. Specifying the INT block (Number 10) to have a lower control block number then the DEAD block (Number 20) means that the integration operation will be performed computationally first. Thus, it will properly receive derivative data from the previous time step as required.

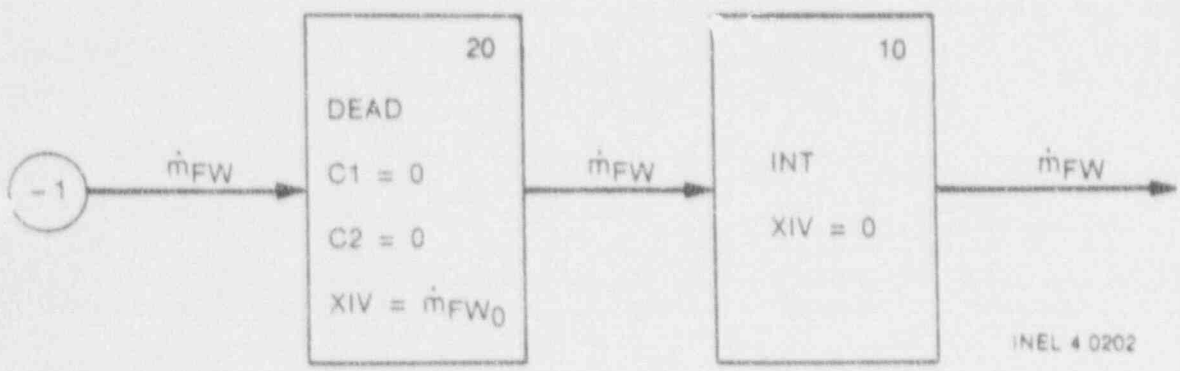


Figure 5-8. Method of integrating thermal-hydraulic data.

5.7 CONTAINMENT MODEL

In addition to Table 3.4-1, the following guidelines are presented to assist in using the TRAC-BF1/MOD1 containment model:

1. Compartment components may be any size the user wishes; but the smaller the compartments are, the greater the computational time required for containment calculations, for a given primary loop.

2. DTIME can generally be set to any value the user desires, given the degree of temporal resolution desired. [It is recommended that EDINT (TIMESTEP card) be set to an integral multiple of DTIME for each time domain].

3. In one-dimensional components attached to a BREAK with ICOMT ≠ 0, it is recommended that there be at least one cell between a cell face (where ICHOICE ≠ 0) and the BREAK junction. This is to allow the two-phase mixture to flash to a quality appropriate for the containment back pressure.

4. Unless large changes in liquid level within a compartment are expected, it is recommended that the level tracking option for heat structures not be used. Rather that use multiple vertical nodes for a heat structure that is partially in the liquid region and partially in the vapor region, the structure should be broken into two single-axial-node structures in the liquid and vapor regions, respectively.

5.8 FEEDWATER HEATER MODEL

It is often convenient to use a PI controller (see Section 5.6) to control the liquid level in the shell of the feedwater heater by adjusting a drain flow control valve at the drain cooler exit of a HEATR component. To eliminate the need for a separate VALVE component to control feedwater heater drain flow, a utility has been built into the HEATR component that allows the control system to adjust the flow area and hydraulic diameter at the next-to-last cell face (cell face NCELL1) in the HEATR primary tube. This adjustable cell face may be used as a control valve for the heater drain flow. The controlled variable type for use on control system input/output cards is AREA. To use this option, NCELL1 should be >3.

The feedwater heater component may also be used to model a condenser component. The shell (the HEATR component) can be cooled by *plant* water that is not part of the primary coolant through the use of a *disconnected* loop. This would generally take the form of a FILL, PIPE, and BREAK, where the PIPE represents the tube bank inside the shell. The shell side arm can be connected to a negative FILL to model the steam-jet ejectors usually found on condensers to limit buildup of noncondensibles. If you put such *disconnected* loops into your model, you must tell TRAC-BF1/MOD1 how many to expect with the NDISLP variable in the MAIN cards.

5.9 TURBINE MODEL INITIALIZATION

A train of TURB components is used to model a complete BWR steam turbine. A typical turbine train would consist of 5 TURB components in series: one for the high-pressure turbine section, one for the moisture separator, and three for sections of the low-pressure turbine. The following procedure is recommended for initializing the complete turbine train.

1. Set desired pressures and rated mass flow rates on input deck.

2. Allow the code to calculate TURB nozzle flow areas. This is done by setting FA = 0.0 on input for cell Face 2 in TURB.

3. Use a control system with PI controllers (see Subsection 5.6) to control steam extraction mass flow rates. The controlled variable to use for this is the TURB side arm loss coefficient, with control system input/output identifier KLOS.

4. Adjust high-pressure stage efficiency to give the correct separator drain flow rate. All liquid phase entering the separator is drained out the side arm, hence the high-pressure stage efficiency will determine the separator drain flow rate by determining the exit vapor fraction from the high-pressure section.

5. Adjust low-pressure stage efficiencies to give the correct total turbine rotor power.

6. For ease of initialization, allow the last low-pressure TURB to exhaust into a VALVE whose area is controlled to yield the correct TURB outlet pressure. If the final TURB is connected directly to a BREAK, it is difficult to control the final stage outlet pressure.

5.10 Time Step Size

The following suggestions are offered as approximate guidelines to establish time step size limits. Each problem has its own optimum limits, and only user experience can determine these limits. Limits are suggested for the early phase of blowdown transients and for other less rapid transient phases.

Rapid Blowdown Transient (0.0 to 0.1 s)

DTMIN = 1.E-6 s
DTMAX = 1.E-3 s.

Slow Transients and Steady State

DTMIN = 5.E-4 s
DTMAX = 3.E-2 s.

The Courant limit on time step size may sometimes cause a calculation to consistently use a time step size much smaller than DTMAX. Each TRAC major edit prints the Courant time step size limit, the component, and cell face number causing this limit. If the same component cell face is found to consistently limit the time step size, the user may increase the upstream cell volume arbitrarily or by combining cells. This will allow larger time step size, since the Courant limit in TRAC-BF1/MOD1 is based on upstream cell fluid volume and on upstream cell length.

5.11 MASS CONSERVATION

Errors in system mass conservation are indicated by system percent mass continuity error printed at the end of each major edit. This quantity is defined as

System percent mass continuity error = 100 (OMASTO-OMAST)/OMASTO)

where OMASTO is the initial system water mass and where OMAST is the current estimate of the initial system mass defined by

OMAST = current total system water mass
+ total mass discharged at BREAKS
- total mass injected at FILLS.

If mass is perfectly conserved, OMAST = OMASTO during the entire transient. In actual TRAC transients, however, mass continuity errors are never exactly zero due to the truncation error. For transients in a system with a small initial water mass (reflood of an initially steam-filled system), large percent mass continuity errors are often not significant. For initially liquid-filled systems, however, a large percent mass continuity error often indicates that too large a time step size is being used.

The percent mass continuity error is also calculated and edited for each component in the system, allowing system mass conservation errors to be traced to a particular component.

5.12 HELPFUL HINTS

Many of these suggestions have been obtained from Los Alamos National Laboratory (LANL). LANL contributions are acknowledged in parentheses.

5.12.1 Implicit Conduction Option

Occasionally, TRAC-BF1/MOD1 problems will be encountered where the time step size allowed by the hydrodynamic solution is so large that the conduction solution in solid structures becomes unstable. This behavior is characterized by large and rapid oscillations of the surface temperatures of fuel rods or other solid structures. This problem can be eliminated by setting the implicit conduction solution flag, IMPCON, to 1 on Card MAINXX. The fully implicit conduction solution option (see Volume 1) does not exactly conserve energy in the reactor system, but the conservation errors are small for slow transients.

5.12.2 Adding or Deleting New Components

Four changes are required to add or dele[illegible]omponent in a TRAC-BF1/MOD1 input deck: (a) add or delete the component [illegible] (b) change NJUN and NCOMP on Main Control Card MAINXX; (c) change the IORDER array on Card COMPLISTXX; and (d) change the number of VESSEL sources (NCSR on VESSEL Card VESSELID0001X) and VESSEL source cards (VESSEL Card VESSELID0014X), if necessary.

The only exception to these guidelines is the containment. To add or delete the containment component, the containment option flag (ICONTA) on the MAIN control card must be appropriately changed, the containment input cards must be inserted (to add the containment), and the input cards for FILL and BREAK components attached to containment compartments must be inserted (to add or delete the containment) with appropriate specifications of the ICOMT parameter.

5.12.3 Flow Areas

The flow area at a cell face should represent the most restrictive value within the cell to help achieve correct pressure drops and velocities (LANL).

In the powered region of a CHAN component, the maximum flow area should be used to avoid overestimation of convective heat transfer and additive form loss coefficients should be used to obtain correct pressure drops.

5.12.4 Flow Restrictions at Cell Ends

If the volume of a cell is more than several times larger than $0.5(FA_1)DX$, it should be divided into two cells. This gives more realistic values for pressure drops (LANL).

5.12.5 Interpretation of GRAV

The one-dimensional component input variable, GRAV, is defined as follows:

GRAV = [elevation (vertical)difference between cell centers]/(flow length between cell centers)

= (elevation of center of Cell 2) - (elevation of center of Cell 1) $/(1/2\ DX_2 + 1/2\ DX_1)$

Only for straight pipes (no bends) does this reduce to the cosine of the angle between a vertical vector pointing up and a vector from Cell N to Cell N + 1 as described in the input description.

For a TEE at the interface between the primary tube and side are, the above expression for GRAV also applies, with Cell 1 being the primary tube joining cell and Cell 2 being the first cell in the side are.

5.12.6 TEE Component

If possible, a TEE should have at least one cell between the secondary junction and either of the primary end cells:

JCELL > 1 and JCELL < NCELL1.

This is required to correct the momentum source terms in the primary leg. One exception is if the primary leg is joined to a VESSEL, a FILL, or a BREAK. Then, the secondary leg may enter the cell adjacent to that junction (LANL).

5.12.7 Junctions

The smaller flow area at the interface between two dissimilar pipes should be used at the connecting junction for both pipes.

At the interface between components, input the same interface values (FA, FKLOS, RKLOS, GRAV, HD, VL VV) for that interface in each component.

5.12.8 Converting from Steady-State to Transient Run

A convenient method of initializing a BWR-TRAC plant deck is to perform a steady-state run using control system assisted initialization (Section 2.4.2), then use EXTRACT to create a new input deck corresponding to the steady-state condition of the system. A transient run may then be initiated from this new deck. If this procedure is used, three items should be checked on the new input deck to ensure continuous conditions at the start of a new run:

1. If a steady-state pressure controller was used, the open area (ALIVE) and open hydraulic diameter (HVLVE) of the pressure control valve should be set so that the same valve characteristics are used at the beginning of the transient run as were set by the control system at the end of the steady-state run. The valve type (IVTY) must be changed to an appropriate value if the valve is not to be operated by a control system during the transient run.

2. If a steady-state downcomer water level controller was used, the feedwater FILL velocity (VIN) should be adjusted on the new deck to equal the fill velocity set by the control system at the end of the steady-state run. The fill type (IFTY) must be changed to an appropriate value if the feedwater FILL is not to be operated by a control system during the transient run.

3. If a recirculation flow controller was used, the recirculation pump speed (OMEGA) should be adjusted on the new deck to equal the final pump speed set by the control system during the steady-state run. The pump type (IPMPTY) must be changed to an appropriate value if the recirculation pump is not to be operated by a control system during the transient run.

5.12.9 Freezing Control System Output

It is sometimes convenient on a restart run to freeze the output on a control system at its current value. This is often easily achieved by setting the time constant to a very large value (10E10 s) in the lag control block smoothing the control system output. For example, LAG2 in Figure 5-? will cause subsequent output changes to be lagged by the very large time constant chosen.

5.12.10 Courant Limit in VESSEL Component

It is possible that the problem time step size might be limited to an unnecessarily small value by the Courant limit applied in a VESSEL component with very small radial dimensions. This might occur in the model of a small-scale test facility when a source, such as a steam line, is connected to a radial face on the VESSEL component. Even though a momentum solution is not performed at this face, the momentum solution form of the Courant time step limit will be applied, resulting in a severely restricted time step size. This unnecessary limit can be eliminated by using an artificially large flow area at the junction between the VESSEL face and the adjoining component. This will reduce the fluid velocity in the junction, resulting in a larger Courant time step limit at the junction. This artifice will have no harmful effects on the overall analysis, since the velocity at the vessel source junction is not used in a junction momentum solution.

5.12.11 Modeling of ECCS Injection

been observed that the injection of cold ECCS liquid into a hot, stea injection pipe can cause abrupt condensation and water packing in a T D1 model, often leading to small time steps and/or code failure. may be alleviated by including in the model a section of ward-oriented injection piping between the ECCS FILL and the el. The vertical section should be initially filled with water erature corresponding to the turn-on pressure of the ECCS FILL This section of piping will remain water-filled until ECCS injection is initiated and will allow a smoother (and more physical) initiation of ECCS flow.

5.12.12 Use of Choking Model

In order to achieve the best possible critical flow calculation with the choking model, the choking flag (ICHOKE) should be set to 1 only at junctions where there is no flow area change from the next junction upstream.

5.12.13 Downcomer Level

When attempting to match downcomer level as predicted by TRAC-BF1/MOD1 to plant data, an additional level calculation may be performed using the control system:

1. Take the pressure data points, one in the liquid downcomer and one in the steam region above it. The exact location depends on the specific plant configuration.

2. Use the control system to perform the calculation

   $P_l - P_g/\rho g$.

   ρ may be obtained via the control system or in a way dependent on the actual plant control system. $g = 9.801\ m/s^2$.

The output will be a relative level that is analogous to how the plant control system attempts to determine level. To relate this level to plant level, the relative value obtained from the TRAC-BF1/MOD1 control system may need to be referenced to the zero point of the plant level measurement.

5.12.14 Time-Step Size and the SEPD Component

The Courant number specified on the MAIN cards may be very large and still produce accurate results. The time integration algorithm is always stable, and accuracy is preserved by reducing the time step if the rate of change of state variables is large. However, the efficiency of the SEPD component is an explicit calculation and, as such, may exhibit some time-step size-dependence. If the model is performing in the regime where high efficiency is achieved, this is not a problem. However, when efficiency is degraded, the results may change. The model should be checked for time-step dependence in cases of low inlet void frafdction or high mass fluxes.

6. SAMPLE PROBLEM

The sample problem chosen for inclusion in this manual is two-loop test apparatus (TLTA) Test 6423, a full BWR simulation with an experimental base used for developmental assessment of TRAC-BD1.[6.1-1] The design base accident test case No. 6423 simulated a large-break (200% area) in one of the main circulation lines. The emergency core cooling system action simulated low flow rate and high injection liquid temperaqture.

TLTA configuration 5A, as used for test 6423, was designed to model fatures of a BWR/6, including the fuel channel-to-core bypass leakage paths. Figure 6.1-1 shows a facility schematic, which is described in greater detail in Section 2.4.3 of Reference 6.1-1. The input model of the system was based on a General Electric Co. model[6.1-2] and had 16 vessel levels, with two cells per level, and a total of 25 components. Figure 6.1-2 shows the original TRAC-BD1/MOD1 model nodalization.

The transient input deck has been modified for use with TRAC-BF1/MOD1 and is reproduced in Appendix A. A representative major edit for this problem is reproduced in Appendix B.

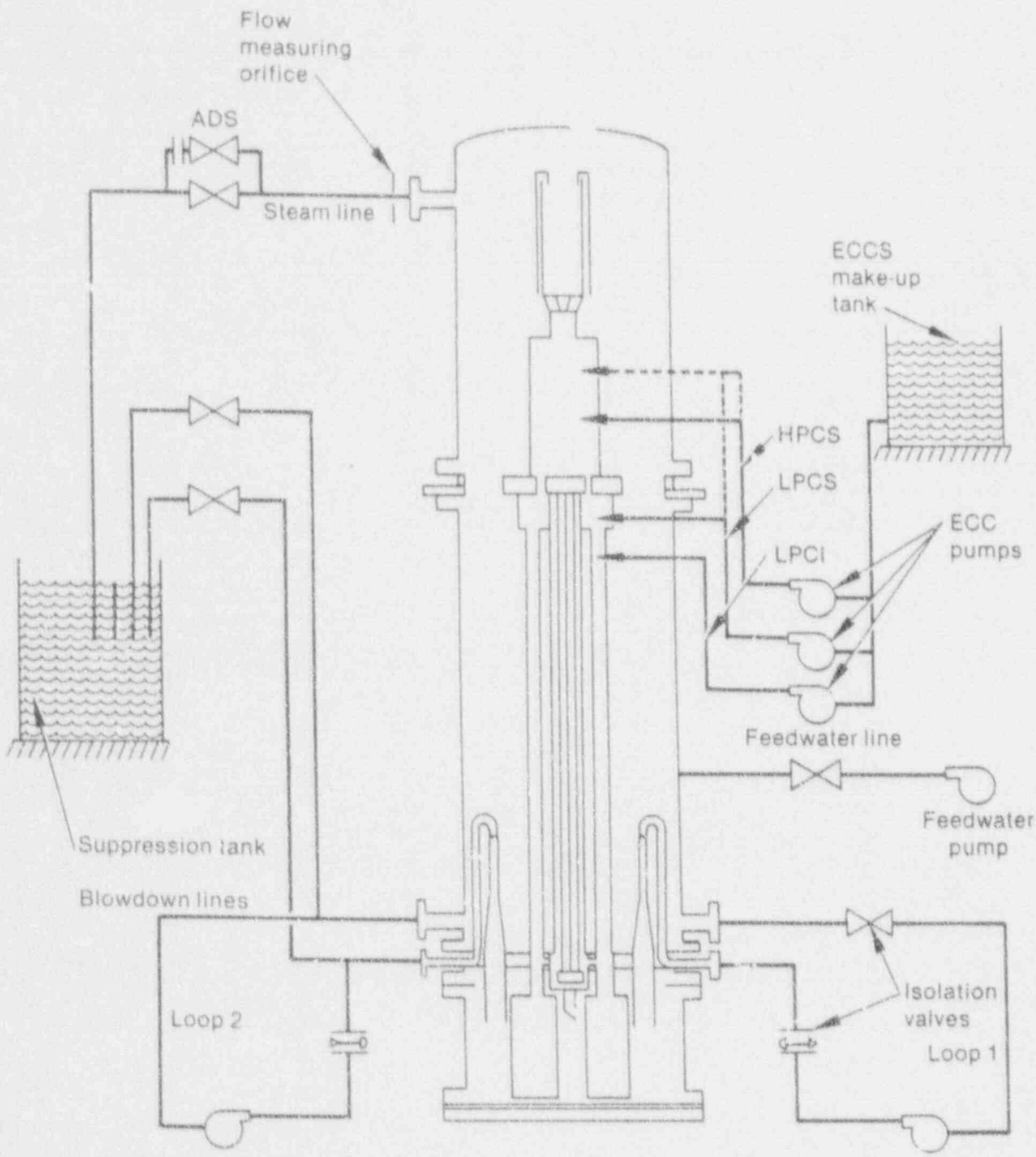


Figure 6-1. TLTA system schematic.

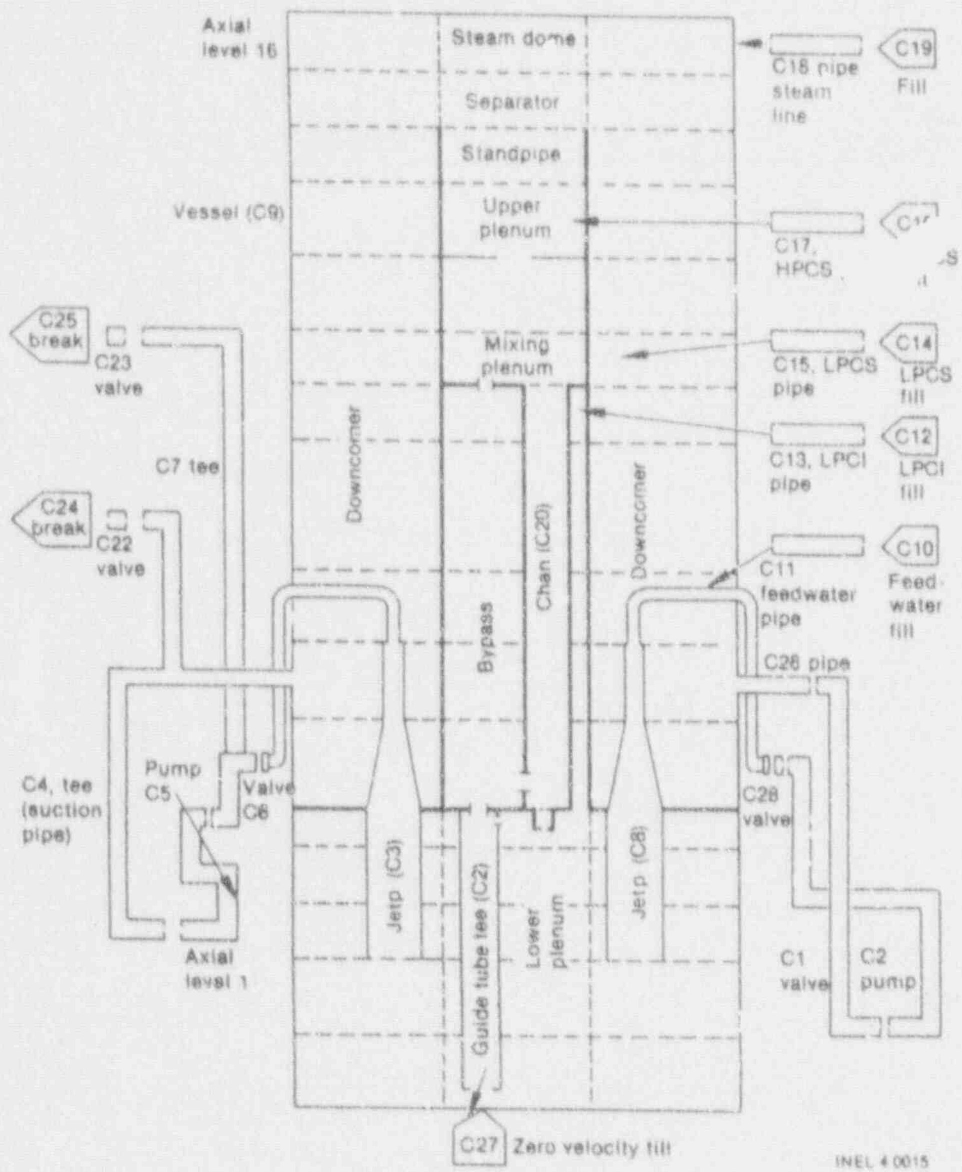


Figure 6-2. TLTA test 6423 TRAC model nodalization.

6.1 REFERENCES

6.1-1. R. W. Shumway et al., *TRAC-BD1/MOD1: An Advanced Best Estimate Computer Program for Boiling Water Reactor Transient Analysis, Volume 4: Developmental Assessment*, NUREG/CR-3633, EGG-2294, August 1985.

6.1-2. M. D. Alamgir, *BWR Refill-Reflood Program Task 4.8-TRAC-BWR Qualification for BWR Safety Analysis Final Report*, GEAP-22049, 1933.

Appendix A

Transient Input Deck for TLTA Test 6423

Appendix A
Transient Input Deck for TLTA Test 6423

This appendix contains the TRAC-BF1/MOD1 transient input deck for the sample problem, TLTA Test 6423.

```
*  TRAC-BD1 TLTA 6423 - TRANSIENT INPUT
**          IEOS          NTRACE             IST          NEXTR     MASTPR
OPTIONS        0              5                0              0          3
CHECKOUT   5   0   0   0   0   0   0   0
*
*        COMPONENT DESCRIPTIONS
*
*     COMPONENT      DESCRIPTION
*         1          BROKEN LOOP SUCTION LINE TEE
*         2          BROKEN LOOP PIPE
*         3          BROKEN LOOP BLOCK VALVE
*         4          BROKEN LOOP JET PUMP
*         5          SUCTION SIDE BREAK
*         6          GUIDE TUBE PIPE WITH LEAK
*         7          ZERO VELOCITY FILL TO GUIDE TUBE
*         8          INTACT SUCTION LINE PIPE AND VALVE
*         9          INTACT LOOP PUMP AND DRIVE LINE
*        10          INTACT LOOP DRIVE LINE VALVE
*        11          INTACT LOOP JET PUMP
*        12          64 ROD BUNDLE CHANNEL
*        13          DISCHARGE SIDE BREAK
*        14          MAIN STEAM - NEGATIVE FILL
*        16          BROKEN LOOP DISCHARGE TEE
*        19          HPCS PIPE
*        20          HPCS FILL
*        21          LPCS PIPE
*        22          LPCS FILL
*        23          LPCI PIPE
*        24          LPCI FILL
*        25          FEEDWATER PIPE
*        26          FEEDWATER FILL
*        27          VESSEL
*
*
**        DSTEP,   START TIMET
MAIN01        0            0.0
**       STDYST          TRANSI          NCOMP          NJUN   WATERPAK
MAIN02        0              1             24            27          0
** CONVER EPSO            EPSI           EPSS         IMPCON
MAIN03 1.0E-04         1.0E-05        1.0E-02            1
** ITER OITMAX      IITMAX      CSFID       NTRX      NLEAKP      NAXN
MAIN04      7           0       100.          4           3         7
*        NDMPTR             ICTR          IBORC          IAIR       NROT
MAIN05        0                0              0             0          0
*        NDMMPT             LEV1         ND1SLP        ICONTA
MAIN06        0                0              0             0
** COMPONENTS   LIST  ORDER   CARDS
COMPLIST01   1      2      3      4      5      6      7      8      9     10
COMPLIST02  11     12     13     14     16     19     20     21     22     23
COMPLIST03  24     25     26     27
*************************************************************************
****                                                                 ****
****        POWER INPUT                                              ****
****                                                                 ****
*************************************************************************
*
*               RPOWRI       IRPOP      N-POINTS
*POWER00010   6.4614E+06    1    0     0     0     0
*****      VLTB
POWER00010    6.4614E+06    2    0    31     0     0
*
POWER0PTAB00    0.000       6.4614E+06       0.500       6.4614E+06
POWER0PTAB01    0.623       6.4066E+06       1.631       5.8300E+06
POWER0PTAB02    3.647       4.0478E+06       4.659       3.5819E+06
POWER0PTAB03    5.674       3.1538E+06       7.186       2.6325E+06
POWER0PTAB04    9.202       2.0327E+06      10.209       1.7706E+06
```

```
POWER0PTAB05    13.233      1.3134E+06      16.257       9.0858E+05
POWER0PTAB06    18.777      7.4841E+05      20.289       6.6687E+05
POWER0PTAB07    23.816      5.5912E+05      26.840       4.8632E+05
POWER0PTAB08    29.863      4.2226E+05      32.383       3.8731E+05
POWER0PTAB09    35.909      3.4654E+05      38.429       3.2033E+05
POWER0PTAB10    40.949      2.9703E+05      45.989       2.6500E+05
POWER0PTAB11    50.020      2.3879E+05      60.099       2.0385E+05
POWER0PTAB12    70.177      1.9802E+05     100.412       1.8055E+05
POWER0PTAB13   200.203      1.8346E+05     300.592       1.7764E+05
POWER0PTAB14   399.592      1.7473E+05     400.592       0.00003+00
POWER0PTAB15   800.000      0.0000E+00
**  AXIAL POWER DISTRIBUTION ***
*            ZPOWER
POWER00ZPOWR0    0.527       1.032       1.330       1.381
POWER00ZPOWR1    1.330       1.032       0.529
*
*
*
*****************************************
* TIME STEP DATA                        *
*****************************************
*
*               DTMIN         DTMAX          TEND          RTWFP
*               EDINT        GRFINT        DMPINT         SEDINT
TIMESTEP011     1.E-6         0.10          15.00          1000.
TIMESTEP012      5.0          0.10            5.0          25.0
TIMESTEP021     1.E-5         0.10           0.00          1000.
TIMESTEP022     2.0            0.10          2.0           1000.
*    TRIP DATA
*    ITID ISID     TSP    TDT         TITLE          ID1  ID2  ID3  ID4
TRIP011  1  0      0.0     0.      "TIME ZERO         " 0    0    0    0
TRIP020  2  0      20.0    0.      "INTACT LOOP VLV   " 0    0    0    0
TRIP030  3  0      0.0     0.      "NOT USED          " 0    0    0    0
TRIP040  4  0      1000.   0.      "NOT USED          " 0    0    0    0
*
*******************************************
*       CONTROL SYSTEM FOR TLTA           *
*******************************************
*
*              TYPE   STPT   ICON  COMP  CELL  COMP  CELL  COMP  CELL  COM
*STEADYST010   WLEVC  2.150  3.54   27     1    14     1    25     1    26
*STEADYST040   PRESC 7.163E6  0.25  14     1    14
**************   CONTROLLER CHANGE CARDS
***
*CNTRL90987   2.0  40.0   1.0    1.E+50    -1.E+50     3.054E-03
*CNTRL90983   0.0    0.0   1.0   1.E+50    -1.E+50     -.1957
*CNTRL90984   1.0   0.0   1.0    755.     -745.0       -.0484
*CNTRL90985   2.15  0.0   1.0   1.E+50   -1.E+50       2.15
*CNTRL90986   0.0   0.0   1.0   1.E+50   -1.E+50       9.9101E-03
*CNTRL90988    0.0   0.0   1.0   1.E+50    -1.E+50     3.4904
*CNTRL90989   0.0   0.0   1.0   1.E+50   -1.E+50       .10542
*CNTRL90990   1.0   0.5   1.0   755.0   -745.0         .0558
*CNTRL90991   3.54  0.0   1.0   1.E+50   -1.E+50       3.54
*CNTRL90992   0.0   0.0   1.0   10.0   0.0             3.49
*CNTRL90993   0.0   0.0   1.0   1.E+50   -1.E+50       445.5
*CNTRL90994   .35   0.0   1.0   1.0   -1.0             8.921E-03
*CNTRL90995   7.16E+06   0.0   1.0   1.E+50  -1.E+50   7.163E+06
*CNTRL90996   0.0   0.0   1.0   1.E+50   -1.E+50       .399
*CNTRL90997   2.7-05   1.E-05   1.0   1.0   -1.0       8.914E-03
*CNTRL90998   .25   0.0   1.0   1.E+50   -1.E+50       .250
*CNTRL90999   0.0   0.0   1.0   1.0   0.0              .2589
$
$$$$$$    TEE HEADER CARD
TEE01000  1 " LOOP SUCTION PIPE  MASS FLOW   "
$$$$$$     TEE PARAMETER CARD
*         JCELL  NODES  MATID        COST    ICHF   IPVHT NCELL1
```

```
TEE01010       4       1       6  1.00000000E+00       0       0      10
*          JUN1    JUN2    ITRP
TEE01011       4       5       0
*              RADIN1          TH1       HOUTL1       HOUTV1
TEE01012  3.68300000E-02  7.60000000E-03   .00000000E+00   .00000000E+00
*              TOUTL1          TOUTV1
TEE01013  5.47000000E+02  5.47000000E+02
*         NCELL2   JUN3       RADIN2            TH2
TEE01020       1      22  3.5[illegible]000000E-02  7.60000000E-03
*              HOUTL2          HOUTV2         TOUTL2         TOUTV2
TEE01021   .00000000E+00   .00[illegible]00000E+00  5.47000000E+02  5.47000000E+02
*         IHTS     IWT
TEE01050       0       0
*****      DX
TEE01DX0        2.60400000E-01        2.79400000E-01        2.42900000E-01
TEE01DX1        2.40900000E+00        2.72900000E+00        1.36400000E+00
TEE01DX2        1.02200000E+00        2.04500000E+00        1.02200000E+00
TEE01DX3        4.96900000E-01 E
*****      VOL
TEE01VOL0         1.09600000E-03        1.19100000E-03        1.03500000E-03
TEE01VOL1         1.02700000E-02        1.16300000E-02        5.8[illegible]200000E-03
TEE01VOL2         4.35500000E-03        8.71400000E-03        4.35500000E-03
TEE01VOL3         2.11700000E-03 E
*****      FA
TEE01FA0        3.08900000E-03        4.26100000E-03        2.797400E-04
TEE01FA1   R08  4.26100000E-03 E
*****      FKLOS
TEE01FKLOS0        1.50000E-00        3.50000E-01        3.20000E+00
TEE01FKLOS1  R03    .00000E+00        3.50000E-01 R02     .00000E+00
TEE01FKLOS2        3.50000000E-01          .00000000E+00 E
*****      RKLOS
TEE01RKLOS0        1.50000E-01        8.70000E-01        [illegible].20000E+00
TEE01RKLOS1  R03    .00000E+00        3.50000E-01 R02     .00000E+00
TEE01RKLOS2        3.50000000E-01          .00000000E+00 E
*****      GRAV
TEE01GRAV0         1.00000000E+00        4.82400000E-01 R04    .00000000E+00
TEE01GRAV1        -4.28400000E-01 R02 -1.00000000E+00       -6.72900000E-01
TEE01GRAV2         3.00600000E-01 E
*****      HD
TEE01HD0       6.27000E-02        7.36600E-02        1.88730E-02
TEE01HD1   R08  7.35600000E-02 E
*****      EPSD
TEE01EPSD0   R09  6.00000000E-04 R02  6.00000000E-04 E
*****      ICHOKE
TEE01ICHOKE0  R02              0               1 R08              0 E
*****      ICCFL
TEE01ICCFL0  R09              0 R02            0 E
*****      ALP
TEE01ALP0         6.80677199E-10        5.96646388E-11        6.81190850E-12
TEE01ALP1         9.38650251E-14        1.15078335E-15        2.80865019E-17
TEE01ALP2         9.25979566E-19        6.58819767E-20        2.96670601E-20
TEE01ALP3         5.57535666E-20 E
*****      VL
TEE01VL0        1.53704575E+00        1.11427976E+00        1.67181378E+01
TEE01VL1   R06  1.11470554E+00 R02  1.11468265E+00 E
*****      VV
TEE01VV0        1.75660697E+00        1.28307135E+00        1.70958498E+01
TEE01VV1        1.27034070E+00 R02  1.27000125E+00        1.25645863E+00
TEE01VV2        1.23853009E+00        1.23850217E+00        1.24865120E+00
TEE01VV3        1.27924336E+00 E
*****      TL
TEE01TL0        5.47136696E+02        5.47128013E+02        5.47005167E+02
TEE01TL1        5.46968384E+02        5.47026997E+02        5.47087390E+02
TEE01TL2        5.47153291E+02        5.47365906E+02        5.47492949E+02
TEE01TL3        5.47558441E+02 E
*****      TV
```

```
TEE01TV0        5.60741667E+02      5.60728319E+02 R04  5.57164116E+02
TEE01TV1        5.57193194E+02      5.57305265E+02      5.57417162E+02
TEE01TV2        5.57452520E+02 E
*****      P
TEE01P0       7.18069712E+06      7.17920048E+06      6.81128272E+06
TEE01P1       6.81114768E+06      6.81080551E+06      6.81067681E+06
TEE01P2       6.81422442E+06      6.82557166E+06      6.83691582E+06
TEE01P3       6.84050352E+06 E
*****      QPPP
TEE01QPPP0  R09   .00000000E+00        .00000000E+00 E
*****      TW
TEE01TW0        5.47136570E+02      5.47127987E+02      5.47005141E+02
TEE01TW1        5.46968305E+02      5.47027108E+02      5.47087620E+02
TEE01TW2        5.47153620E+02      5.47366436E+02      5.47493575E+02
TEE01TW3        5.47559113E+02 E
*****      DX
TEE01DXS0         2.74000000E+00 E
*****      VOL
TEE01VOLS0         1.16800000E-02 E
*****      FA
TEE01FAS0         4.26100000E-03       4.2610E-03    E
*****      FKLOS
TEE01FKLOSS0  R02    .00000000E+00 E
*****      RKLOS
TEE01RKLOSS0  R02    .00000000E+00 E
*****      GRAV
TEE01GRAVS0  R02  1.00000000E+00 E
*****      HD
TEE01HDS0     R02    7.36600E-02     E
*****      EPSD
TEE01EPSDS0  R02    .00000000E+00 E
*****      ICHOKE
TEE01ICHOKES0              0            1   E
*****      ICCFL
TEE01ICCFLS0  R02          0 E
*****      ALP
TEE01ALPS0         1.28136268E-17 E
*****      VL
TEE01VLS0       -2.42367656E-06       .00000000E+00 E
*****      VV
TEE01VVS0         1.37689037E-02       .00000000E+00 E
*****      TL
TEE01TLS0         5.47025125E+02 E
*****      TV
TEE01TVS0         5.56971456E+02 E
*****      P
TEE01PS0       6.79181667E+06 E
*****      QPPP
TEE01QPPPS0           .00000000E+00 E
*****      TW
TEE01TWS0         5.47025147E+02 E
$
$$$$$$     PUMP HEADER CARD
PUMP02000   2 "LOOP PUMP - MASS FLOW    "
$$$$$$     PUMP PARAMETER CARD
*          NCELLS  NODES   JUN1    JUN2     MAT
PUMP02010       6      3      5       6       9
*            ICHF  IPVHT IPMPTY IPFACE     IRP     IPM IPMPTR NPMPTX
PUMP02011       0      0      1      2       0       0      1     28
*               RADIN              TH              HOUTL              HOUTV
PUMP02013  3.68300000E-02  7.62000000E-03  1.17200000E+01  1.17200000E+01
*               TOUTL            TOUTV
PUMP02016  5.51000000E+02  5.51000000E+02
*               RHEAD            RTORK           RFLOW              RRHO
PUMP02020  2.12390000E+03  7.59250000E+01  7.57080000E-03  7.56050000E+02
*               ROMEGA           EFFMI           TFR1               TFR2
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PUMP02021   3.71760000E+02   1.03240000E+00    .00000000E+00    .00000000E+00
*             OMEGAN            OPTION
PUMP02022   3.37000000E+02        0
*
PUMP02030   11  11  11  11   2   2   2   2  11  11  11  11   2   2   2
PUMP02031    2  11   7
*****       HSP1
PUMP02HSP10       -1.00000000E+00        1.60000000E+00        -8.00000000E-01
PUMP02HSP11        1.35000000E+00       -6.00000000E-01         1.23000000E+00
PUMP02HSP12       -4.00000000E-01        1.16000000E+00        -2.00000000E-01
PUMP02HSP13        1.13000000E+00         .00000000E+00         1.12000000E+00
PUMP02HSP14        2.00000000E-01        1.11000000E+00         4.00000000E-01
PUMP02HSP15        1.10000000E+00        6.00000000E-01         1.09000000E+00
PUMP02HSP16        8.00000000E-01        1.06000000E+00  R02   1.00000000E+00  E
*****       HSP2
PUMP02HSP20       -1.00000000E+00       -4.00000000E-01        -8.00000000E-01
PUMP02HSP21       -5.10000000E-01       -6.00000000E-01        -5.40000000E-01
PUMP02HSP22       -4.00000000E-01       -5.60000000E-01        -2.00000000E-01
PUMP02HSP23       -5.80000000E-01         .00000000E+00        -5.60000000E-01
PUMP02HSP24        2.00000000E-01       -5.20000000E-01         4.00000000E-01
PUMP02HSP25       -4.60000000E-01        6.00000000E-01        -3.30000000E-01
PUMP02HSP26        8.00000000E-01         .00000000E+00  R02   1.00000000E+00  E
*****       HSP3
PUMP02HSP30       -1.00000000E+00        1.60000000E+00        -8.00000000E-01
PUMP02HSP31        1.22000000E+00       -6.00000000E-01         1.01000000E+00
PUMP02HSP32       -4.00000000E-01        8.80000000E-01        -2.00000000E-01
PUMP02HSP33        7.80000000E-01         .00000000E+00         7.10000000E-01
PUMP02HSP34        2.00000000E-01        6.90000000E-01         4.00000000E-01
PUMP02HSP35        7.00000000E-01        6.00000000E-01         7.60000000E-01
PUMP02HSP36        8.00000000E-01        8.40000000E-01  R02   1.00000000E+00  E
*****       HSP4
PUMP02HSP40       -1.00000000E+00       -4.00000000E-01        -8.00000000E-01
PUMP02HSP41       -2.40000000E-01       -6.00000000E-01        -8.00000000E-02
PUMP02HSP42       -4.00000000E-01        1.30000000E-01        -2.00000000E-01
PUMP02HSP43        4.80000000E-01         .00000000E+00         6.40000000E-01
PUMP02HSP44        2.00000000E-01        6.90000000E-01         4.00000000E-01
PUMP02HSP45        7.00000000E-01        6.00000000E-01         7.60000000E-01
PUMP02HSP46        8.00000000E-01        8.40000000E-01  R02   1.00000000E+00  E
*****       HTP1
PUMP02HTP10       -1.00000000E+00         .00000000E+00         1.00000000E+00
PUMP02HTP11         .00000000E+00  E
*****       HTP2
PUMP02HTP20       -1.00000000E+00         .00000000E+00         1.00000000E+00
PUMP02HTP21         .00000000E+00  E
*****       HTP3
PUMP02HTP30       -1.00000000E+00         .00000000E+00         1.00000000E+00
PUMP02HTP31         .00000000E+00  E
*****       HTP4
PUMP02HTP40       -1.00000000E+00         .00000000E+00         1.00000000E+00
PUMP02HTP41         .00000000E+00  E
*****       TSP1
PUMP02TSP10       -1.00000000E+00        1.00000000E+00        -8.00000000E-01
PUMP02TSP11        7.20000000E-01       -6.00000000E-01         5.40000000E-01
PUMP02TSP12       -4.00000000E-01        4.20000000E-01        -2.00000000E-01
PUMP02TSP13        4.20000000E-01         .00000000E+00         6.00000000E-01
PUMP02TSP14        2.00000000E-01        7.00000000E-01         4.00000000E-01
PUMP02TSP15        7.90000000E-01        6.00000000E-01         8.80000000E-01
PUMP02TSP16        8.00000000E-01        9.50000000E-01  R02   1.00000000E+00  E
*****       TSP2
PUMP02TSP20       -1.00000000E+00       -2.50000000E+00        -8.00000000E-01
PUMP02TSP21       -2.15000000E+00       -6.00000000E-01        -1.73000000E+00
PUMP02TSP22       -4.00000000E-01       -1.22000000E+00        -2.00000000E-01
PUMP02TSP23       -7.60000000E-01         .00000000E+00        -4.20000000E-01
PUMP02TSP24        2.00000000E-01       -1.70000000E-01         4.00000000E-01
PUMP02TSP25        4.00000000E-02        6.00000000E-01         3.00000000E-01
PUMP02TSP26        8.00000000E-01        6.70000000E-01  R02   1.00000000E+00  E
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*****      TSP3
PUMP02TSP30    -1.00000000E+00      1.00000000E+00      -8.00000000E-01
PUMP02TSP31     9.80000000E-01     -6.00000000E-01       9.50000000E-01
PUMP02TSP32    -4.00000000E-01      9.10000000E-01      -2.00000000E-01
PUMP02TSP33     8.70000000E-01       .00000000E+00       8.30000000E-01
PUMP02TSP34     2.00000000E-01      7.60000000E-01       4.00000000E-01
PUMP02TSP35     7.20000000E-01      6.00000000E-01       6.40000000E-01
PUMP02TSP36     8.00000000E-01      5.60000000E-01       1.00000000E+00
PUMP02TSP37     5.00000000E-01 E
*****      TSP4
PUMP02TSP40    -1.00000000E+00     -2.50000000E+00      -8.00000000E-01
PUMP02TSP41    -2.31000000E+00     -6.00000000E-01      -2.03000000E+00
PUMP02TSP42    -4.00000000E-01     -1.62000000E+00      -2.00000000E-01
PUMP02TSP43    -1.04000000E+00       .00000000E+00      -6.10000000E-01
PUMP02TSP44     2.00000000E-01     -3.50000000E-01       4.00000000E-01
PUMP02TSP45    -1.20000000E-01      6.00000000E-01       6.00000000E-02
PUMP02TSP46     8.00000000E-01      2.40000000E-01       1.00000000E+00
PUMP02TSP47     5.00000000E-01 E
*****      TTP1
PUMP02TTP10    -1.00000000E+00       .00000000E+00       1.00000000E+00
PUMP02TTP11      .00000000E+00 E
*****      TTP2
PUMP02TTP20    -1.00000000E+00       .00000000E+00       1.00000000E+00
PUMP02TTP21      .00000000E+00 E
*****      TTP3
PUMP02TTP30    -1.00000000E+00       .00000000E+00       1.00000000E+00
PUMP02TTP31      .00000000E+00 E
*****      TTP4
PUMP02TTP40    -1.00000000E+00       .00000000E+00       1.00000000E+00
PUMP02TTP41      .00000000E+00 E
*****      HDM
PUMP02HDM0  R02  .00000000E+00      1.00000000E-01       .00000000E+00
PUMP02HDM1      1.50000000E-01      5.00000000E-02       2.40000000E-01
PUMP02HDM2      8.00000000E-01      3.00000000E-01       9.60000000E-01
PUMP02HDM3      4.00000000E-01      9.80000000E-01       6.00000000E-01
PUMP02HDM4      9.70000000E-01      8.00000000E-01 R02   9.00000000E-01
PUMP02HDM5      8.00000000E-01      9.60000000E-01       5.00000000E-01
PUMP02HDM6      1.00000000E+00       .00000000E+00 E
*****      TDM
PUMP02TDM0  R02  .00000000E+00      1.00000000E-01       .00000000E+00
PUMP02TDM1      1.50000000E-01      5.00000000E-02       2.40000000E-01
PUMP02TDM2      5.60000000E-01      8.00000000E-01       5.60000000E-01
PUMP02TDM3      9.60000000E-01      4.50000000E-01       1.00000000E+00
PUMP02TDM4       .00000000E+00 E
*          IHTS    IWT
PUMP02050      0      0
*****      SPTBL
PUMP02SPTBL0       .00000E+00      3.37000E+02      2.45000E-01
PUMP02SPTBL1      3.24900E+02      4.45000E-01      3.06300E+02
PUMP02SPTBL2      6.47000E-01      2.8810E+02       8.47000E-01
PUMP02SPTBL3      2.72200E+02      1.0500E+00       2.58200E+02
PUMP02SPTBL4      1.45000E+00      2.3330E+02       2.05500E+00
PUMP02SPTBL5      2.06400E+02      3.0620E+00       1.72100E+02
PUMP02SPTBL6      4.10900E+00      1.4570E+02       5.11400E+00
PUMP02SPTBL7      1.26400E+02      6.1210E+00       1.10200E+02
PUMP02SPTBL8      7.12600E+00      0.9820E+02       8.13400E+00
+                 8.8000E+01      9.14000E+00      7.97000E+01
+                 1.0150E+01      7.27000E+01      1.22400E+01
+                 6.0800E+01      1.40500E+01      5.28000E+01
+                 1.6060E+01      4.54000E+01      1.81200E+01
+                 3.9400E+01      2.01700E+01      3.43000E+01
+                 2.2180E+01      2.92000E+01      2.42000E+01
+                 2.4600E+01      2.50400E+01      2.30000E+01
+                 3.0070E+01      1.35000E+01      3.51400E+01
+                 5.2000E+00      3.81600E+01      0.00000E+00
PUMP02SPTBL9      4.00000E+02      0.00000E+00 E
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*****     DX
PUMP02DX0          4.96900000E-01          3.04800000E-01          2.20000000E+00
PUMP02DX1          8.25500000E-01 R02  8.02500000E-01 E
*****     VOL
PUMP02VOL0         2.11700000E-03          3.47500000E-04          2.50900000E-03
PUMP02VOL1         9.41200000E-04 R02  9.14900000E-04 E
*****     FA
PUMP02FA0  R02  4.26100000E-03          1.14000000E-03          3.80000000E-04
PUMP02FA1  R03  1.14000000E-03 E
*****     FKLOS
PUMP02FKLOS0  R02   .00000000E+00          7.20000000E-01          2.25000000E+00
PUMP02FKLOS1       4.00000000E-01 R02    .00000000E+00 E
*****     RKLOS
PUMP02RKLOS0  R02   .00000000E+00          7.20000000E-01          2.25000000E+00
PUMP02RKLOS1       4.00000000E-01 R02    .00000000E+00 E
*****     GRAV
PUMP02GRAV0        3.00600000E-01           .00000000E+00 R02  1.00000000E+00
PUMP02GRAV1        5.07100000E-01 R02    .00000000E+00 E
*****     HD
PUMP02HD0  R02  7.36600000E-02          3.81000000E-02          2.20000000E-02
PUMP02HD1  R03  3.81000000E-02 E
*****     EPSD
PUMP02EPSD0  R02  6.00000000E-04           .00000000E+00 R04  1.20000000E-03 E
*****     ICHOKE
PUMP02ICHOKE0  R03          0               0 R03          0 E
*****     ICCFL
PUMP02ICCFL0  R07          0 E
*****     ALP
PUMP02ALP0         8.54727879E-20          3.98334709E-20          4.10742095E-20
PUMP02ALP1         1.21622449E-20          6.96635569E-20          3.15897674E-20 E
*****     VL
PUMP02VL0  R02  1.11467912E+00          4.16021937E+00          1.24810989E+01
PUMP02VL1  R02  4.16137051E+00          4.16145933E+00 E
*****     VV
PUMP02VV0          1.27924336E+00          1.11468268E+00          4.44542702E+00
PUMP02VV1          1.29034751E+01          4.43259678E+00          4.40924000E+00
PUMP02VV2          4.40895977E+00 E
*****     TL
PUMP02TL0          5.47627020E+02          5.48096286E+02          5.48185585E+02
PUMP02TL1          5.48148482E+02          5.48180796E+02          5.48215559E+02 E
*****     TV
PUMP02TV0          5.57440988E+02          5.70567736E+02          5.70426518E+02
PUMP02TV1          5.68450983E+02          5.68375652E+02          5.68350710E+02 E
*****     P
PUMP02P0           8.83933330E+06          8.27582934E+06          8.25922427E+06
PUMP02P1           8.02963395E+06          8.02097848E+06          8.01811429E+06 E
*****     QPPP
PUMP02QPPP0  R06   .00000000E+00 E
*****     TW
PUMP02TW0  R02  5.47640006E+02          5.47653289E+02 R02  5.48101650E+02
PUMP02TW1          5.48113173E+02 R02  5.48187431E+02          5.48198651E+02
PUMP02TW2  R02  5.48150353E+02          5.48161724E+02 R02  5.48184179E+02
PUMP02TW3          5.48195429E+02 R02  5.48218907E+02          5.48230032E+02 E
$
$$$$$$     VALVE HEADER CARD
VALVE03000    3 "LOOP BLOCK VALVE    "
$$$$$$     VALVE PARAMETER CARD
*          NCELLS   NODES    JUN1    JUN2     MAT    ICHF   IPVHT
VALVE03010      2       0       6       7       6       0       0
*                 RADIN           TH           HOUTL          HOUTV
VALVE03011  1.90500000E-02  5.08000000E-03   .00000000E+00   .00000000E+00
*                 TOUTL          TOUTV
VALVE03012  5.47000000E+02  5.47000000E+02
*            IVTY    IVTR    NVTX    IVPG    IVGS          AVLVE
VALVE03020      3       ?       3       0       2  4.73100000E-04
*                 HVLVE          PVC1          PVC2         ALEAK        DELSTP
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VALVE03021  2.45400000E-02   .00000000E+00   .00000000E+00   .00000000E+00   .00
*          IHTS    IWT
VALVE03050      0      0
*****      DX
VALVE03DX0  R02  6.80000000E-01 E
*****      VOL
VALVE03VOL0  R02  7.75200000E-04 E
VALVE03FA0       1.14000000E-03      4.73100000E-04      1.14000000E-03 E
*****      FKLOS
VALVE03FKLOS0        .00000000E+00      3.50000000E+00       .00000000E+00 E
*****      RKLOS
VALVE03RKLOS0        .00000000E+00      3.50000000E+00       .00000000E+00 E
*****      GRAV
VALVE03GRAV0  R03   .00000000E+00 E
*****      HD
VALVE03HD0       3.81000000E-02      2.45400000E-02      3.81000000E-02 E
*****      EPSD
VALVE03EPSD0  R03  1.20000000E-03 E
*****      ICHOKE
VALVE03ICHOKE0  R03          0      E
*****      ICCFL
VALVE03ICCFL0  R03          0 E
*****      ALP
VALVE03ALP0       3.97314944E-20      3.44575942E-20 E
*****      VL
VALVE03VL0       4.16145932E+00      1.00276392E+01      4.16213731E+00 E
*****      VV
VALVE03VV0       4.40895977E+00      1.03682742E+01      4.41221787E+00 E
*****      TL
VALVE03TL0       5.48243739E+02      5.48223035E+02 E
*****      TV
VALVE03TV0       5.68327661E+02      5.66954353E+02 E
*****      P
VALVE03P0       8.01546822E+06      7.85902684E+06 E
*****      VLTB
VALVE03VLTB0        .00000000E+00      1.00000000E+00      5.00000000E-01
VALVE03VLTB1        .00000000E+00      1.00000000E+03       .00000000E+00 E
$
$$$$$$     TEE HEADER CARD
TEE16000 16 " PUMP DISCHARGE      "
$$$$$$     TEE PARAMETER CARD
*          JCELL  NODES  MATID        COST   ICHF  IPVHT NCELL1
TEE16010      1      1      6   .00000000E+00      0      0      4
*           JUN1   JUN2   ITRP
TEE16011      7      8      0
*              RADIN1          TH1       HOUTL1       HOUTV1
TEE16012  1.90000000E-02  5.00000000E-03  .00000000E+00   .00000000E+00
*              TOUTL1         TOUTV1
TEE16013  5.47000000E+02  5.47000000E+02
*        NCELL2   JUN3      RADIN2          TH2
TEE16020      2     23  2.50000000E-02  7.00000000E-03
*              HOUTL2         HOUTV2       TOUTL2       TOUTV2
TEE16021   .00000000E+00   .00000000E+00  5.47000000E+02  5.47000000E+02
*          IHTS    IWT
TEE16050      0      0
*****      DX
TEE16DX0       3.04800000E-01 R02  1.13900000E+00      3.55600000E-01 E
*****      VOL
TEE16VOL0        3.47500000E-04 R02  1.30000000E-03      1.58500000E-04 E
*****      FA
TEE16FA0   R04  1.14000000E-03      4.45800000E-04 E
*****      FKLOS
TEE16FKLOS0  R02  4.00000000E-01       .00000000E+00      2.50000000E-01
TEE16FKLOS1        .00000000E+00 E
*****      RKLOS
TEE16RKLOS0  R02  4.00000000E-01       .00000000E+00      2.50000000E-01
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TEE16RKLOS1          .00000000E+00 E
*****       GRAV
TEE16GRAV0         1.00000000E+00        3.34100000E-01 R02    .00000000E+00
TEE16GRAV1         7.62500000E-01 E
*****       HD
TEE16HD0    R04  3.81000000E-02       2.38300000E-02 E
*****       EPSD
TEE16EPSD0   R03  1.20000000E-03 R02  1.80000000E-03 E
*****       ICHOKE
TEE16ICHOKE0  R05           0 E
*****       ICCFL
TEE16ICCFL0  R05            0 E
*****       ALP
TEE16ALP0          4.65418120E-20       4.89619691E-20       5.24760778E-20
TEE16ALP1          9.04636915E-20 E
*****       VL
TEE16VL0    R03  4.16213731E+00       4.16220720E+00       1.06440656E+01 E
*****       VV
TEE16VV0         4.41221787E+00       4.42512504E+00       4.41075007E+00
TEE16VV1         4.54137986E+00       1.10454800E+01 E
*****       TL
TEE16TL0         5.48236150E+02       5.48285171E+02 R02  5.48336140E+02 E
*****       TV
TEE16TV0         5.66938798E+02       5.66876681E+02       5.66840691E+02
TEE16TV1         5.66474026E+02 E
*****       P
TEE16P0        7.85726852E+06       7.85025013E+06       7.84618607E+06
TEE16P1        7.80487379E+06 E
*****       QPPP
TEE16QPPP0  R04    .00000000E+00 E
*****       TW
TEE16TW0         5.48236324E+02       5.48285347E+02 R02  5.48336319E+02 E
*****       DX
TEE16DXS0   R02  1.40000000E+00 E
*****       VOL
TEE16VOLS0         1.56400000E-03       2.60000000E-03 E
*****       FA
TEE16FAS0          1.1400000E-03       1.904000E-03        5.200E-05   E
*****       FKLOS
TEE16FKLOSS0  R03    .00000000E+00 E
*****       RKLOS
TEE16RKLOSS0  R03    .00000000E+00 E
*****       GRAV
TEE16GRAVS0  R02  1.00000000E+00         .00000000E+00 E
*****       HD
TEE16HDS0          3.81000E-02     4.9000E-02   8.137E-03    E
*****       EPSD
TEE16EPSDS0  R03    .00000000E+00 E
*****       ICHOKE
TEE16ICHOKES0  R02          0            1      E
*****       ICCFL
TEE16ICCFLS0  R03           0 E
*****       ALP
TEE16ALPS0  R02    .00000000E+00 E
*****       VL
TEE16VLS0          1.02368009E-05       5.91837145E-06        .00000000E+00 E
*****       VV
TEE16VVS0          1.17522447E-02       1.17732405E-02        .00000000E+00 E
*****       TL
TEE16TLS0          5.46855489E+02       5.46831266E+02 E
*****       TV
TEE16TVS0          5.66882071E+02       5.66788765E+02 E
*****       P
TEE16PS0         7.85085900E+06       7.81032522E+06 E
*****       QPPP
TEE16QPPPS0  R02    .00000000E+00 E
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*****      TW
TEE16TWS0        5.46855428E+02       5.46831199E+02 E
$
$$$$$$     JETP HEADER CARD
JETP04000  4 "LOOP JET PUMP      "
$$$$$$      JETP PARAMETER CARD
*          JCELL  NODES  MATID         COST   ICHF  IPVHT NCELL1
JETP04010      1      3      6  1.00000000E+00       0      0      3
*           JUN1   JUN2   ITRP
JETP04011     28      9      0
*              RADIN1           TH1        HOUTL1        HOUTV1
JETP04012  2.69880000E-02  4.76250000E-03   .00000000E+00   .00000000E+00
*              TOUTL1         TOUTV1
JETP04013  5.54820000E+02  5.54820000E+02
*        NCELL2   JUN3       RADIN2          TH2
JETP04020      2      8  1.18110000E-02  3.96240000E-03
*              HOUTL2         HOUTV2        TOUTL2        TOUTV2
JETP04021   .00000000E+00   .00000000E+00  5.54820000E+02  5.54820000E+02
*           NJETP
JETP04060      1
*              EPSDFF        EPSDFR       EPSNZF        EPSNZR
JETP04070  5.50000E+00  3.80000E-01  5.50000E+00  3.80000E-01
*              FINLET         FOTLET
JETP04071  4.00000000E-02  4.50000000E-01
*          IHTS    IWT
JETP04050      0      0
*****      DX
JETP04DX0        2.89800000E-01       3.49900000E-01       7.26500000E-01 E
*****      VOL
JETP04VOL0        1.22700000E-04       4.31100000E-04       1.66200000E-03 E
*****      FA
JETP04FA0        3.19300000E-04       4.23300000E-04 R02  2.28800000E-03 E
*****      FKLOS
JETP04FKLOS0  R04    .00000000E+00 E
*****      RKLOS
JETP04RKLOS0  R04    .00000000E+00 E
*****      GRAV
JETP04GRAV0  R04 -1.00000000E+00 E
*****      HD
JETP04HD0        2.01600000E-02       2.32200000E-02 R02  5.39700000E-02 E
*****      EPSD
JETP04EPSD0  R04    .00000000E+00 E
*****      ICHOKE
JETP04ICHOKE0                1 R03            0 E
*****      ICCFL
JETP04ICCFL0                 1 R03            0 E
*****      ALP
JETP04ALP0        8.98479658E-13       3.03387163E-13       3.79565746E-14 E
*****      VL
JETP04VL0        2.19159829E+01       2.77554769E+01       5.13300211E+00
JETP04VL1        5.13285941E+00 E
*****      VV
JETP04VV0        2.25993976E+01       2.80014998E+01       5.29494811E+00
JETP04VV1        5.32030953E+00 E
*****      TL
JETP04TL0        5.47574387E+02       5.47696518E+02       5.47714249E+02 E
*****      TV
JETP04TV0        5.58397377E+02       5.61992685E+02       5.62246935E+02 E
*****      P
JETP04P0        6.93691848E+06       7.31348302E+06       7.34070139E+06 E
*****      QPPP
JETP04QPPP0  R03    .00000000E+00 E
*****      TW
JETP04TW0  R03  5.47574900E+02 R03  5.47696539E+02 R03  5.47714305E+02 E
*****      DX
JETP04DXS0        3.52500000E-01       3.93900000E-01 E
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*****       VOL
JETP04VOLS0         8.99020000E-C        1.75600000E-04 E
*****       FA
JETP04FAS0        1.04000000E-04 R02  4.45800000E-04 E
*****       FKLOS
JETP04FKLOSS0  R03    .00000000E+00 E
*****       RKLOS
JETP04RKLOSS0  R03    .00000000E+00 E
*****       GRAV
JETP04GRAVS0         1.00000000E+00      -1.00000000E+00       -7.62500000E-01 E
*****       HD
JETP04HDS0  R03  2.38300000E-02 E
*****       EPSD
JETP04EPSDS0  R03    .00000000E+00 E
*****       ICHOKE
JETP04ICHOKES0  R03            0 E
*****       ICCFL
JETP04ICCFLS0  R03            0 E
*****       ALP
JETP04ALPS0         9.17835327E-20       9.11880919E-20 E
*****       VL
JETP04VLS0        -4.56317913E+01      -1.06442703E+01      -1.06440656E+01 E
*****       VV
JETP04VVS0        -4.61894734E+01      -1.12072142E+01      -1.10454800E+01 E
*****       TL
JETP04TLS0         5.48304767E+02       5.48331910E+02 E
*****       TV
JETP04TVS0         5.65431734E+02       5.66317053E+02 E
*****       P
JETP04PS0        7.68836093E+06       7.78723937E+06 E
*****       QPPP
JETP04QPPPS0  R02    .00000000E+00 E
*****       TW
JETP04TWS0  R03  5.48304797E+02 R03  5.48331973E+02 E
$
$$$$$$     BREAK HEADER CARD
BREAK05000    5 * BREAK SUCTION SIDE                            *
*              JUN1   IBROP   NBTB   ISAT   ICOMT
BREAK05010      22       1       3      3      0
*                   DXIN         VOLIN        ALPIN         TIN
BREAK05011  2.74000E+00  1.0000E+05  1.0000E+00  3.73000000E+02
*                   PIN,
BREAK05012  1.00000000E+05
*****      PTB
BREAK05PTB0         .00000000E+00       6.70000000E+06       1.00000000E-01
BREAK05PTB1        1.00000000E+05       4.00000000E+02       1.00000000E+05 E
$
$$$$$$     BREAK HEADER CARD
BREAK13000  13 * BREAK DISCHARGE SIDE                           *
*              JUN1   IBROP   NBTB   ISAT   ICOMT
BREAK13010      23       1       3      3      0
*                   DXIN         VOLIN        ALPIN         TIN
BREAK13011  1.40000E+00  1.5000E+05  1.0000E+00  3.73000E+02
*                   PIN,
BREAK13012  1.00000000E+05
*****      PTB
BREAK13PTB0        .00000E+00       7.80000E+06       1.00000E-01
BREAK13PTB1       1.00000E+05       4.00000E+02       1.00000E+05    E
$
$$$$$$     PIPE HEADER CARD
PIPE06000  6 *  GUIDETUBE PIPE                         *
$$$$$$     PIPE PARAMETER CARD
*         NCELLS  NODES   JUN1   JUN2    MAT
PIPE06010      5      3     32     33      6
*            ICHF  IPVHT        RADIN           TH
PIPE06011      0     27  2.57300000E-01  2.11000000E-02
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*                HOUTL          HOUTV          TOUTL          TOUTV
PIPE06012    .00000000E+00   .00000000E+00  5.50000000E+02  5.50000000E+02
*           IHTS     IWT
PIPE06050      0        0
*           NCLK    FALK          CLOS           VMLK           DELZLK
PIPE06040       5  5.8570000E-05  5.0000000E+00 -7.4706415E+00    .0000000E+00
*           NCMPTO NCLKTO  NLEVTO
PIPE06041     27       1       4
*****       DX
PIPE06DX0          8.8900E-02     4.8/71E-01     4.0881E-01
PIPE06DX1          1 1578E-01     1.0910E-01     E
*****       VOL
PIPE06VOL0  R04  1.05700000E-02       1.29800000E-02 E
*****       FA
PIPE06FA0  R05  4.85600000E-02       4.56000000E-03 E
*****       FKLOS
PIPE06FKLOS0  R06   .00000000E+00 E
*****       RKLOS
PIPE06RKLOS0  R06   .00000000E+00 E
*****       GRAV
PIPE06GRAV0  R06  1.00000000E+00 E
*****       HD
PIPE06HD0  R05  1.24300000E-01       3.81000000E-02 E
*****       EPSD
PIPE06EPSD0  R06   .00000000E+00 E
*****       ICHOKE
PIPE06ICHOKE0  R06           0 E
*****       ICCFL
PIPE06ICCFL0  R06           0 E
*****       ALP
PIPE06ALP0          3.03739703E-22 R02   .00000000E+00       1.17289371E-22
PIPE06ALP1          1.87316894E-15 E
*****       VL
PIPE06VL0            .00000000E+00       1.00198608E-06       2.00398694E-06
PIPE06VL1           2.84405816E-06       3.68413961E-06       9.60055347E-02 E
*****       VV
PIPE06VV0            .00000000E+00       1.29779911E-02       1.29828183E-02
PIPE06VV1           1.29868004E-02       1.30034319E-02       1.43783880E-01 E
*****       TL
PIPE06TL0  R02  5.47161456E+02 R02  5.47143447E+02       5.47776339E+02 E
*****       TV
PIPE06TV0           5.61291529E+02       5.61276111E+02       5.61260691E+02
PIPE06TV1           5.61245267E+02       5.61225474E+02 E
*****       P
PIPE06P0          7.23882787E+06       7.23719299E+06       7.23555809E+06
PIPE06P1          7.23392315E+06       7.23182541E+06 E
*****       QPPP
PIPE06QPPP0  R05   .00000000E+00 E
*****       TW
PIPE06TW0           5.47520140E+02       5.47650107E+02       5.47774457E+02
PIPE06TW1           5.47520140E+02       5.47650106E+02       5.47774456E+02
PIPE06TW2           5.47457903E+02       5.47566957E+02       5.47671505E+02
PIPE06TW3           5.47457903E+02       5.47566957E+02       5.47671506E+02
PIPE06TW4  R02  5.47787545E+02       5.47795916E+02 E
*****       KLVC
PIPE06KLVC0        1      2      3      4      5       E
*****       KRVC
PIPE06KRVC0  R05          1        E
$
$$$$$$      FILL HEADER CARD
FILL07000     7 *  ZERO VELOCITY FILL                               *
*              JUN1    IFTY    IFTR    NFTX   ICOMT
FILL07010       32       1       0       0       0
*                DXIN          VOLIN          ALPIN          VIN
FILL07011  2.17700000E-01  1.05700000E-02   .00000000E+00   .00000000E+00
*                TIN            PIN         BORCIN
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FILL07012  5.54820000E+02  7.17740000E+06
$
$$$$$$    VALVE HEADER CARD
*origVALVE08000    8 *INT SUCTN LINE ; PIPE & VALVE          *
VALVE08000   8 *INT SUCTN LINE , PIPE AND VALVE        *
$$$$$$    VALVE PARAMETER CARD
*           NCELLS  NODES    JUN1    JUN2     MAT    ICHF  IPVHT
VALVE08010       9      3      26       2       9       0      0
*                 RADIN           TH         HOUTL          HOUTV
VALVE08011  3.68300000E-02  7.62000000E-03  1.16800000E+01  1.16800000E+01
*               TOUTL          TOUTV
VALVE08012  5.47000000E+02  5.47000000E+02
*             IVTY    IVTR   NVTX   IVPG    IVGS        AVLVE
VALVE08020       1       2      0      0       4  1.06530000E-03
*                  HVLVE          PVC1           PVC2          ALEAK          DELSTP
VALVE08021  3.68280000E-02   .00000000E+00   .00000000E+00   .00000000E+00    .00
*           IHTS     IWT
VALVE08050      0       0
*****       DX
VALVE08DX0        2.60400000E-01      8.36600000E-01       2.57700000E+00
VALVE08DX1        1.07700000E+00      1.15800000E+00 R02  2.31600000E+00
VALVE08DX2        1.15800000E+00      3.84200000E-01 E
*****       VOL
VALVE08VOL0        1.11000000E-04      3.56500000E-03       1.09800000E-02
VALVE08VOL1        4.59100000E-03      4.93400000E-03 R02  9.86800000E-03
VALVE08VOL2        4.93400000E-03      1.63700000E-03 E
*****       FA
VALVE08FA0        3.08900000E-03 R02  4.26100000E-03       1.06530000E-03
VALVE08FA1  R06   4.26100000E-03 E
*****       FKLOS
VALVE08FKLOS0        1.50000000E+00      3.50000000E-01        .00000000E+00
VALVE08FKLOS1        1.70000000E+01      3.50000000E-01 R03    .00000000E+00
VALVE08FKLOS2        3.50000000E-01       .00000000E+00 E
*****       RKLOS
VALVE08RKLOS0        1.50000000E+00      3.50000000E-01        .00000000E+00
VALVE08RKLOS1        1.70000000E+01      3.50000000E-01 R03    .00000000E+00
VALVE08RKLOS2        3.50000000E-01       .00000000E+00 E
*****       GRAV
VALVE08GRAV0        1.00000000E+00      2.37300000E-01 R02    .00000000E+00
VALVE08GRAV1       -5.18000000E-01 R03 -1.00000000E+00       -7.50900000E-01
VALVE08GRAV2        8.62500000E-01 E
*****       HD
VALVE08HD0        6.27100000E-02 R02  7.36600000E-02       3.68280000E-02
VALVE08HD1  R06   7.36600000E-02 E
*****       EPSD
VALVE08EPSD0  R09  6.00000000E-04      6.00000000E-04 E
*****       ICHOKE
VALVE08ICHOKE0  R09          0          0        E
*****       ICCFL
VALVE08ICCFL0  R09           0                0 E
*****       ALP
VALVE08ALP0        4.12306261E-09      1.03450764E-10       9.66287544E-13
VALVE08ALP1        2.13968533E-14      4.64385549E-16       5.07658359E-18
VALVE08ALP2        8.33253630E-20       .00000000E+00       4.43056357E-21 E
*****       VL
VALVE08VL0        1.41719165E+00      1.02743490E+00       1.02739341E+00
VALVE08VL1        4.10937910E+00 R02  1.02751553E+00       1.02749787E+00
VALVE08VL2  R02   1.02747929E+00      1.02746127E+00 E
*****       VV
VALVE08VV0        1.76015703E+00      1.04833943E+00       1.17512732E+00
VALVE08VV1        4.35744395E+00      1.16070833E+00       1.14647874E+00
VALVE08VV2  R02   1.14644259E+00      1.15360229E+00       1.20084927E+00 E
*****       TL
VALVE08TL0        5.47130368E+02      5.47116534E+02       5.47094054E+02
VALVE08TL1        5.47063480E+02      5.47094031E+02       5.47273502E+02
VALVE08TL2        5.47560580E+02      5.47728303E+02       5.47786318E+02 E
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*****        TV
VALVE08TV0          5.60353982E+02 R02  5.60723095E+02        5.59619823E+02
VALVE08TV1          5.59659301E+02      5.59783038E+02        5.59947666E+02
VALVE08TV2          5.60070874E+02      5.60110386E+02 E
*****        P
VALVE08P0         7.13992991E+06      7.17874001E+06       7.17859291E+06
VALVE08P1         7.06322215E+06      7.06733059E+06       7.08021980E+06
VALVE08P2         7.09739690E+06      7.11027345E+06       7.11440671E+06 E
*****        QPPP
VALVE08QPPP0  R09   .00000000E+00 E
*****        TW
VALVE08TW0  R03  5.47129806E+02 R03  5.47115929E+02 R03  5.47093869E+02
VALVE08TW1  R03  5.47063380E+02 R03  5.47093794E+02 R03  5.47272822E+02
VALVE08TW2  R03  5.47559018E+02 R03  5.47726194E+02 R03  5.47784010E+02 E
$
$$$$$$       PUMP HEADER CARD
PUMP09000   9 "INT LOOP PMP AND DRIVE        "
$$$$$$       PUMP PARAMETER CARD
*            NCELLS  NODES    JUN1    JUN2     MAT
PUMP09010        8       3       2      50       9
*              ICHF   IPVHT IPMPTY IPFACE     IRP     IPM IPMPTR NPMPTX
PUMP09011         0       0       1      2       0       0      1     16
*                RADIN              TH             HOUTL             HOUTV
PUMP09013  1.90500000E-02  5.08000000E-03  1.16800000E+01  1.16800000E+01
*                TOUTL           TOUTV
PUMP09014  5.47000000E+02  5.47000000E+02
*                RHEAD            RTORK            RFLOW             RRHO
PUMP09020  2.06410000E+03  7.59250000E+01  9.14810000E-03  7.56050000E+02
*               ROMEGA            EFFMI             TFR1              TFR2
PUMP09021  3.71760000E+02  1.03240000E+00   .00000000E+00   .00000000E+00
*               OMEGAN           OPTION
PUMP09022  3.29000000E+02        0
*
PUMP09030  11  11  11  11   2   2   2   2  11  11  11  11   2   2   2
PUMP09031   2  11   7
*****       HSP1
PUMP09HSP10        -1.00000000E+00       1.60000000E+00       -8.00000000E-01
PUMP09HSP11         1.35000000E+00      -6.00000000E-01        1.23000000E+00
PUMP09HSP12        -4.00000000E-01       1.16000000E+00       -2.00000000E-01
PUMP09HSP13         1.13000000E+00        .00000000E+00        1.12000000E+00
PUMP09HSP14         2.00000000E-01       1.11000000E+00        4.00000000E-01
PUMP09HSP15         1.10000000E+00       6.00000000E-01        1.09000000E+00
PUMP09HSP16         8.00000000E-01       1.06000000E+00 R02  1.00000000E+00 E
*****       HSP2
PUMP09HSP20        -1.00000000E+00      -4.00000000E-01       -8.00000000E-01
PUMP09HSP21        -5.10000000E-01      -6.00000000E-01       -5.40000000E-01
PUMP09HSP22        -4.00000000E-01      -5.60000000E-01       -2.00000000E-01
PUMP09HSP23        -5.80000000E-01        .00000000E+00       -5.60000000E-01
PUMP09HSP24         2.00000000E-01      -5.20000000E-01        4.00000000E-01
PUMP09HSP25        -4.60000000E-01       6.00000000E-01       -3.30000000E-01
PUMP09HSP26         8.00000000E-01        .00000000E+00 R02  1.00000000E+00 E
*****       HSP3
PUMP09HSP30        -1.00000000E+00       1.60000000E+00       -8.00000000E-01
PUMP09HSP31         1.22000000E+00      -6.00000000E-01        1.01000000E+00
PUMP09HSP32        -4.00000000E-01       8.80000000E-01       -2.00000000E-01
PUMP09HSP33         7.80000000E-01        .00000000E+00        7.10000000E-01
PUMP09HSP34         2.00000000E-01       6.90000000E-01        4.00000000E-01
PUMP09HSP35         7.00000000E-01       6.00000000E-01        7.60000000E-01
PUMP09HSP36         8.00000000E-01       8.40000000E-01 R02  1.00000000E+00 E
*****       HSP4
PUMP09HSP40        -1.00000000E+00      -4.00000000E-01       -8.00000000E-01
PUMP09HSP41        -2.40000000E-01      -6.00000000E-01       -8.00000000E-02
PUMP09HSP42        -4.00000000E-01       1.30000000E-01       -2.00000000E-01
PUMP09HSP43         4.80000000E-01        .00000000E+00        6.40000000E-01
PUMP09HSP44         2.00000000E-01       6.90000000E-01        4.00000000E-01
PUMP09HSP45         7.00000000E-01       6.00000000E-01        7.60000000E-01
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PUMP09HSP46        8.00000000E-01       8.40000000E-01 R02  1.00000000E+00 E
*****     HTP1
PUMP09HTP10       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09HTP11         .00000000E+00 E
*****     HTP2
PUMP09HTP20       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09HTP21         .00000000E+00 E
*****     HTP3
PUMP09HTP30       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09HTP31         .00000000E+00 E
*****     HTP4
PUMP09HTP40       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09HTP41         .00000000E+00 E
*****     TSP1
PUMP09TSP10       -1.00000000E+00       1.00000000E+00     -8.00000000E-01
PUMP09TSP11        7.20000000E-01      -6.00000000E-01      5.40000000E-01
PUMP09TSP12       -4.00000000E-01       4.20000000E-01     -2.00000000E-01
PUMP09TSP13        4.20000000E-01        .00000000E+00      6.00000000E-01
PUMP09TSP14        2.00000000E-01       7.00000000E-01      4.00000000E-01
PUMP09TSP15        7.90000000E-01       6.00000000E-01      8.80000000E-01
PUMP09TSP16        8.00000000E-01       9.50000000E-01 R02  1.00000000E+00 E
*****     TSP2
PUMP09TSP20       -1.00000000E+00      -2.50000000E+00     -8.00000000E-01
PUMP09TSP21       -2.15000000E+00      -6.00000000E-01     -1.73000000E+00
PUMP09TSP22       -4.00000000E-01      -1.22000000E+00     -2.00000000E-01
PUMP09TSP23       -7.60000000E-01        .00000000E+00     -4.20000000E-01
PUMP09TSP24        2.00000000E-01      -1.70000000E-0[illegible]  4.00000000E-01
PUMP09TSP25        4.00000000E-02       6.00000000E-0[illegible]   3.00000000E-01
PUMP09TSP26        8.00000000E-01       6.70000000E-01 R02  1.00000000E+00 E
*****     TSP3
PUMP09TSP30       -1.00000000E+00       1.00000000E+00     -8.00000000E-01
PUMP09TSP31        9.80000000E-01      -6.00000000E-01      9.50000000E-01
PUMP09TSP32       -4.00000000E-01       9.10000000E-01     -2.00000000E-01
PUMP09TSP33        8.70000000E-01        .00000000E+00      8.30000000E-01
PUMP09TSP34        2.00000000E-01       7.60000000E-01      4.00000000E-01
PUMP09TSP35        7.20000000E-01       6.00000000E-01      6.40000000E-01
PUMP09TSP36        8.00000000E-01       5.60000000E-01      1.00000000E+00
PUMP09TSP37        5.00000000E-01 E
*****     TSP4
PUMP09TSP40       -1.00000000E+00      -2.50000000E+00     -8.00000000E-01
PUMP09TSP41       -2.31000000E+00      -6.00000000E-01     -2.03000000E+00
PUMP09TSP42       -4.00000000E-01      -1.62000000E+00     -2.00000000E-01
PUMP09TSP43       -1.04000000E+00        .00000000E+00     -6.10000000E-01
PUMP09TSP44        2.00000000E-01      -3.50000000E-01      4.00000000E-01
PUMP09TSP45       -1.20000000E-01       6.00000000E-01      6.00000000E-02
PUMP09TSP46        8.00000000E-01       2.40000000E-01      1.00000000E+00
PUMP09TSP47        5.00000000E-01 E
*****     TTP1
PUMP09TTP10       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09TTP11         .00000000E+00 E
*****     TTP2
PUMP09TTP20       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09TTP21         .00000000E+00 E
*****     TTP3
PUMP09TTP30       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09TTP31         .00000000E+00 E
*****     TTP4
PUMP09TTP40       -1.00000000E+00        .00000000E+00      1.00000000E+00
PUMP09TTP41         .00000000E+00 E
*****     HDM
PUMP09HDM0   R02    .00000000E+00       1.00000000E-01       .00000000E+00
PUMP09HDM1         1.50000000E-01       5.00000000E-02      2.40000000E-01
PUMP09HDM2         8.00000000E-01       3.00000000E-01      9.60000000E-01
PUMP09HDM3         4.00000000E-01       9.80000000E-01      6.00000000E-01
PUMP09HDM4         9.70000000E-01       8.00000000E-01 R02  9.00000000E-01
PUMP09HDM5         8.00000000E-01       9.60000000E-01      5.00000000E-01
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PUMP09HDM6        1.00000000E+00         .00000000E+00 E
*****       TDM
PUMP09TDM0  R02    .00000000E+00        1.00000000E-01         .00000000E+00
PUMP09TDM1        1.50000000E-01        5.00000000E-02        2.40000000E-01
PUMP09TDM2        5.60000000E-01        8.00000000E-01        5.60000000E-01
PUMP09TDM3        9.60000000E-01        4.50000000E-01        1.00000000E+00
PUMP09TDM4         .00000000E+00 E
*           IHTS     IWT
PUMP09050        0        0
*****       SPTBL
PUMP09SPTBL0        0.0000E+00       3.2900E+02       4.4500E-01
PUMP09SPTBL1        2.9500E+02       6.4700E-01       2.7250E+02
PUMP09SPTBL2        1.5000E+00       2.3820E+02       2.0600E+00
PUMP09SPTBL3        2.2710E+02       3.1500E+00       2.0300E+02
PUMP09SPTBL4        5.0000E+00       1.5750E+02       7.0000E+00
PUMP09SPTBL5        1.2510E+02       8.3000E+00       1.1580E+02
PUMP09SPTBL6        1.0500E+01       8.9000E+01       1.2200E+01
PUMP09SPTBL7        6.5800E+01       1.4300E+01       4 6300E+01
PUMP09SPTBL8        1.6[illegible]00E+01       3.6100E+01       1.8100E+01
+                   2.2200E+01       1.9200E+01       0.00000E+00
PUMP09SPTBL9        4.00000E+02      0.00000E+00 E
*****       DX
PUMP09DX0        3.77800000E-01        6.63600000E-01 R02  2.25000000E+00
PUMP09DX1        7.93100000E-01        6.84700000E-01      2.61000000E+00
PUMP09DX2        6.84700000E-01 E
*****       VOL
PUMP09VOL0        1.61000000E-03        7.56500000E-04 R02  2.56500000E-03
PUMP09VOL1        9.04200000E-04        7.80700000E-04      2.97600000E-03
PUMP09VOL2        7.80700000E-04 E
*****       FA
PUMP09FA0  R02   4.26100000E-03        1.14000000E-03      3.80000000E-04
PUMP09FA1  R05   1.14000000E-03 E
*****       FKLOS
PUMP09FKLOS0  R02    .00000000E+00        7.20000000E-01        2.25000000E+00
PUMP09FKLOS1         .00000000E+00        4.00000000E-01 R03     .00000000E+00 E
*****       RKLOS
PUMP09RKLOS0  R02    .00000000E+00        7.20000000E-01        2.25000000E+00
PUMP09RKLOS1         .00000000E+00        4.00000000E-01 R03     .00000000E+00 E
*****       GRAV
PUMP09GRAV0        8.62500000E-01         .00000000E+00 R03  1.00000000E+00
PUMP09GRAV1        5.36700000E-01 R02     .00000000E+00      5.84800000E-01 E
*****       HD
PUMP09HD0  R02   7.36600000E-02        3.81000000E-02      2.20060000E-02
PUMP09HD1  R05   3.81000000E-02 E
*****       EPSD
PUMP09EPSD0  R02   6.00000000E-04 R07  1.20000000E-03 E
*****       ICHOKE
PUMP09ICHOKE0  R03           0                 0 R05            0 E
*****       ICCFL
PUMP09ICCFL0  R09           0 E
*****       ALP
PUMP09ALP0        4.98906912E-20        4.97207016E-21        4.12881487E-20
PUMP09ALP1        4.49125759E-20        2.91532009E-20        3.72868291E-20
PUMP09ALP2        4.05106294E-20        6.89334570E-20 E
*****       VL
PUMP09VL0  R02   1.02746127E+00        3 83504879E+00        1.15054312E+01
PUMP09VL1        3.83609002E+00 R02  3.83615570E+00 R02  3.83621548E+00 E
*****       VV
PUMP09VV0        1.20084927E+00        1.02746394E+00        4.10743322E+00
PUMP09VV1        1.19108884E+01        4.11400263E+00        4.09492515E+00
PUMP09VV2        4.07306230E+00        4.07296883E+00        4.09648764E+00 E
*****       TL
PUMP09TL0        5.47843230E+02        5.48302844E+02        5.48396899E+02
PUMP09TL1        5.48423943E+02        5.48455084E+02        5.48484150E+02
PUMP09TL2        5.48602488E+02        5.48632439E+02 E
*****       TV
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PUMP09TV0        5.60086530E+02      5.72148888E+02      5.71986872E+02
PUMP09TV1        5.69981645E+02      5.69844481E+02      5.69780531E+02
PUMP09TV2        5.69737725E+02      5.69694898E+02 E
*****       P
PUMP09P0        7.11191098E+06      8.46352550E+06      8.44414220E+06
PUMP09P1        8.20708323E+06      8.19105866E+06      8.18359586E+06
PUMP09P2        8.17860348E+06      8.17361099E+06 E
*****       QPPP
PUMP09QPPP0  R08    .00000000E+00 E
*****       TW
PUMP09TW0   R03  5.47840336E+02 R03  5.48300579E+02 R03  5.48396040E+02
PUMP09TW1   R03  5.48423068E+02 R03  5.48453450E+02 R03  5.48482481E+02
PUMP09TW2   R03  5.48600671E+02 R03  5.48630584E+02 E
$
$$$$$$      VALVE HEADER CARD
VALVE10000  10 "INTACT LOOP VALVE         "
$$$$$$      VALVE PARAMETER CARD
*             NCELLS  NODES    JUN1    JUN2     MAT    ICHF   IPVHT
VALVE10010         4      3      50       3       9       0       0
*                 RADIN             TH            HOUTL          HOUTV
VALVE10011  1.90500000E-02  5.08000000E-03  1.16800000E+01  1.16800000E+01
*                 TOUTL            TOUTV
VALVE10012  5.47000000E+02  5.47000000E+02
*               IVTY    IVTR    NVTX    IVPG    IVGS         AVLVE
VALVE10020         1       2       0       0       3  3.76200000E-04
*                 HVLVE            PVC1            PVC2           ALEAK          DELSTP
VALVE10021  2.18900000E-02   .00000000E+00   .00000000E+00   .00000000E+00   .00
*           IHTS     IWT
VALVE10050     0       0
*****       DX
VALVE10DX0         5.36600000E-01      5.57200000E-01      2.22900000E+00
VALVE10DX1         5.33400000E-01 E
*****       VOL
VALVE10VOL0        6.11700000E-04      6.35300000E-04      2.54100000E-03
VALVE10VOL1        2.37800000E-04 E
*****       FA
VALVE10FA0   R02  1.14000000E-03      3.76200000E-04      1.14000000E-03
VALVE10FA1        4.45800000E-04 E
*****       FKLOS
VALVE10FKLOS0  R02   .00000000E+00      6.00000000E+00 R02   .00000000E+00 E
*****       RKLOS
VALVE10RKLOS0  R02   .00000000E+00      6.00000000E+00 R02   .00000000E+00 E
*****       GRAV
VALVE10GRAV0        5.84800000E-01      4.90600000E-01 R02   .00000000E+00
VALVE10GRAV1        6.16300000E-01 E
*****       HD
VALVE10HD0   R02  3.81000000E-02      2.18900000E-02      3.81000000E-02
VALVE10HD1        2.38300000E-02 E
*****       EPSD
VALVE10EPSD0  R04  1.20000000E-03      1.80000000E-03 E
*****       ICHOKE
VALVE10ICHOKE0  R02           0              0 R02           0 E
*****       ICCFL
VALVE10ICCFL0  R05           0 E
*****       ALP
VALVE10ALP0        4.50524051E-20      4.71140884E-20      2.62067038E-20
VALVE10ALP1        2.08194807E-20 E
*****       VL
VALVE10VL0   R02  3.83623739E+00      1.16250800E+01      3.83778196E+00
VALVE10VL1        9.81434648E+00 E
*****       VV
VALVE10VV0         4.09648764E+00      4.09310372E+00      1.19837883E+01
VALVE10VV1         4.18359365E+00      1.01913235E+01 E
*****       TL
VALVE10TL0         5.48655621E+02      5.48680243E+02 R02  5.48659006E+02 E
*****       TV
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VALVE10TV0        5.69656028E+02       5.69624556E+02       5.66326736E+02
VALVE10TV1        5.66011387E+02 E
*****       P
VALVE10P0        8.16908182E+06       8.16541611E+06       7.78832625E+06
VALVE10P1        7.75298953E+06 E
*****       QPPP
VALVE10QPPP0  R04    .00000000E+00 E
*****       TW
VALVE10TW0   R03  5.48653738E+02 R03  5.48679200E+02 R06  5.48657974E+02 E
$
$$$$$$      JETP HEADER CARD
JETP11000 11 "INTACT LOOP JET PUMP - 7.711                    "
$$$$$$       JETP PARAMETER CARD
*           JCELL  NODES  MATID          COST    ICHF   IPVHT NCELL1
JETP11010        1      3      6  1.00000000E+00       0       0      3
*             JUN1    JUN2    ITRP
JETP11011       29      30       0
*               RADIN1           TH1         HOUTL1         HOUTV1
JETP11012  2.69880000E-02  4.76250000E-03   .00000000E+00   .00000000E+00
*               TOUTL1         TOUTV1
JETP11013  5.47000000E+02  5.47000000E+02
*         NCELL2   JUN3       RADIN2           TH2
JETP11020        2      3  1.18110000E-02  3.96240000E-03
*               HOUTL2         HOUTV2         TOUTL2         TOUTV2
JETP11021   .00000000E+00   .00000000E+00  5.47000000E+02  5.47000000E+02
*             NJETP
JETP11060        1
*               EPSDFF         EPSDFR         EPSNZF         EPSNZR
JETP11070  5.50000E+00  3.80000E-01  5.50000E+00  3.80000E-01
*               FINLET         FOTLET
JETP11071  4.00000000E-02  4.50000000E-01
*           IHTS     IWT
JETP11050        0       0
*****       DX
JETP11DX0         2.89800000E-01       3.49900000E-01       7.26500000E-01 E
*****       VOL
JETP11VOL0        1.22700000E-04       4.31100000E-04       1.66200000E-03 E
*****       FA
JETP11FA0         3.19300000E-04       4.23300000E-04 R02   2.28800000E-03 E
*****       FKLOS
JETP11FKLOS0  R04    .00000000E+00 E
*****       RKLOS
JETP11RKLOS0  R04    .00000000E+00 E
*****       GRAV
JETP11GRAV0  R04 -1.00000000E+00 E
*****       HD
JETP11HD0         2.01600000E-02       2.32200000E-02 R02   5.39700000E-02 E
*****       EPSD
JETP11EPSD0  R04    .00000000E+00 E
*****       ICHOKE
JETP11ICHOKE0                  1 R03            0 E
*****       ICCFL
JETP11ICCFL0                 1 R03            0 E
*****       ALP
JETP11ALP0        8.09635854E-13       2.52452637E-13       2.82654795E-14 E
*****       VL
JETP11VL0         1.82353102E+01       2.41013556E+01       4.45753866E+00
JETP11VL1         4.45744096E+00 E
*****       VV
JETP11VV0         1.88576811E+01       2.43201890E+01       4.60948881E+00
JETP11VV1         4.63157659E+00 E
*****       TL
JETP11TL0         5.47765895E+02       5.47866222E+02       5.47882867E+02 E
*****       TV
JETP11TV0         5.59117742E+02       5.62043763E+02       5.62244439E+02 E
*****       P
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JETP11P0        7.01113257E+06      7.31894479E+06      7.34043385E+06 E
*****      QPPP
JETP11QPPP0  R03    .00000000E+00 E
*****      TW
JETP11TW0  R03  5.47765910E+02 R03  5.47866244E+02 R03  5.47882925E+02 E
*****      DX
JETP11DXS0        3.52500000E-01      3.93900000E-01 E
*****      VOL
JETP11VOLS0        8.99020000E-05      1.75600000E-04 E
*****      FA
JETP11FAS0        1.04000000E-04 R02  4.45800000E-04 E
*****      FKLOS
JETP11FKLOSS0  R03    .00000000E+00 E
*****      RKLOS
JETP11RKLOSS0  R03    .00000000E+00 E
*****      GRAV
JETP11GRAVS0        1.00000000E+00     -1.00000000E+00     -6.16300000E-01 E
*****      HD
JETP11HDS0  R03  2.38300000E-02 E
*****      EPSD
JETP11EPSDS0  R03    .00000000E+00 E
*****      ICHOKE
JETP11ICHOKES0  R03          0 E
*****      ICCFL
JETP11ICCFLS0  R03          0 E
*****      ALP
JETP11ALPS0        9.45063446E-20      6.91419018E-20 E
*****      VL
JETP11VLS0       -4.20741483E+01     -9.81454302E+00     -9.81434648E+00 E
*****      VV
JETP11VVS0       -4.26015930E+01     -1.03549694E+01     -1.01913235E+01 E
*****      TL
JETP11TLS0        5.48636022E+02      5.48658866E+02 E
*****      TV
JETP11TVS0        5.65086509E+02      5.65846405E+02 E
*****      P
JETP11PS0       7.65006948E+06      7.73455201E+06 E
*****      QPPP
JETP11QPPPS0  R02    .00000000E+00 E
*****      TW
JETP11TWS0  R03  5.48636050E+02 R03  5.48658926E+02 E
$
$$$$$$    CHAN HEADER CARD
CHAN1200000  12 "  64 ROD BUNDLE                          "
$$$$$$    CHAN PARAMTER CARD
*          NCELLS  NODES   JUN1   JUN2   MAT  ICHF IPVHT IEDTEM ITMINR
CHAN1200010      9      3     20     21     6     2     0     5     1
*                RADIN              TH
CHAN1200011  6.43270000E-02  2.62260000E-02
*                HOUTL          HOUTV          TOUTL          TOUTV
CHAN1200012   .00000000E+00   .00000000E+00  5.47000000E+04  5.47000000E+04
*            NGRP NCHANS NODESR  NMWRX   NFCI
CHAN1200020     4      1      6      0      0
*           NFCIL  NRFDT  NZMAX NZMAXW
CHAN1200021     0      0      8     10
*                HGAPO          PDRAT           PLDR
CHAN1200030  1.00000E+01  1.31680E+00   .00000E+00
*           ICRNK  ICRLH  NCRZ   NROD        BUNDW
CHAN1200031     2      2      7      8  1.32460000E-01
*                ALPTST         EPSR           EPSC   IRAD  NRDMX   IANI
CHAN1200033  9.00000000E-01  7.00000000E-01  7.00000000E-01      0     10      1
*                DZNHT   DTXHTW(1)   DTXHTW(2)       DZNHTW
CHAN1200034   .00000000E+00   .00000000E+00   .00000000E+00   .00000000E+00
*       NCLK    FALK          CLOS          VMLK          DELZLK
CHAN1200040   2  1.7700000E-04  3.7300000E+00  7.7022535E+00   .0000000E+00
*            NCMPTO NCLKTO NLEVTO
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CHAN1200041       27       1       6
*               IHTS     IWT
CHAN1200050        0       1
*****        DX
CHAN1200DX0         2.36600000E-01        1.09600000E-01         5.08000000E-01
CHAN1200DX1         7.62000000E-01        5.08000000E-01         2.54000000E-01
CHAN1200DX2         5.08000000E-01        7.62000000E-01         5.08000000E-01 E
*****        VOL
CHAN1200VOL0         1.26600000E-03        4.68800000E-03         5.01000000E-03
CHAN1200VOL1         7.51600000E-03        5.01000000E-03         2.50500000E-03
CHAN1200VOL2         5.01000000E-03        7.51600000E-03         5.01000000E-03 E
*****        FA
CHAN1200FA0         2.99200000E-03        1.75000000E-02         5.35200000E-03
CHAN1200FA1  R06    9.86300000E-03        7.33500000E-03 E
*****        FKLOS
CHAN1200FKLOS0          1.00000000E+00        5.00000000E-01         2.36000000E+00
CHAN1200FKLOS1  R06    1.46000000E+00        8.50000000E-01 E
*****        RKLOS
CHAN1200RKLOS0          1.00000000E+00        5.00000000E-01         2.36000000E+00
CHAN1200RKLOS1  R06    1.28000000E+00        7.90000000E-01 E
*****        GRAV
CHAN1200GRAV0  R09  1.00000000E+00        1.00000000E+00 E
*****        HD
CHAN1200HD0         6.17200000E-03        8.25500000E-02 R07  1.30900000E-02
CHAN1200HD1         8.54400000E-03 E
*****        EPSD
CHAN1200EPSD0  R09  4.10000000E-04        4.10000000E-04 E
*****        ICHOKE
CHAN1200ICHOKE0  R09          0                 0 E
*****        ICCFL
CHAN1200ICCFL0                2 R08             0                  1 E
*****        WETP
CHAN1200WETP0         1.93900000E-01 R09   .00000000E+00 E
*****        ALP
CHAN1200ALP0         1.91790090E-12        1.69721463E-13         2.95783[illegible]E-02
CHAN1200ALP1         4.02956932E-01        5.79660065E-01         6.38726060E-01
CHAN1200ALP2         7.15208626E-01        7.72671603E-01         8.16409143E-01 E
*****        VL
CHAN1200VL0         7.18658909E+00        1.22874078E+00         3.763[illegible]153E+00
CHAN1200VL1         2.14093942E+00        3.40755454E+00         4.638193[illegible]9E+00
CHAN1200VL2         5.25221989E+00        6.31536480E+00         7.39007360E+00
CHAN1200VL3          .19566449E+01 E
*****        VV
CHAN1200VV0         7.68385680E+00        1.29325807E+00         4.29822886E+00
CHAN1200VV1         1.37026782E+00        3.75973884E+00         5.66226813E+00
CHAN1200VV2         6.75234728E+00        8.73058611E+00         1.10699313E+01
CHAN1200VV3         1.58489585E+01 E
*****        TL
CHAN1200TL0         5.47850987E+02        5.47910884E+02         5.54711937E+02
CHAN1200TL1         5.60249412E+02        5.61342271E+02         5.61502043E+02
CHAN1200TL2         5.61595166E+02        5.61534673E+02         5.61411810E+02 E
*****        TV
CHAN1200TV0         5.61958422E+02        5.62000261E+02         5.61830932E+02
CHAN1200TV1         5.61762320E+02        5.61663137E+02         5.61559597E+02
CHAN1200TV2         5.61454913E+02        5.61315461E+02         5.61124200E+02 E
*****        P
CHAN1200P0         7.30982107E+06        7.31429292E+06         7.29621971E+06
CHAN1200P1         7.28890288E+06        7.27851993E+06         7.26815418E+06
CHAN1200P2         7.25790460E+06        7.24243800E+06         7.22389487E+06 E
*****        QPPP
CHAN1200QPPP0  R09    .00000000E+00 E
*****        TW
CHAN1200TW0  R03  5.47851300E+02 R03  5.47870441E+02 R03  5.53458772E+02
CHAN1200TW1  R03  5.57673911E+02 R03  5.60630511E+02 R03  5.61391403E+02
CHAN1200TW2  R03  5.61562147E+02 R03  5.61549596E+02 R03  5.61459454E+02
CHAN1200TW3  R03  5.61411812E+02 .
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*****     RDPWR
CHAN1200RDPWR0  R04   .00000000E+00 R02  4.74214845E+04 R04   .00000000E+00
CHAN1200RDPWR1  R02  4.74214845E+04 R04   .00000000E+00 R02  4.74214845E+04
CHAN1200RDPWR2  R06   .00000000E+00 E
*****     CPOWR
CHAN1200CPOWR0       1.69796604E-02      1.64396712E-02      1.54796904E-02
CHAN1200CPOWR1        .00000000E+00 E
*****     RADPW
CHAN1200RADPW0  R07  1.00000000E+00 E
*****     RDX
CHAN1200RDX0        7.00000000E+00      3.10000000E+01      2.40000000E+01
CHAN1200RDX1        2.[illegible]000000E+00 E
*****     RADRD
CHAN1200RADRD0        .00000000E+00      1.00000000E-09      3.17000000E-03
CHAN1200RADRD1       5.50000000E-03      5.62000000E-03      6.13400000E-03
CHAN1200RADRD2        .00000000E+00      1.00000000E-09      3.17000000E-03
CHAN1200RADRD3       5.50000000E-03      5.62000000E-03      6.13400000E-03
CHAN1200RADRD4        .00000000E+00      1.00000000E-09      3.17000000E-03
CHAN1200RADRD5       5.50000000E-03      5.62000000E-03      6.13400000E-03
CHAN1200RADRD6        .00000000E+00      1.00000000E-09      3.17000000E-03
CHAN1200RADRD7       5.50000000E-03      5.62000000E-03      6.13400000E-03 E
*****     MATRD
CHAN1200MATRD0                4                 3 R02         11                10
CHAN1200MATRD1                4                 3 R02         11                10
CHAN1200MATRD2                4                 3 R02         11 R02            10
CHAN1200MATRD3                3 R03            10 E
*****     HGAP
CHAN1200HGAP0  R09  1.00000000E+01 R09  1.00000000E+01 R09  1.00000000E+01
CHAN1200HGAP1       1.00000000E+01 E
*****     FPUO2
CHAN1200FPUO20  R04   .00000000E+00 E
*****     FTD
CHAN1200FTD0  R04  9.40000000E-01 E
*****     BURN
CHAN1200BURN0  R09   .00000000E+00 R09   .00000000E+00 R09   .00000000E+00
CHAN1200BURN1        .00000000E+00 E
*****     RFTN
CHAN1201RFTN0  R05  5.73990722E+02      5.66779448E+02 R05  5.84793888E+02
CHAN1201RFTN1       5.73534339E+02 R05  5.94623364E+02      5.79124630E+02
CHAN1201RFTN2  R05  5.99659301E+02      5.81591076E+02 R05  5.99640053E+02
CHAN1201RFTN3       5.81571483E+02 R05  5.94183016E+02      5.78677485E+02
CHAN1201RFTN4  R05  5.84937157E+02      5.73668362E+02 R05  5.74497902E+02
CHAN1201RFTN5       5.67262891E+02 E
*****     RFTN
CHAN1202RFTN0  R05  5.73466468E+02      5.66481723E+02 R05  5.84199895E+02
CHAN1202RFTN1       5.73291117E+02 R05  5.93787931E+02      5.78773362E+02
CHAN1202RFTN2  R05  5.986638[illegible]      5.81158021E+02 R05  5.98631479E+02
CHAN1202RFTN3       5.81122069E+02 R05  5.93275957E+02      5.78253729E+02
CHAN1202RFTN4  R05  5.84250819E+02      5.73334933E+02 R05  5.74094961E+02
CHAN1202RFTN5       5.67088088E+02 E
*****     RFTN
CHAN1203RFTN0  R05  5.72526756E+02      5.65942312E+02 R05  5.83133612E+02
CHAN1203RFTN1       5.72846924E+02 R05  5.92286340E+02      5.78133693E+02
CHAN1203RFTN2  R05  5.96878476E+02      5.80371128E+02 R05  5.96811715E+02
CHAN1203RFTN3       5.80306254E+02 R05  5.91649009E+02      5.77437366E+02
CHAN1203RFTN4  R05  5.83022960E+02      5.72735279E+02 R05  5.73376653E+02
CHAN1203RFTN5       5.66775673E+02 E
*****     RFTN
CHAN1204RFTN0  R06  5.54708941E+02 R06  5.57655925E+02 R06  5.60625664E+02
CHAN1204RFTN1  R06  5.61390667E+02 R09  5.61565123E+02 R03  5.61558873E+02
CHAN1204RFTN2  R06  5.61459057E+02 R06  5.61411403E+02 E
*****     RFTN
CHAN1200FIJ0        5.14200000E-01      4.35000000E-02      6.24500000E-02
CHAN1200FIJ1        9.46200000E-03      3.88800000E-02      1.02700000E-01
CHAN1200FIJ2        5.54500000E-01      2.00100000E-01      1.54700000E-01
CHAN1200FIJ3        5.34700000E-01      2.14100000E-01      1.54900000E-01
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CHAN1200FIJ4        5.92900000E-01      2.89800000E-01      2.10200000E-01
CHAN1200FIJ5        2.70300000E-03      9.98300000E-03      2.41500000E-02
CHAN1200FIJ6        5.41000000E-01      7.26400000E-04      7.63500000E-02
CHAN1200FIJ7        2.37100000E-01      1.20400000E-01      4.99300000E-03
CHAN1200FIJ8        2.15500000E-01 E
*****      RIJ
CHAN1200RIJ0        1.03000000E-03      1.15800000E-02      1.05600000E-02
CHAN1200RIJ1        2.95900000E-02      1.48900000E-02      1.75800000E-02
CHAN1200RIJ2        3.00500000E-03      1.09400000E-02      1.03600000E-02
CHAN1200RIJ3        9.18300000E-03      1.05600000E-02      1.09400000E-02
CHAN1200RIJ4        2.94100000E-03      1.18900000E-02      1.08900000E-02
CHAN1200RIJ5        2.95900000E-02      1.03600000E-02      1.18900000E-02
CHAN1200RIJ6        1.05100000E-03      5.68400000E-02      1.48900000E-02
CHAN1200RIJ7        9.18300000E-03      1.08900000E-02      5.68400000E-02
CHAN1200RIJ8        2.34500000E-02 E
$
*$$$$$$    VALVE HEADER CARD
*VALVE14000  14 * MAIN STEAM ISOLATION VALVE                    *
*$$$$$$    VALVE PARAMETER CARD
*          NCELLS  NODES   JUN1    JUN2    MAT   ICHF  IPVHT
*VALVE14010     2      0      18      45      6      0     0
*                RADIN            TH          HOUTL          HOUTV
*VALVE14011  3.68300000E-02  7.62000000E-03  .00000000E+00   .00000000E+
*              TOUTL          TOUTV
*VALVE14012  5.60640000E+02  5.60640000E+02
*            IVTY    IVTR    NVTX    IVPG    IVGS         AVLVE
*VALVE14020     1       2       0       0       2  5.47940000E-04
*               HVLVE          PVC1          PVC2          ALEAK        DELSTP
*VALVE14021  9.482000E-03   .00000E+00    .00000E+00    .00000E+00     0.0
*          IHTS    IWT
*VALVE14050     0       0
*****      DX
*VALVE14DX0  R02  1.00000000E+00 E
*****      VOL
*VALVE14VOL0  R02  4.26100000E-03 E
*****      FA
*VALVE14FA0       4.26100000E-02      5.47943500E-04      4.26100000E-03
*****      FKLOS
*VALVE14FKLOS0  R03   .00000000E+00 E
*****      RKLOS
*VALVE14RKLOS0  R03   .00000000E+00 E
*****      GRAV
*VALVE14GRAV0  R03   .00000000E+00 E
*****      HD
*VALVE14HD0       7.36600000E-02      9.48186666E-03      7.36600000E-02
*****      EPSD
*VALVE14EPSD0  R03   .00000000E+00 E
*****      ICHOKE
*VALVE14ICHOKE0  R03          0 E
*****      ICCFL
*VALVE14ICCFL0  R03         0 E
*****      ALP
*VALVE14ALP0       9.99999989E-01      9.99942785E-01 E
*****      VL
*VALVE14VL0       2.48197206E+00      1.71052418E+02      2.45333754E+01
*****      VV
*VALVE14VV0       2.21709960E+00      1.72582093E+02      2.35962398E+01
*****      TL
*VALVE14TL0       5.60545047E+02      5.55378561E+02 E
*****      TV
*VALVE14TV0       5.60423105E+02      5.51395053E+02 E
*****      P
*VALVE14P0       7.15999892E+06      6.63352310E+06 E
*$
*$$$$$$    BREAK HEADER CARD
*BREAK15000  15 *  MAIN STEAM LINE                              *
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*             JUN1  IBROP   NBTB   ISAT  ICOMT
*BREAK15010     45      0      0      3      0
*                  DXIN        VOLIN          ALPIN            TIN
*BREAK15011  1.000000E+00  4.261000E-03  1.000000E+00  5.55353082E+02
*                 PIN
*BREAK15012  6.63000000E+06
$
$$$$$$   STEAM FILL HEADER CARD
FILL14000    14   *STEAM FLOW VELOCITY     *
FILL14010    0   2   0   10   0   1.0   4.261CE-03
FILL14011   1.0   -21.15   560.6    7.1692E+06
FILL14040   4.261E-03     27    2     16
****  VAPOR VELOCITY TBL
FILL14110   0.00   -21.15   4.56  -20.97
FILL14111   5.17   -13.44   5.38  -10.91
FILL14112   6.25    -4.01   8.70   -3.91
FILL14113  10.08    -4.06  11.48   -1.52
FILL14114  12.00     0.0  400.0     0.0
$
$$$$$$    PIPE HEADER CARD
PIPE25000 25 "  FEEDWATER PIPE                              "
$$$$$$    PIPE PARAMETER CARD
*         NCELLS  NODES   JUN1   JUN2    MAT
PIPE25010     1      0     10     11      9
*         IHTS    IWT
PIPE25050     0      0
*****     DX
PIPE25DX0        1.00000000E+00 E
*****     VOL
PIPE25VOL0        4.64100000E-04 E
*****     FA
PIPE25FA0   R02  4.64100000E-04 E
*****     FKLOS
PIPE25FKLOS0  R02   .00000000E+00 E
*****     RKLOS
PIPE25RKLOS0  R02   .00000000E+00 E
*****     GRAV
PIPE25GRAV0  R02   .00000000E+00 E
*****     HD
PIPE25HD0  R02  2.43100000E-02 E
*****     EPSD
PIPE25EPSD0  R02   .00000000E+00 E
*****     ICHOKE
PIPE25ICHOKE0  R02           0 E
*****     ICCFL
PIPE25ICCFL0  R02           0 E
*****     ALP
PIPE25ALP0           .00000000E+00 E
*****     VL
PIPE25VL0        9.04419130E+00       9.04482231E+00 E
*****     VV
PIPE25VV0        9.04419130E+00       9.23241532E+00 E
*****     TL
PIPE25TL0        4.92980411E+02 E
*****     TV
PIPE25TV0        5.60452576E+02 E
*****     P
PIPE25P0       7.15028052E+06 E
$
$$$$$$    FILL HEADER CARD
FILL26000  26 "   FEEDWATER FILL                           "
*            JUN1    IFTY    IFTR    NFTX  ICOMT
FILL26010     10       2       1      3      0
*                 DXIN         VOLIN          ALPIN          VIN
FILL26011  1.00000E+00  4.641000E-04   .0000uE+00  0.977000E+00
*                 TIN            PIN        BORCIN
```

```
FILL26012  2.943000E+02  7.24640000E+06
*****      VMTB
FILL26VMTB0        .000000E+00      0.977000E+00      5.000000E-01
FILL26VMTB1        .00000000E+00      1.00000000E+04      .00000000E+00 E
$
$$$$$$     PIPE HEADER CARD
PIPE19000 19 *    HPCS PIPE                                    *
$$$$$$     PIPE PARAMETER CARD
*          NCELLS  NODES   JUN1    JUN2    MAT
PIPE19010       1      0     16      17      9
*          IHTS    IWT
PIPE19050       0      0
*****      DX
PIPE19DX0        1.00000000E+00 E
*****      VOL
PIPE19VOL0        1.13100000E-04 E
*****      FA
PIPE19FA0   R02  1.13000000E-04 E
*****      FKLOS
PIPE19FKLOS0  R02   .00000000E+00 E
*****      RKLOS
PIPE19RKLOS0  R02   .00000000E+00 E
*****      GRAV
PIPE19GRAV0  R02   .00000000E+00 E
*****      HD
PIPE19HD0   R02  2.55700000E-02 E
*****      EPSD
PIPE19EPSD0  R02   .00000000E+00 E
*****      ICHOKE
PIPE19ICHOKE0  R02          0 E
*****      ICCFL
PIPE19ICCFL0  R02          0 E
*****      ALP
PIPE19ALP0        3.09988054E-24 E
*****      VL
PIPE19VL0         .00000000E+00      1.07845945E-07 E
*****      VV
PIPE19VV0         .00000000E+00      1.05568508E-05 E
*****      TL
PIPE19TL0        5.50758204E+02 E
*****      TV
PIPE19TV0        5.60902207E+02 E
*****      P
PIPE19P0       7.19763159E+06 E
$
$$$$$$     FILL HEADER CARD
FILL20000  20 *   HPCS  FILL                                   *
*            JUN1    IFTY    IFTR    NFTX   ICONT
FILL20010     16       5       1      14      0
*                DXIN          VOLIN          ALPIN           VIN
FILL20011  1.00000000E+00  1.13100000E-04   .00000000E+00   .00000000E+00
*                TIN            PIN           BORCIN
FILL20012  3.66480000E+02  7.24640000E+06
*****      VMTB
FILL20VMTB0        .00000000E+00      1.82100000E+00      4.99300000E+05
FILL20VMTB1       1.82100000E+00      5.21200000E+05      1.82100000E+00
FILL20VMTB2       5.56200000E+05      1.82100000E+00      5.75900000E+05
FILL20VMTB3       1.82100000E+00      6.19700000E+05      1.82100000E+00
FILL20VMTB4       8.71500000E+05      1.82100000E+00      1.18000000E+06
FILL20VMTB5       1.89800000E+00      1.82800000E+06      1.90500000E+00
FILL20VMTB6       2.67300000E+06      1.87100000E+00      3.97800000E+06
FILL20VMTB7       1.79200000E+00      4.89500000E+06      1.52700000E+00
FILL20VMTB8       4.94800000E+06       .00000000E+00      1.03400000E+07
FILL20VMTB9        .00000000E+00 E
$
$$$$$$     PIPE HEADER CARD
```

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PIPE21000 21 *   LPCS PIPE                              *
$$$$$$    PIPE PARAMETER CARD
*         NCELLS  NODES   JUN1    JUN2    MAT
PIPE21010      1      0     14      15      9
*         IHTS    IWT
PIPE21050      0      0
*****     DX
PIPE21DX0         1.00000000E+00 E
*****     VOL
PIPE21VOL0         1.13000000E-04 E
*****     FA
PIPE21FA0  R02  1.13000000E-04 E
*****     FKLOS
PIPE21FKLOS0  R02    .00000000E+00 E
*****     RKLOS
PIPE21RKLOS0  R02    .00000000E+00 E
*****     GRAV
PIPE21GRAV0  R02    .00000000E+00 E
*****     HD
PIPE21HD0  R02  2.55700000E-02 E
*****     EPSD
PIPE21EPSD0  R02    .00000000E+00 E
*****     ICHOKE
PIPE21ICHOKE0  R02           0 E
*****     ICCFL
PIPE21ICCFL0  R02           0 E
*****     ALP
PIPE21ALF0         3.16870363E-23 E
*****     VL
PIPE21VL0          .00000000E+00       1.11217794E-07 E
*****     VV
PIPE21VV0          .00000000E+00       5.86340659E-06 E
*****     TL
PIPE21TL0         5.50653392E+02 E
*****     TV
PIPE21TV0         5.60931390E+02 E
*****     P
PIPE21P0        7.20071327E+06 E
$
$$$$$$    FILL HEADER CARD
FILL22000  22 *   LPCS FILL                             *
*           JUN1    IFTY    IFTR    NFTX   ICOMT
FILL22010     14       5       1      17       0
*                 DXIN          VOLIN          ALPIN           VIN
FILL22011  1.00000000E+00  1.13000000E-04   .00000000E+00   .00000000E+00
*                 TIN            PIN        BORCIN
FILL22012  3.66480000E+02  7.24640000E+06
*****     VMTB
FILL22VMTB0         .00000000E+00       2.36800000E+00       5.05900000E+05
FILL22VMTB1        2.36800000E+00       5.34300000E+05       2.34100000E+00
FILL22VMTB2        5.56200000E+05       2.30300000E+00       5.93400000E+05
FILL22VMTB3        2.26400000E+00       6.56900000E+05       2.22800000E+00
FILL22VMTB4        7.42300000E+05       2.15400000E+00       8.71500000E+05
FILL22VMTB5        1.97100000E+00       9.54700000E+05       1.91300000E+00
FILL22VMTB6        1.06000000E+06       1.79300000E+00       1.18000000E+06
FILL22VMTB7        1.62100000E+00       1.32200000E+06       1.42300000E+00
FILL22VMTB8        1.48000000E+06       1.13800000E+00       1.62700000E+06
+       8.50800000E-01       1.60200000E+06       3.67300000E-01
+       1.82700000E+06        .00000000E+00       1.03400000E+07
FILL22VMTB9         .00000000E+00 E
$
$$$$$$    PIPE HEADER CARD
PIPE23000 23 *   LPCI PIPE                              *
$$$$$$    PIPE PARAMETER CARD
*         NCELLS  NODES   JUN1    JUN2    MAT
PIPE23010      1      0     12      13      6
```

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*          IHTS     IWT
PIPE23050       0        0
*****      DX
PIPE23DX0       1.00000000E+00 E
*****      VOL
PIPE23VOL0       2.26100000E-04 E
*****      FA
PIPE23FA0  R02  2.26000000E-04 E
*****      FKLOS
PIPE23FKLOS0  R02    .00000000E+00 E
*****      RKLOS
PIPE23RKLOS0  R02    .00000000E+00 E
*****      GRAV
PIPE23GRAV0  R02    .00000000E+00 E
*****      HD
PIPE23HD0  R02  8.48000000E-03 E
*****      EPSD
PIPE23EPSD0  R02    .00000000E+00 E
*****      ICHOKE
PIPE23ICHOKE0  R02           0 E
*****      ICCFL
PIPE23ICCFL0  R02           0 E
*****      ALP
PIPE23ALP0       2.27517263E-24 E
*****      VL
PIPE23VL0        .00000000E+00       6.05953302E-09 E
*****      VV
PIPE23VV0        .00000000E+00       8.01641779E-09 E
*****      TL
PIPE23TL0       5.48999817E+02 E
*****      TV
PIPE23TV0       5.60974961E+02 E
*****      P
PIPE23P0       7.20531617E+06 E
$
$$$$$$     FILL HEADER CARD
FILL24000  24 *  LPCI  FILL                                    *
*            JUN1    IFTY    IFTR    NFTX   ICOMT
FILL24010     12       5       1      16      0
*                DXIN          VOLIN          ALPIN           VIN
FILL24011  1.00000000E+00  2.26100000E-04   .00000000E+00   .00000000E+00
*                TIN            PIN         BORCIN
FILL24012  3.66480000E+02  7.24640000E+06
*****      VMTB
FILL24VMTB0        .00000000E+00       2.07200000E+00       5.05900000E+05
FILL24VMTB1       2.07200000E+00       5.34300000E+05       2.04100000E+00
FILL24VMTB2       5.56200000E+05       2.01400000E+00       5.93400000E+05
FILL24VMTB3       2.00100000E+00       6.56900000E+05       1.89300000E+00
FILL24VMTB4       7.42300000E+05       1.79700000E+00       8.71500000E+05
FILL24VMTB5       1.62700000E+00       9.54700000E+05       1.51300000E+00
FILL24VMTB6       1.06000000E+06       1.36000000E+00       1.18000000E+06
FILL24VMTB7       1.16000000E+00       1.32200000E+06       8.79000000E-01
FILL24VMTB8       1.48000000E+06       4.75700000E-01       1.57600000E+06
*     2.20800000E-01       1.59200000E+06        .00000000E+00
FILL24VMTB9       1.03400000E+07        .00000000E+00 E
$
$$$$$$      VESSEL HEADER CARD
VESSEL2700000  27 *  VESSEL                                    *
$$$$$$      VESSEL PARAMETER CARD
*                NASX    NRSX    NTSX    NCSR    IDCU    IDCL    IDCR
VESSEL2700010     16       2       1      13      13       6       1
*                ICRU    ICRL    ICRR
VESSEL2700011     11       3       1
*                   ROHS           CPHS           CHS           EMHS
VESSEL2700012  7.83300000E+03  4.60000000E+02  4.30000000E+01  8.00000000E-01
*                ISDU    ISDL    ISDR        CZSDL        CRSDV
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VESSEL2700013      14       14        1  1.00000000E+26  1.00000000E+26
*              NODESD       DHOUTL        DHOUTV        DTOUTL        DTOUTV
VESSEL2700014       3   4.226600E+00  4.226600E+00  2.970400E+02  2.970400E+02
*              LEVOPT       ALPCUT         DALPC        DALPCI       EPSALPL
VESSEL2700015       1   7.000000E-01  2.000000E-01  1.000000E-01  1.000000E-03
*           IMTS
VESSEL2700050       2
*****        Z
VESSEL2700110  8.8900E-02  5.7861E-01  9.8742E-01  1.1032E+00
VESSEL2700111  1.2160E+00  1.4384E+00  1.5685E+00  1.9448E+00
VESSEL2700112  2.8812E+00  3.9642E+00  5.1436E+00  5.4516E+00
VESSEL2700113  6.4174E+00  7.1882E+00  7.6319E+00  7.8296E+00 E
*****        RAD
VESSEL2700120  1.3233E-01  2.0472E-01 E
*****        TH
VESSEL2700130  6.2832E+00 E
*                ISRL     ISRC     ISRF    JUNS          ZJN
VESSEL2700140       7        2        2       4  1.00000000E+00
VESSEL2700141       9        2       -2      28   .00000000E+00
VESSEL2700142       2        2        2       9  1.00000000E+00
VESSEL2700143       6        1       -2      33   .00000000E+00
VESSEL2700144       7        2        2      26  1.00000000E+00
VESSEL2700145       9        2       -2      29   .00000000E+00
VESSEL2700146       2        2        2      30  1.00000000E+00
VESSEL2700147       3        1        2      20  1.00000000E+00
+                  12        1       -2      21   .00000000E+00
+                   9        2        3      11  5.00000000E-01
+                  13        1        3      17  5.00000000E-01
+                  12        1        3      15  5.00000000E-01
+                  11        1        3      13  5.00000000E-01
*       LEVEL  1 DATA
*****        HSA
VESSEL2701HSA0        4.23500000E-02        5.64700000E-02 E
*****        HSM
VESSEL2701HSM0        8.57200000E-01        1.14300000E+00 E
*****        DSA
VESSEL2701DSA0         .00000000E+00        1.14400000E-01 E
*****        DSTH
VESSEL2701DSTH0         .00000000E+00        2.38000000E-02 E
*****        MATDS
VESSEL2701MATDS0  R02            9 E
*****        DST
VESSEL2701DST0  R03  5.47000000E+02       5.45635128E+02       5.45104923E+02
VESSEL2701DST1       5.44603214E+02 E
*****        FKLOS-T
VESSEL2701FKLOS-T0  R02    .00000000E+00 E
*****        FKLOS-Z
VESSEL2701FKLOS-Z0  R02    .00000000E+00 E
*****        FKLOS-R
VESSEL2701FKLOS-R0  R02    .00000000E+00 E
*****        RKLOS-T
VESSEL2701RKLOS-T0  R02    .00000000E+00 E
*****        RKLOS-Z
VESSEL2701RKLOS-Z0  R02    .00000000E+00 E
*****        RKLOS-R
VESSEL2701RKLOS-R0  R02    .00000000E+00 E
*****        VOL
VESSEL2701VOL0        4.40900000E-01        5.06600000E-01 E
*****        FA-T
VESSEL2701FA-T0  R02    .00000000E+00 E
*****        FA-Z
VESSEL2701FA-Z0        4.40900000E-01        5.06600000E-01 E
*****        FA-R
VESSEL2701FA-R0        2.03000000E-01         .00000000E+00 E
*****        HD-T
VESSEL2701HD-T0  R02  7.39700000E-02 E
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*****        HD-Z
VESSEL2701HD-Z0         7.39700000E-02       5.69700000E-02 E
*****        HD-R
VESSEL2701HD-R0  R02  8.43900000E-02 E
*****        EPSD-T
VESSEL2701EPSD-T0  R02    .00000000E+00 E
*****        EPSD-Z
VESSEL2701EPSD-Z0  R02    .00000000E+00 E
*****        EPSD-R
VESSEL2701EPSD-R0  R02    .00000000E+00 E
*****        HSTN
VESSEL2701HSTN0         5.47768748E+02       5.47790694E+02 E
*****        ALPN
VESSEL2701ALPN0         4.83150016E-11       3.36013046E-11 E
*****        VVN-T
VESSEL2701VVN-T0  R02    .00000000E+00 E
*****        VVN-Z
VESSEL2701VVN-Z0         5.88963158E-02      -1.53107298E-02 E
*****        VVN-R
VESSEL2701VVN-R0        -7.26352155E-02        .00000000E+00 E
*****        VLN-T
VESSEL2701VLN-T0  R02    .00000000E+00 E
*****        VLN-Z
VESSEL2701VLN-Z0         3.35678788E-02      -2.09718205E-02 E
*****        VLN-R
VESSEL2701VLN-R0        -5.42618433E-02        .00000000E+00 E
*****        TVN
VESSEL2701TVN0  R02  5.62298428E+02 E
*****        TLN
VESSEL2701TLN0          5.47769037E+02       5.47790228E+02 E
*****        PN
VESSEL2701PN0  R02  7.34622354E+06 E
*****        ILEV
VESSEL2701ILEV0  R02              0 E
*****        DZLEV
VESSEL2701DZLEV0  R02  8.89000000E-02 E
*****        VLEV
VESSEL2701VLEV0  R02    .00000000E+00 E
*****        ALPP
VESSEL2701ALPP0  R02    .00000000E+00 E
*****        ALPM
VESSEL2701ALPM0  R02    .00000000E+00 E
*****        ICCFL
VESSEL2701ICCFL0  R02              0 E
*      LEVEL  2 DATA
*****        HSA
VESSEL2702HSA0          2.33300000E-01       3.11100000E-01 E
*****        HSM
VESSEL2702HSM0          4.72200000E+00       6.29600000E+00 E
*****        DSA
VESSEL2702DSA0           .00000000E+00       6.29900000E-01 E
*****        DSTH
VESSEL2702DSTH0          .00000000E+00       2.38000000E-02 E
*****        MATDS
VESSEL2702MATDS0  R02              9 E
*****        DST
VESSEL2702DST0  R03  5.47000000E+02       5.46609276E+02       5.46077400E+02
VESSEL2702DST1          5.45573543E+02 E
*****        FKLOS-T
VESSEL2702FKLOS-T0  R02    .00000000E+00 E
*****        FKLOS-Z
VESSEL2702FKLOS-Z0  R02    .00000000E+00 E
*****        FKLOS-R
VESSEL2702FKLOS-R0  R02    .00000000E+00 E
*****        RKLOS-T
VESSEL2702RKLOS-T0  R02    .00000000E+00 E
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*****        RKLOS-Z
VESSEL2702RKLOS-Z0  R02    .00000000E+00 E
*****        RKLOS-R
VESSEL2702RKLOS-R0  R02    .00000000E+00 E
*****        VOL
VESSEL2702VOL0        4.40900000E-01        5.06600000E-01 E
*****        FA-T
VESSEL2702FA-T0  R02    .00000000E+00 E
*****        FA-Z
VESSEL2702FA-Z0        4.40900000E-01        4.65300000E-01 E
*****        FA-R
VESSEL2702FA-R0        2.03000000E-01         .00000000E+00 E
*****        HD-T
VESSEL2702HD-T0  R02  7.39700000E-02 E
*****        HD-Z
VESSEL2702HD-Z0        7.39700000E-03        4.99000000E-02 E
*****        HD-R
VESSEL2702HD-R0  R02  4.64900000E-01 E
*****        EPSD-T
VESSEL2702EPSD-T0  R02    .00000000E+00 E
*****        EPSD-Z
VESSEL2702EPSD-Z0  R02    .00000000E+00 E
*****        EPSD-R
VESSEL2702EPSD-R0  R02    .00000000E+00 E
*****        HSTN
VESSEL2702HSTN0        5.47867717E+02        5.47828882E+02 E
*****        ALPN
VESSEL2702ALPN0        1.17599954E-11        2.65978299E-13 E
*****        VVN-T
VESSEL2702VVN-T0  R02    .00000000E+00 E
*****        VVN-Z
VESSEL2702VVN-Z0        4.08648054E-01        4.84842463E-01 E
*****        VVN-R
VESSEL2702VVN-R0       -1.21827005E-01         .00000000E+00 E
*****        VLN-T
VESSEL2702VLN-T0  R02    .00000000E+00 E
*****        VLN-Z
VESSEL2702VLN-Z0        3.42774161E-01        3.82077162E-01 E
*****        VLN-R
VESSEL2702VLN-R0       -9.07375831E-02         .00000000E+00 E
*****        TVN
VESSEL2702TVN0  R02  5.62278189E+02 E
*****        TLN
VESSEL2702TLN0        5.47867564E+02        5.47828592E+02 E
*****        PN
VESSEL2702PN0  R02  7.34405276E+06 E
*****        ILEV
VESSEL2702ILEV0  R02           0 E
*****        DZLEV
VESSEL2702DZLEV0  R02  4.89710000E-01 E
*****        VLEV
VESSEL2702VLEV0  R02    .00000000E+00 E
*****        ALPP
VESSEL2702ALPP0  R02    .00000000E+00 E
*****        ALPM
VESSEL2702ALPM0  R02    .00000000E+00 E
*****        ICCFL
VESSEL2702ICCFL0  R02           0 E
*     LEVEL  3 DATA
*****        HSA
VESSEL2703HSA0        1.47600000E-02        1.96800000E-02 E
*****        HSM
VESSEL2703HSM0        2.98800000E-01        3.98400000E-01 E
*****        DSA
VESSEL2703DSA0         .00000000E+00        5.26000000E-01 E
*****        DSTH
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VESSEL2703DSTH0          .00000000E+00       2.38000000E-02 E
*****        MATDS
VESSEL2703MATDS0  R02             9 E
*****        DST
VESSEL2703DST0  R03  5.47000000E+02      5.46946385E+02      5.46413291E+02
VESSEL2703DST1       5.45908486E+02 E
*****        FKLOS-T
VESSEL2703FKLOS-T0  R02   .00000000E+00 E
*****        FKLOS-Z
VESSEL2703FKLOS-Z0  R02   .00000000E+00 E
*****        FKLOS-R
VESSEL2703FKLOS-R0  R02   .00000000E+00 E
*****        RKLOS-T
VESSEL2703RKLOS-T0  R02   .00000000E+00 E
*****        RKLOS-Z
VESSEL2703RKLOS-Z0  R02   .00000000E+00 E
*****        RKLOS-R
VESSEL2703RKLOS-R0  R02   .00000000E+00 E
*****        VOL
VESSEL2703VOL0        4.91400000E-01       5.55000000E-01 E
*****        FA-T
VESSEL2703FA-T0  R02   .00000000E+00 E
*****        FA-Z
VESSEL2703FA-Z0        3.82800000E-01       4.78300000E-01 E
*****        FA-R
VESSEL2703FA-R0        2.03000000E-01        .00000000E+00 E
*****        HD-T
VESSEL2703HD-T0  R02  7.55800000E-02 E
*****        HD-Z
VESSEL2703HD-Z0        7.55800000E-02       5.51100000E-02 E
*****        HD-R
VESSEL2703HD-R0  R02  3.88200000E-01 E
*****        EPSD-T
VESSEL2703EPSD-T0  R02   .00000000E+00 E
*****        EPSD-Z
VESSEL2703EPSD-Z0  R02   .00000000E+00 E
*****        EPSD-R
VESSEL2703EPSD-R0  R02   .00000000E+00 E
*****        HSTN
VESSEL2703HSTN0  R02  5.47859338E+02 E
*****        ALPN
VESSEL2703ALPN0        7.06127690E-12       6.01580854E-13 E
*****        VVN-T
VESSEL2703VVN-T0  R02   .00000000E+00 E
*****        VVN-Z
VESSEL2703VVN-Z0       -2.65746359E-01       1.97575794E-01 E
*****        VVN-R
VESSEL2703VVN-R0       -1.68605566E-01        .00000000E+00 E
*****        VLN-T
VESSEL2703VLN-T0  R02   .00000000E+00 E
*****        VLN-Z
VESSEL2703VLN-Z0       -2.15226029E-01       1.36147948E-01 E
*****        VLN-R
VESSEL2703VLN-R0       -1.25444359E-01        .00000000E+00 E
*****        TVN
VESSEL2703TVN0  R02  5.62244719E+02 E
*****        TLN
VESSEL2703TLN0  R02  5.47859109E+02 E
*****        PN
VESSEL2703PN0  R02  7.34046385E+06 E
*****        ILEV
VESSEL2703ILEV0  R02             0 E
*****        DZLEV
VESSEL2703DZLEV0  R02  4.08810000E-01 E
*****        VLEV
VESSEL2703VLEV0  R02   .00000000E+00 E
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*****       ALPP
VESSEL2703ALPP0  R02   .00000000E+00 E
*****       ALPM
VESSEL2703ALPM0  R02   .00000000E+00 E
*****       ICCFL
VESSEL2703ICCFL0              2              0 E
*****       WETP
VESSEL2703WETP0  R02   .00000000E+00 E
*     LEVEL  4 DATA
*****     HSA
VESSEL2704HSA0  R02   .00000000E+00 E
*****     HSM
VESSEL2704HSM0  R02   .00000000E+00 E
*****     DSA
VESSEL2704DSA0        .00000000E+00       1.48800000E-01 E
*****     DSTH
VESSEL2704DSTH0        .00000000E+00       2.38000000E-02 E
*****       MATDS
VESSEL2704MATDS0  R02           9 E
*****       DST
VESSEL2704DST0  R03  5.47000000E+02       5.45912455E+02       5.45381791E+02
VESSEL2704DST1       5.44879476E+02 E
*****       FKLOS-T
VESSEL2704FKLOS-T0  R02   .00000000E+00 E
*****       FKLOS-Z
VESSEL2704FKLOS-Z0  R02   .00000000E+00 E
*****       FKLOS-R
VESSEL2704FKLOS-R0  R02   .00000000E+00 E
*****       RKLOS-T
VESSEL2704RKLOS-T0  R02   .00000000E+00 E
*****       RKLOS-Z
VESSEL2704RKLOS-Z0  R02   .00000000E+00 E
*****       RKLOS-R
VESSEL2704RKLOS-R0  R02   .00000000E+00 E
*****       VOL
VESSEL2704VOL0       3.82800000E-01       5.59000000E-01 E
*****       FA-T
VESSEL2704FA-T0  R02   .00000000E+00 E
*****       FA-Z
VESSEL2704FA-Z0       3.82800000E-01       4.76300000E-01 E
*****       FA-R
VESSEL2704FA-R0       2.03000000E-01        .00000000E+00 E
*****       HD-T
VESSEL2704HD-T0  R02  7.55800000E-02 E
*****       HD-Z
VESSEL2704HD-Z0       7.55800000E-02       5.51100000E-02 E
*****       HD-R
VESSEL2704HD-R0  R02  1.09800000E-01 E
*****       EPSD-T
VESSEL2704EPSD-T0  R02   .00000000E+00 E
*****       EPSD-Z
VESSEL2704EPSD-Z0  R02   .00000000E+00 E
*****       EPSD-R
VESSEL2704EPSD-R0  R02   .00000000E+00 E
*****       HSTN
VESSEL2704HSTN0  R02  5.54800000E+02 E
*****       ALPN
VESSEL2704ALPN0       2.61659008E-12       8.10152600E-13 E
*****       VVN-T
VESSEL2704VVN-T0  R02   .00000000E+00 E
*****       VVN-Z
VESSEL2704VVN-Z0      -1.37216638E-01       1.01948998E-01 E
*****       VVN-R
VESSEL2704VVN-R0      -1.77955993E-01        .00000000E+00 E
*****       VLN-T
VESSEL2704VLN-T0  R02   .00000000E+00 E
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*****        VLN-Z
VESSEL2704VLN-Z0       -1.13594771E-01       6.55348876E-02 E
*****        VLN-R
VESSEL2704VLN-R0       -1.31911964E-01        .00000000E+00 E
*****        TVN
VESSEL2704TVN0  R02  5.62226675E+02 E
*****        TLN
VESSEL2704TLN0        5.47800008E+02       5.47866038E+02 E
*****        PN
VESSEL2704PN0  R02  7.33852969E+06 E
*****        ILEV
VESSEL2704ILEV0  R02            0 E
*****        DZLEV
VESSEL2704DZLEV0  R02  1.15780000E-01 E
*****        VLEV
VESSEL2704VLEV0  R02   .00000000E+00 E
*****        ALPP
VESSEL2704ALPP0  R02   .00000000E+00 E
*****        ALPM
VESSEL2704ALPM0  R02   .00000000E+00 E
*****        ICCFL
VESSEL2704ICCFL0  R02            0 E
*     LEVEL  5 DATA
*****        HSA
VESSEL2705HSA0        2.02700000E-02       1.43100000E-02 E
*****        HSM
VESSEL2705HSM0        3.17500000E+00       2.24200000E+00 E
*****        DSA
VESSEL2705DSA0         .00000000E+00       2.88200000E-01 E
*****        DSTH
VESSEL2705DSTH0         .00000000E+00       2.38000000E-02 E
*****        MATDS
VESSEL2705MATDS0  R02            9 E
*****        DST
VESSEL2705DST0  R03  5.47000000E+02       5.45613477E+02       5.45082[illegible]54E+02
VESSEL2705DST1       5.44581179E+02 E
*****        FKLOS-T
VESSEL2705FKLOS-T0  R02   .00000000E+00 E
*****        FKLOS-Z
VESSEL2705FKLOS-Z0  R02   .00000000E+00 E
*****        FKLOS-R
VESSEL2705FKLOS-R0  R02   .00000000E+00 E
*****        RKLOS-T
VESSEL2705RKLOS-T0  R02   .00000000E+00 E
*****        RKLOS-Z
VESSEL2705RKLOS-Z0  R02   .00000000E+00 E
*****        RKLOS-R
VESSEL2705RKLOS-R0  R02   .00000000E+00 E
*****        VOL
VESSEL2705VOL0        5.44600000E-01       6.75100000E-01 E
*****        FA-T
VESSEL2705FA-T0  R02   .00000000E+00 E
*****        FA-Z
VESSEL2705FA-Z0  R02   .00000000E+00 E
*****        FA-R
VESSEL2705FA-R0        7.33200000E-01        .00000000E+00 E
*****        HD-T
VESSEL2705HD-T0  R02  1.92500000E-01 E
*****        HD-Z
VESSEL2705HD-Z0  R02  1.92500000E-01 E
*****        HD-R
VESSEL2705HD-R0  R02  1.92500000E-01 E
*****        EPSD-T
VESSEL2705EPSD-T0  R02   .00000000E+00 E
*****        EPSD-Z
VESSEL2705EPSD-Z0  R02   .00000000E+00 E
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*****         EPSD-R
VESSEL2705EPSD-R0  R02    .00000000E+00 E
*****         HSTN
VESSEL2705HSTN0         5.47731422E+02        5.47768019E+02 E
*****         ALPN
VESSEL2705ALPN0         3.77528412E-12        2.09722921E-12 E
*****         VVN-T
VESSEL2705VVN-T0  R02    .00000000E+00 E
*****         VVN-Z
VESSEL2705VVN-Z0  R02    .00000000E+00 E
*****         VVN-R
VESSEL2705VVN-R0        -4.71787767E-02         .00000000E+00 E
*****         VLN-T
VESSEL2705VLN-T0  R02    .00000000E+00 E
*****         VLN-Z
VESSEL2705VLN-Z0  R02    .00000000E+00 E
*****         VLN-R
VESSEL2705VLN-R0        -3.47878058E-02         .00000000E+00 E
*****         TVN
VESSEL2705TVN0  R02  5.62219371E+02 E
*****         TLN
VESSEL2705TLN0         5.47734457E+02        5.47770213E+02 E
*****         PN
VESSEL2705PN0  R02  7.33774681E+06 E
*****         ILEV
VESSEL2705ILEV0  R02            0 E
*****         DZLEV
VESSEL2705DZLEV0  R02  1.12800000E-01 E
*****         VLEV
VESSEL2705VLEV0  R02    .00000000E+00 E
*****         ALPP
VESSEL2705ALPP0  R02    .00000000E+00 E
*****         ALPM
VESSEL2705ALPM0         2.61659008E-12        8.10152600E-13 E
*****         ICCFL
VESSEL2705ICCFL0  R02            0 E
*     LEVEL  6 DATA
*****       HSA
VESSEL2706HSA0        1.06400000E-01        .00000000E+00 E
*****       HSM
VESSEL2706HSM0        1.66700000E+01        .00000000E+00 E
*****       DSA
VESSEL2706DSA0  R02    .00000000E+00 E
*****       DSTH
VESSEL2706DSTH0  R02    .00000000E+00 E
*****       MATDS
VESSEL2706MATDS0  R02          9 E
*****       DST
VESSEL2706DST0  R06  5.47000000E+02 E
*****         FKLOS-T
VESSEL2706FKLOS-T0  R02    .00000000E+00 E
*****         FKLOS-Z
VESSEL2706FKLOS-Z0  R02    .00000000E+00 E
*****         FKLOS-R
VESSEL2706FKLOS-R0  R02    .00000000E+00 E
*****         RKLOS-T
VESSEL2706RKLOS-T0  R02    .00000000E+00 E
*****         RKLOS-Z
VESSEL2706RKLOS-Z0  R02    .00000000E+00 E
*****         RKLOS-R
VESSEL2706RKLOS-R0  R02    .00000000E+00 E
*****         VOL
VESSEL2706VOL0        8.29000000E-02        .00000000E+00 E
*****         FA-T
VESSEL2706FA-T0  R02    .00000000E+00 E
*****         FA-Z
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VESSEL2706FA-Z0         8.29000000E-02        .00000000E+00 E
*****        FA-R
VESSEL2706FA-R0  R02    .00000000E+00 E
*****        HD-T
VESSEL2706HD-T0  R02  3.81000000E-02 E
*****        HD-Z
VESSEL2706HD-Z0  R02  3.81000000E-02 E
*****        HD-R
VESSEL2706HD-R0  R02  3.81000000E-02 E
*****        EPSD-T
VESSEL2706EPSD-T0  R02    .00000000E+00 E
*****        EPSD-Z
VESSEL2706EPSD-Z0  R02    .00000000E+00 E
*****        EPSD-R
VESSEL2706EPSD-R0  R02    .00000000E+00 E
*****        HSTN
VESSEL2706HSTN0         5.47861787E+02       5.54800000E+02 E
*****        ALPN
VESSEL2706ALPN0         3.70289882E-13        .00000000E+00 E
*****        VVN-T
VESSEL2706VVN-T0  R02    .00000000E+00 E
*****        VVN-Z
VESSEL2706VVN-Z0         4.96988181E-01        .00000000E+00 E
*****        VVN-R
VESSEL2706VVN-R0  R02    .00000000E+00 E
*****        VLN-T
VESSEL2706VLN-T0  R02    .00000000E+00 E
*****        VLN-Z
VESSEL2706VLN-Z0         3.94949903E-01        .00000000E+00 E
*****        VLN-R
VESSEL2706VLN-R0  R02    .00000000E+00 E
*****        TVN
VESSEL2706TVN0        5.61205481E+02       5.60135168E+02 E
*****        TLN
VESSEL2706TLN0        5.47861533E+02       5.47000000E+02 E
*****        PN
VESSEL2706PN0       7.22970700E+06       7.11700000E+06 E
*****        ILEV
VESSEL2706ILEV0  R02          0 E
*****        DZLEV
VESSEL2706DZLEV0  R02  2.22400000E-01 E
*****        VLEV
VESSEL2706VLEV0  R02    .00000000E+00 E
*****        ALPP
VESSEL2706ALPP0  R02    .00000000E+00 E
*****        ALPM
VESSEL2706ALPM0  R02    .00000000E+00 E
*****        ICCFL
VESSEL2706ICCFL0  R02          0 E
*     LEVEL  7 DATA
*****        HSA
VESSEL2707HSA0        2.02700000E-02       1.03800000E-01 E
*****        HSM
VESSEL2707HSM0        3.17500000E+00       1.62700000E+01 E
*****        DSA
VESSEL2707DSA0        6.22600000E-02       3.10200000E-01 E
*****        DSTH
VESSEL2707DSTH0        1.58800000E-03       2.38000000E-02 E
*****        MATDS
VESSEL2707MATDS0  R02          9 E
*****        DST
VESSEL2707DST0  R02  5.47708309E+02       5.47694745E+02       5.44988447E+02
VESSEL2707DST1        5.44459219E+02       5.43958892E+02 E
*****        FKLOS-T
VESSEL2707FKLOS-T0  R02    .00000000E+00 E
*****        FKLOS-Z
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VESSEL2707FKLOS-Z0  R02    .00000000E+00 E
*****          FKLOS-R
VESSEL2707FKLOS-R0  R02    .00000000E+00 E
*****          RKLOS-T
VESSEL2707RKLOS-T0  R02    .00000000E+00 E
*****          RKLOS-Z
VESSEL2707RKLOS-Z0  R02    .00000000E+00 E
*****          RKLOS-R
VESSEL2707RKLOS-R0  R02    .00000000E+00 E
*****          VOL
VESSEL2707VOL0         1.50600000E-01       1.07400000E+00 E
*****          FA-T
VESSEL2707FA-T0  R02    .00000000E+00 E
*****          FA-Z
VESSEL2707FA-Z0         1.65600000E-01       9.75500000E-01 E
*****          FA-R
VESSEL2707FA-R0  R02    .00000000E+00 E
*****          HD-T
VESSEL2707HD-T0         5.38500000E-02       8.36500000E-02 E
*****          HD-Z
VESSEL2707HD-Z0         5.38500000E-02       8.36500000E-02 E
*****          HD-R
VESSEL2707HD-R0         5.38500000E-02       8.36500000E-02 E
*****          EPSD-T
VESSEL2707EPSD-T0  R02    .00000000E+00 E
*****          EPSD-Z
VESSEL2707EPSD-Z0  R02    .00000000E+00 E
*****          EPSD-R
VESSEL2707EPSD-R0  R02    .00000000E+00 E
*****          HSTN
VESSEL2707HSTN0         5.47857033E+02       5.47142314E+02 E
*****          ALPN
VESSEL2707ALPN0         4.68331989E-13       7.29281023E-09 E
*****          VVN-T
VESSEL2707VVN-T0  R02    .00000000E+00 E
*****          VVN-Z
VESSEL2707VVN-Z0         2.75413031E-01      -1.46607790E-01 E
*****          VVN-R
VESSEL2707VVN-R0  R02    .00000000E+00 E
*****          VLN-T
VESSEL2707VLN-T0  R02    .00000000E+00 E
*****          VLN-Z
VESSEL2707VLN-Z0         1.97711834E-01      -1.22049370E-01 E
*****          VLN-R
VESSEL2707VLN-R0  R02    .00000000E+00 E
*****          TVN
VESSEL2707TVN0         5.61190314E+02       5.60765155E+02 E
*****          TLN
VESSEL2707TLN0         5.47857050E+02       5.47145182E+02 E
*****          PN
VESSEL2707PN0         7.22810023E+06       7.1831727[illegible]E+06 E
*****          ILEV
VESSEL2707ILEV0  R02            0 E
*****          DZLEV
VESSEL2707DZLEV0  R02  1.30100000E-01 E
*****          VLEV
VESSEL2707VLEV0  R02    .00000000E+00 E
*****          ALPP
VESSEL2707ALPP0  R02    .00000000E+00 E
*****          ALPM
VESSEL2707ALPM0  R02    .00000000E+00 E
*****          ICCFL
VESSEL2707ICCFL0  R02            0 E
*     LEVEL  8 DATA
*****       HSA
VESSEL2708HSA0  R02    .00000000E+00 E
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*****        HSM
VESSEL2708HSM0  R02    .00000000E+00 E
*****        DSA
VESSEL2708DSA0        2.55200000E-02       4.84000000E-01 E
*****        DSTH
VESSEL2708DSTH0        1.58800000E-03       2.38000000E-02 E
*****        MATL
VESSEL2708MATDS0  R02            9 E
*****        DST
VESSEL2708DST0  R02  5.47598769E+02       5.47584342E+02       5.45243515E+02
VESSEL2708DST1       5.44713680E+02       5.44212737E+02 E
*****          FKLOS-T
VESSEL2708FKLOS-T0  R02    .00000000E+00 E
*****          FKLOS-Z
VESSEL2708FKLOS-Z0  R02    .00000000E+00 E
*****          FKLOS-R
VESSEL2708FKLOS-R0  R02    .00000000E+00 E
*****          RKLOS-T
VESSEL2708RKLOS-T0  R02    .00000000E+00 E
*****          RKLOS-Z
VESSEL2708RKLOS-Z0  R02    .00000000E+00 E
*****          RKLOS-R
VESSEL2708RKLOS-R0  R02    .00000000E+00 E
*****        VOL
VESSEL2708VOL0        1.65600000E-01       1.01900000E+00 E
*****        FA-T
VESSEL2708FA-T0  R02    .00000000E+00 E
*****        FA-Z
VESSEL2708FA-Z0        1.65600000E-01       1.09600000E+00 E
*****        FA-R
VESSEL2708FA-R0  R02    .00000000E+00 E
*****        HD-T
VESSEL2708HD-T0        5.38500000E-02       1.06900000E-01 E
*****        HD-Z
VESSEL2708HD-Z0        5.38500000E-02       1.06900000E-01 E
*****        HD-R
VESSEL2708HD-R0        5.38500000E-02       1.06900000E-01 E
*****         EPSD-T
VESSEL2708EPSD-T0  R02    .00000000E+00 E
*****         EPSD-Z
VESSEL2708EPSD-Z0  R02    .00000000E+00 E
*****         EPSD-R
VESSEL2708EPSD-R0  R02    .00000000E+00 E
*****         HSTN
VESSEL2708HSTN0  R02  5.54800000E+02 E
*****         ALPN
VESSEL2708ALPN0        1.08936678E-12       4.57190130E-09 E
*****         VVN-T
VESSEL2708VVN-T0  R02    .00000000E+00 E
*****         VVN-Z
VESSEL2708VVN-Z0        2.75547401E-01      -1.28860502E-01 E
*****         VVN-R
VESSEL2708VVN-R0  R02    .00000000E+00 E
*****         VLN-T
VESSEL2708VLN-T0  R02    .00000000E+00 E
*****         VLN-Z
VESSEL2708VLN-Z0        1.97711372E-01      -1.08639802E-01 E
*****         VLN-R
VESSEL2708VLN-R0  R02    .00000000E+00 E
*****         TVN
VESSEL2708TVN0        5.61172509E+02       5.60747114E+02 E
*****         TLN
VESSEL2708TLN0        5.47824704E+02       5.47200208E+02 E
*****         PN
VESSEL2708PN0       7.22621436E+06       7.18127[illegible]15E+06 E
*****         ILEV
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VESSEL2708ILEV0  R02          0 E
*****        DZLEV
VESSEL2708DZLEV0  R02  3.76300000E-01 E
*****        VLEV
VESSEL2708VLEV0  R02   .00000000E+00 E
*****        ALPP
VESSEL2708ALPP0  R02   .00000000E+00 E
*****        ALPM
VESSEL2708ALPM0  R02   .00000000E+00 E
*****        ICCFL
VESSEL2708ICCFL0  R02          0 E
*      LEVEL  9 DATA
*****      HSA
VESSEL2709HSA0  R02   .00000000E+00 E
*****      HSM
VESSEL2709HSM0  R02   .00000000E+00 E
*****      DSA
VESSEL2709DSA0       6.35200000E-01      1.20500000E+00 E
*****      DSTH
VESSEL2709DSTH0       1.58800000E-03      2.38000000E-02 E
*****        MATDS
VESSEL2709MATDS0  R02          9 E
*****        DST
VESSEL2709DST0  R02  5.47581942E+02      5.47570220E+02      5.45723376E+02
VESSEL2709DST1       5.45192608E+02      5.44690572E+02 E
*****        FKLOS-T
VESSEL2709FKLOS-T0  R02   .00000000E+00 E
*****        FKLOS-Z
VESSEL2709FKLOS-Z0  R02   .00000000E+00 E
*****        FKLOS-R
VESSEL2709FKLOS-R0  R02   .00000000E+00 E
*****        RKLOS-T
VESSEL2709RKLOS-T0  R02   .00000000E+00 E
*****        RKLOS-Z
VESSEL2709RKLOS-Z0  R02   .00000000E+00 E
*****        RKLOS-R
VESSEL2709RKLOS-R0  R02   .00000000E+00 E
*****        VOL
VESSEL2709VOL0       1.65600000E-01      1.13400000E+00 E
*****        FA-T
VESSEL2709FA-T0  R02   .00000000E+00 E
*****        FA-Z
VESSEL2709FA-Z0       1.65600000E-01      1.13800000E+00 E
*****        FA-R
VESSEL2709FA-R0  R02   .00000000E+00 E
*****        HD-T
VESSEL2709HD-T0       5.38500000E-02      1.27100000E-01 E
*****        HD-Z
VESSEL2709HD-Z0       5.38500000E-02      1.27100000E-01 E
*****        HD-R
VESSEL2709HD-R0       5.38500000E-02      1.27100000E-01 E
*****        EPSD-T
VESSEL2709EPSD-T0  R02   .00000000E+00 E
*****        EPSD-Z
VESSEL2709EPSD-Z0  R02   .00000000E+00 E
*****        EPSD-R
VESSEL2709EPSD-R0  R02   .00000000E+00 E
*****        HSTN
VESSEL2709HSTN0  R02  5.54800000E+02 E
*****        ALPN
VESSEL2709ALPN0       1.32585786E-11      2.01124579E-12 E
*****        VVN-T
VESSEL2709VVN-T0  R02   .00000000E+00 E
*****        VVN-Z
VESSEL2709VVN-Z0       2.75561535E-01      1.78751900E-01 E
*****        VVN-R
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VESSEL2709VVN-R0  R02   .00000000E+00 E
*****          VLN-T
VESSEL2709VLN-T0  R02   .00000000E+00 E
*****          VLN-Z
VESSEL2709VLN-Z0       1.97695254E-01      -2.05844783E-01 E
*****          VLN-R
VESSEL2709VLN-R0  R02   .00000000E+00 E
*****          TVN
VESSEL2709TVN0        5.61126030E+02       5.60700280E+02 E
*****          TLN
VESSEL2709TLN0        5.47765394E+02       5.47316860E+02 E
*****          PN
VESSEL2709PN0        7.22129320E+06      7.17633644E+06 E
*****          ILEV
VESSEL2709ILEV0  R02          0 E
*****          DZLEV
VESSEL2709DZLEV0  R02  9.36400000E-01 E
*****          VLEV
VESSEL2709VLEV0  R02   .00000000E+00 E
*****          ALPP
VESSEL2709ALPP0  R02   .00000000E+00 E
*****          ALPM
VESSEL2709ALPM0  R02   .00000000E+00 E
*****          ICCFL
VESSEL2709ICCFL0  R02          0 E
*     LEVEL 10 DATA
*****       HSA
VESSEL2710HSA0  R02   .00000000E+00 E
*****       HSM
VESSEL2710HSM0  R02   .00000000E+00 E
*****       DSA
VESSEL2710DSA0        7.34500000E-01       1.39300000E+00 E
*****       DSTH
VESSEL2710DSTH0        1.58800000E-03       2.38000000E-02 E
*****          MATDS
VESSEL2710MATDS0  R02          9 E
*****          DST
VESSEL2710DST0        5.57347942E+02       5.57601473E+02       5.57853557E+02
VESSEL2710DST1        5.59924857E+02       5.59356278E+02       5.588183381E+02 E
*****          FKLOS-T
VESSEL2710FKLOS-T0  R02   .00000000E+00 E
*****          FKLOS-Z
VESSEL2710FKLOS-Z0  R02   .00000000E+00 E
*****          FKLOS-R
VESSEL2710FKLOS-R0  R02   .00000000E+00 E
*****          RKLOS-T
VESSEL2710RKLOS-T0  R02   .00000000E+00 E
*****          RKLOS-Z
VESSEL2710RKLOS-Z0  R02   .00000000E+00 E
*****          RKLOS-R
VESSEL2710RKLOS-R0  R02   .00000000E+00 E
*****          VOL
VESSEL2710VOL0        1.65600000E-01       1.13800000E+00 E
*****          FA-T
VESSEL2710FA-T0  R02   .00000000E+00 E
*****          FA-Z
VESSEL2710FA-Z0        1.65600000E-01       1.13800000E+00 E
*****          FA-R
VESSEL2710FA-R0  R02   .00000000E+00 E
*****          HD-T
VESSEL2710HD-T0        5.38500000E-02       1.27100000E-01 E
*****          HD-Z
VESSEL2710HD-Z0        5.38500000E-02       1.27100000E-01 E
*****          HD-R
VESSEL2710HD-R0        5.38500000E-02       1.27100000E-01 E
*****          EPSD-T
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VESSEL2710EPSD-T0  R02   .00000000E+00 E
*****         EPSD-Z
VESSEL2710EPSD-Z0  R02   .00000000E+00 E
*****         EPSD-R
VESSEL2710EPSD-R0  R02   .00000000E+00 E
*****         HSTN
VESSEL2710HSTN0  R02  5.54800000E+02 E
*****         ALPN
VESSEL2710ALPN0         1.47885092E-10        7.80537170E-01 E
*****         VVN-T
VESSEL2710VVN-T0  R02   .00000000E+00 E
*****         VVN-Z
VESSEL2710VVN-Z0         2.76613353E-01       -4.?3692359E-03 E
*****         VVN-R
VESSEL2710VVN-R0  R02   .00000000E+00 E
*****         VLN-T
VESSEL2710VLN-T0  R02   .00000000E+00 E
*****         VLN-Z
VESSEL2710VLN-Z0         1.98549972E-01       -1.66525887E+00 E
*****         VLN-R
VESSEL2710VLN-R0  R02   .00000000E+00 E
*****         TVN
VESSEL2710TVN0         5.61054651E+02        5.60681862E+02 E
*****         TLN
VESSEL2710TLN0         5.49512570E+02        5.60676839E+02 E
*****         PN
VESSEL2710PN0         7.21374079E+06        7.17439653E+06 E
*****         ILEV
VESSEL2710ILEV0                  0                 1 E
*****         DZLEV
VESSEL2710DZLEV0         1.08300000E+00        1.18767140E-01 E
*****         VLEV
VESSEL2710VLEV0          .00000000E+00       -3.19924185E-04 E
*****         ALPP
VESSEL2710ALPP0          .00000000E+00        8.76678021E-01 E
*****         ALPM
VESSEL2710ALPM0          .00000000E+00        2.01124579E-12 E
*****         ICCFL
VESSEL2710ICCFL0  R02            0 E
*     LEVEL 11 DATA
*****      HSA
VESSEL2711HSA0  R02   .00000000E+00 E
*****      HSM
VESSEL2711HSM0  R02   .00000000E+00 E
*****      DSA
VESSEL2711DSA0        8.00000000E-01        1.51700000E+00 E
*****      DSTH
VESSEL2711DSTH0        1.58800000E-03        2.38000000E-02 E
*****         MATDS
VESSEL2711MATDS0  R02            9 E
*****         DST
VESSEL2711DST0        5.57857999E+02        5.58075927E+02        5.58292604E+02
VESSEL2711DST1        5.59951844E+02        5.59383190E+02        5.58845222E+02 E
*****         FKLOS-T
VESSEL2711FKLOS-T0  R02   .00000000E+00 E
*****         FKLOS-Z
VESSEL2711FKLOS-Z0  R02   .00000000E+00 E
*****         FKLOS-R
VESSEL2711FKLOS-R0  R02   .00000000E+00 E
*****         RKLOS-T
VESSEL2711RKLOS-T0  R02   .00000000E+00 E
*****         RKLOS-Z
VESSEL2711RKLOS-Z0  R02   .00000000E+00 E
*****         RKLOS-R
VESSEL2711RKLOS-R0  R02   .00000000E+00 E
*****         VOL
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VESSEL2711VOL0        1.65600000E-01      1.13800000E+00 E
*****          FA-T
VESSEL2711FA-T0  R02    .00000000E+00 E
*****          FA-Z
VESSEL2711FA-Z0        1.65600000E-01      7.96200000E-01 E
*****          FA-R
VESSEL2711FA-R0  R02    .00000000E+00 E
*****          HD-T
VESSEL2711HD-T0        5.38500000E-02      9.62500000E-02 E
*****          HD-Z
VESSEL2711HD-Z0        5.38500000E-02      9.62500000E-02 E
*****          HD-R
VESSEL2711HD-R0        5.38500000E-02      9.62500000E-02 E
*****          EPSD-T
VESSEL2711EPSD-T0  R02    .00000000E+00 E
*****          EPSD-Z
VESSEL2711EPSD-Z0  R02    .00000000E+00 E
*****          EPSD-R
VESSEL2711EPSD-R0  R02    .00000000E+00 E
*****          HSTN
VESSEL2711HSTN0  R02  5.54800000E+02 E
*****          ALPN
VESSEL2711ALPN0        1.46934014E-10      8.76678021E-01 E
*****          VVN-T
VESSEL2711VVN-T0  R02    .00000000E+00 E
*****          VVN-Z
VESSEL2711VVN-Z0        5.47020468E-01     -1.19101469E-02 E
*****          VVN-R
VESSEL2711VVN-R0  R02    .00000000E+00 E
*****          VLN-T
VESSEL2711VLN-T0  R02    .00000000E+00 E
*****          VLN-Z
VESSEL2711VLN-Z0        1.99365147E-01     -1.57151560E+00 E
*****          VLN-R
VESSEL2711VLN-R0  R02    .00000000E+00 E
*****          TVN
VESSEL2711TVN0        5.60974961E+02      5.60669570E+02 E
*****          TLN
VESSEL2711TLN0        5.51136825E+02      5.60662704E+02 E
*****          PN
VESSEL2711PN0        7.20531617E+06      7.17310205E+06 E
*****          ILEV
VESSEL2711ILEV0  R02           0 E
*****          DZLEV
VESSEL2711DZLEV0        1.17940000E+00       .00000000E+00 E
*****          VLEV
VESSEL2711VLEV0  R02    .00000000E+00 E
*****          ALPP
VESSEL2711ALPP0  R02    .00000000E+00 E
*****          ALPM
VESSEL2711ALPM0        1.46934014E-10       .00000000E+00 E
*****          ICCFL
VESSEL2711ICCFL0  R02           0 E
*     LEVEL 12 DATA
*****        HSA
VESSEL2712HSA0        1.30800000E-01      1.96100000E-01 E
*****        HSM
VESSEL2712HSM0        2.04900000E+01      3.07200000E+01 E
*****        DSA
VESSEL2712DSA0        1.41900000E-01      3.96100000E-01 E
*****        DSTH
VESSEL2712DSTH0        4.75000000E-03      2.38000000E-02 E
*****          MATDS
VESSEL2712MATDS0  R02           9 E
*****          DST
VESSEL2712DST0        5.60703283E+02      5.60682971E+02      5.60663014E+02
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VESSEL2712DST1        5.60041249E+02       5.59472353E+02       5.58934157E+02 E
*****          FKLOS-T
VESSEL2712FKLOS-T0  R02   .00000000E+00 E
*****          FKLOS-Z
VESSEL2712FKLOS-Z0       2.00000000E+00        .00000000E+00 E
*****          FKLOS-R
VESSEL2712FKLOS-R0  R02   .00000000E+00 E
*****          RKLOS-T
VESSEL2712RKLOS-T0  R02   .00000000E+00 E
*****          RKLOS-Z
VESSEL2712RKLOS-Z0  R02   .00000000E+00 E
*****          RKLOS-R
VESSEL2712RKLOS-R0  R02   .00000000E+00 E
*****          VOL
VESSEL2712VOL0        7.98800000E-01       7.04500000E-01 E
*****          FA-T
VESSEL2712FA-T0  R02   .00000000E+00 E
*****          FA-Z
VESSEL2712FA-Z0        5.67600000E-01       6.77000000E-01 E
*****          FA-R
VESSEL2712FA-R0  R02   .00000000E+00 E
*****          HD-T
VESSEL2712HD-T0        1.99400000E-01       9.65500000E-02 E
*****          HD-Z
VESSEL2712HD-Z0        1.99400000E-01       9.65500000E-02 E
*****          HD-R
VESSEL2712HD-R0        1.99400000E-01       9.65500000E-02 E
*****          EPSD-T
VESSEL2712EPSD-T0  R02   .00000000E+00 E
*****          EPSD-Z
VESSEL2712EPSD-Z0  R02   .00000000E+00 E
*****          EPSD-R
VESSEL2712EPSD-R0  R02   .00000000E+00 E
*****          HSTN
VESSEL2712HSTN0        5.60844719E+02       5.60656062E+02 E
*****          ALPN
VESSEL2712ALPN0        8.15385976E-01       8.13396872E-01 E
*****          VVN-T
VESSEL2712VVN-T0  R02   .00000000E+00 E
*****          VVN-Z
VESSEL2712VVN-Z0       3.71434538E+00      -1.47633919E-02 E
*****          VVN-R
VESSEL2712VVN-R0  R02   .00000000E+00 E
*****          VLN-T
VESSEL2712VLN-T0  R02   .00000000E+00 E
*****          VLN-Z
VESSEL2712VLN-Z0       3.10662613E+00      -1.80904121E+00 E
*****          VLN-R
VESSEL2712VLN-R0  R02   .00000000E+00 E
*****          TVN
VESSEL2712TVN0       5.60914521E+02       5.60659203E+02 E
*****          TLN
VESSEL2712TLN0       5.60844712E+02       5.60656061E+02 E
*****          PN
VESSEL2712PN0       7.20071327E+06       7.17201000E+06 E
*****          ILEV
VESSEL2712ILEV0                -1                0 E
*****          DZLEV
VESSEL2712DZLEV0  R02   .00000000E+00 E
*****          VLEV
VESSEL2712VLEV0  R02   .00000000E+00 E
*****          ALPP
VESSEL2712ALPP0  R02   .00000000E+00 E
*****          ALPM
VESSEL2712ALPM0  R02   .00000000E+00 E
*****          ICCFL
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VESSEL2712lCCFL0  R02          0 E
*      LEVEL 13 DATA
*****        HSA
VESSEL2713HSA0  R02   .00000000E+00 E
*****        HSM
VESSEL2713HSM0  R02   .00000000E+00 E
*****        DSA
VESSEL2713DSA0        8.03100000E-01      1.24200000E+00 E
*****        DSTH
VESSEL2713DSTH0        4.19100000E-03      2.38000000E-02 E
*****        MATDS
VESSEL2713MATDS0  R02          9 E
*****        DST
VESSEL2713DST0        5.60760729E+02      5.60711887E+02      5.60663802E+02
VESSEL2713DST1        5.60034872E+02      5.59465993E+02      5.58927813E+02 E
*****          FKLOS-T
VESSEL2713FKLOS-T0  R02   .00000000E+00 E
*****          FKLOS-Z
VESSEL2713FKLOS-Z0        6.00000000E-01        .00000000E+00 E
*****          FKLOS-R
VESSEL2713FKLOS-R0  R02   .00000000E+00 E
*****          RKLOS-T
VESSEL2713RKLOS-T0  R02   .00000000E+00 E
*****          RKLOS-Z
VESSEL2713RKLOS-Z0  R02   .00000000E+00 E
*****          RKLOS-R
VESSEL2713RKLOS-R0  R02   .00000000E+00 E
*****          VOL
VESSEL2713VOL0        8.99200000E-01      9.53800000E-01 E
*****          FA-T
VESSEL2713FA-T0  R02   .00000000E+00 E
*****          FA-Z
VESSEL2713FA-Z0        1.33900000E-01      9.53800000E-01 E
*****          FA-R
VESSEL2713FA-R0  R02   .00000000E+00 E
*****          HD-T
VESSEL2713HD-T0        9.68400000E-02      1.94800000E-01 E
*****          HD-Z
VESSEL2713HD-Z0        9.68400000E-02      1.94800000E-01 E
*****          HD-R
VESSEL2713HD-R0        9.68400000E-02      1.94800000E-01 E
*****          EPSD-T
VESSEL2713EPSD-T0  R02   .00000000E+00 E
*****          EPSD-Z
VESSEL2713EPSD-Z0  R02   .00000000E+00 E
*****          EPSD-R
VESSEL2713EPSD-R0  R02   .00000000E+00 E
*****          HSTN
VESSEL2713HSTN0  R02  5.54800000E+02 E
*****          ALPN
VESSEL2713ALPN0        8.34412637E-01      8.09381829E-01 E
*****          VVN-T
VESSEL2713VVN-T0  R02   .00000000E+00 E
*****          VVN-Z
VESSEL2713VVN-Z0        1.53790960E+01     -1.02778806E-02 E
*****          VVN-R
VESSEL2713VVN-R0  R02   .00000000E+00 E
*****          VLN-T
VESSEL2713VLN-T0  R02   .00000000E+00 E
*****          VLN-Z
VESSEL2713VLN-Z0        1.46867507E+01     -2.25022155E+00 E
*****          VLN-R
VESSEL2713VLN-R0  R02   .00000000E+00 E
*****          TVN
VESSEL2713TVN0        5.60901113E+02      5.60647532E+02 E
*****          TLN
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VESSEL2713TLN0        5.60898503E+02        [illegible].60646310E+02 E
*****         PN
VESSEL2713PN0        7.19763160E+06        7.17078158E+06 E
*****         ILEV
VESSEL2713ILEV0              -1                  0 E
*****         DZLEV
VESSEL2713DZLEV0  R02    .00000000E+00 E
*****         VLEV
VESSEL2713VLEV0  R02    .00000000E+00 E
*****         ALPP
VESSEL2713ALPP0  R02    .00000000E+00 E
*****         ALPM
VESSEL2713ALPM0  R02    .00000000E+00 E
*****         ICCFL
VESSEL2713ICCFL0  R02            0 E
*      LEVEL 14 DATA
*****         HSA
VESSEL2714HSA0         .00000000E+00        2.90000000E-01 E
*****         HSM
VESSEL2714HSM0         .00000000E+00        7.21100000E+00 E
*****         DSA
VESSEL2714DSA0        2.86100000E-01        9.91400000E-01 E
*****         DSTH
VESSEL2714DSTH0        3.17500000E-03        2.38000000E-02 E
*****         MATDS
VESSEL2714MATDS0  R02            9 E
*****         DST
VESSEL2714DST0        5.60679062E+02        5.60664520E+02        5.60650150E+02
VESSEL2714DST1        5.59863622E+02        5.59295205E+02        5.58757463E+02 E
*****         FKLOS-T
VESSEL2714FKLOS-T0  R02    .00000000E+00 E
*****         FKLOS-Z
VESSEL2714FKLOS-Z0        3.90000000E+00         .00000000E+00 E
*****         FKLOS-R
VESSEL2714FKLOS-R0        6.06600000E+01         .00000000E+00 E
*****         RKLOS-T
VESSEL2714RKLOS-T0  R02    .00000000E+00 E
*****         RKLOS-Z
VESSEL2714RKLOS-Z0        1.21300000E+01         .00000000E+00 E
*****         RKLOS-R
VESSEL2714RKLOS-R0  R02    .00000000E+00 E
*****         VOL
VESSEL2714VOL0        2.10000000E-01        1.52800000E+00 E
*****         FA-T
VESSEL2714FA-T0  R02    .00000000E+00 E
*****         FA-Z
VESSEL2714FA-Z0        1.42800000E-01        1.46500000E+00 E
*****         FA-R
VESSEL2714FA-R0        7.69800000E-02         .00000000E+00 E
*****         HD-T
VESSEL2714HD-T0        1.00100000E-01        2.52300000E-01 E
*****         HD-Z
VESSEL2714HD-Z0        1.00100000E-01        2.52300000E-01 E
*****         HD-R
VESSEL2714HD-R0        1.00100000E-01        2.52300000E-01 E
*****         EPSD-T
VESSEL2714EPSD-T0  R02    .00000000E+00 E
*****         EPSD-Z
VESSEL2714EPSD-Z0  R02    .00000000E+00 E
*****         EPSD-R
VESSEL2714EPSD-R0  R02    .00000000E+00 E
*****         HSTN
VESSEL2714HSTN0        5.54800000E+02        5.60638379E+02 E
*****         ALPN
VESSEL2714ALPN0        6.52487908E-01        8.91257036E-01 E
*****         VVN-T
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VESSEL2714VVN-T0  R02    .00000000E+00 E
*****           VVN-Z
VESSEL2714VVN-Z0        1.85429865E+01       -5.57573329E-03 E
*****           VVN-R
VESSEL2714VVN-R0        5.78642144E-26        .00000000E+00 E
*****           VLN-T
VESSEL2714VLN-T0  R02    .00000000E+00 E
*****           VLN-Z
VESSEL2714VLN-Z0       -3.66954413E-25       -1.82776320E+00 E
*****           VLN-R
VESSEL2714VLN-R0        1.04377799E+00        .00000000E+00 E
*****           TVN
VESSEL2714TVN0        5.60660795E+02       5.60636998E+02 E
*****           TLN
VESSEL2714TLN0        5.60707340E+02       5.60638379E+02 E
*****           PN
VESSEL2714PN0       7.17378375E+06       7.16966637E+06 E
*****           ILEV
VESSEL2714ILEV0                -1                0 E
*****           DZLEV
VESSEL2714DZLEV0  R02    .00000000E+00 E
*****           VLEV
VESSEL2714VLEV0  R02    .00000000E+00 E
*****           ALPP
VESSEL2714ALPP0  R02    .00000000E+00 E
*****           ALPM
VESSEL2714ALPM0  R02    .00000000E+00 E
*****           ICCFL
VESSEL2714ICCFL0  R02           0 E
*       LEVEL 15 DATA
*****         HSA
VESSEL2715HSA0         .00000000E+00       5.00100000E-01 E
*****         HSM
VESSEL2715HSM0         .00000000E+00       1.24400000E-01 E
*****         DSA
VESSEL2715DSA0        1.80300000E-01       5.70700000E-01 E
*****         DSTH
VESSEL2715DSTH0        3.17500000E-03       2.38000000E-02 E
*****           MATDS
VESSEL2715MATDS0  R02           9 E
*****           DST
VESSEL2715DST0   R03  5.60630508E+02       5.59761209E+02        5.59193069E+02
VESSEL2715DST1        5.58655589E+02 E
*****           FKLOS-T
VESSEL2715FKLOS-T0  R02    .00000000E+00 E
*****           FKLOS-Z
VESSEL2715FKLOS-Z0        2.90000000E+00        .00000000E+00 E
*****           FKLOS-R
VESSEL2715FKLOS-R0  R02    .00000000E+00 E
*****           RKLOS-T
VESSEL2715RKLOS-T0  R02    .00000000E+00 E
*****           RKLOS-Z
VESSEL2715RKLOS-Z0  R02    .00000000E+00 E
*****           RKLOS-R
VESSEL2715RKLOS-R0  R02    .00000000E+00 E
*****           VOL
VESSEL2715VOL0        2.39000000E-01       1.48100000E+00 E
*****           FA-T
VESSEL2715FA-T0  R02    .00000000E+00 E
*****           FA-Z
VESSEL2715FA-Z0        1.59600000E-01       1.24700000E+00 E
*****           FA-R
VESSEL2715FA-R0  R02    .00000000E+00 E
*****           HD-T
VESSEL2715HD-T0        1.05700000E-01       1.95100000E-01 E
*****           HD-Z
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VESSEL2715HD-Z0         1.05700000E-01        1.95100000E-01 E
*****          HD-R
VESSEL2715HD-R0         4.04600000E-02        1.95100000E-01 E
*****          EPSD-T
VESSEL2715EPSD-T0  R02    .00000000E+00 E
*****          EPSD-Z
VESSEL2715EPSD-Z0  R02    .00000000E+00 E
*****          EPSD-R
VESSEL2715EPSD-R0  R02    .00000000E+00 E
*****          HSTN
VESSEL2715HSTN0         5.60600000E+02        5.61084145E+02 E
*****          ALPN
VESSEL2715ALPN0  R02  9.99999999E-01 E
*****          VVN-T
VESSEL2715VVN-T0  R02    .00000000E+00 E
*****          VVN-Z
VESSEL2715VVN-Z0         1.08788130E+01       -6.55164233E-03 E
*****          VVN-R
VESSEL2715VVN-R0  R02    .00000000E+00 E
*****          VLN-T
VESSEL2715VLN-T0  R02    .00000000E+00 E
*****          VLN-Z
VESSEL2715VLN-Z0         1.01885714E+01       -6.78659002E-01 E
*****          VLN-R
VESSEL2715VLN-R0  R02    .00000000E+00 E
*****          TVN
VESSEL2715TVN0        5.60613751E+02        5.61083967E+02 E
*****          TLN
VESSEL2715TLN0        5.60649946E+02        5.60633764E+02 E
*****          PN
VESSEL2715PN0       7.17103580E+06        7.16933235E+06 E
*****          ILEV
VESSEL2715ILEV0              -1                 0 E
*****          DZLEV
VESSEL2715DZLEV0  R02    .00000000E+00 E
*****          VLEV
VESSEL2715VLEV0  R02    .00000000E+00 E
*****          ALPP
VESSEL2715ALPP0  R02    .00000000E+00 E
*****          ALPM
VESSEL2715ALPM0  R02    .00000000E+00 E
*****          ICCFL
VESSEL2715ICCFL0  R02          0 E
*     LEVEL 16 DATA
*****          HSA
VESSEL2716HSA0  R02    .00000000E+00 E
*****          HSM
VESSEL2716HSM0  R02    .00000000E+00 E
*****          DSA
VESSEL2716DSA0        1.37500000E-02        2.73400000E-01 E
*****          DSTH
VESSEL2716DSTH0  R02  2.38000000E-02 E
*****          MATDS
VESSEL2716MATDS0  R02          9 E
*****          DST
VESSEL2716DST0  R03  5.60632?49E+02        5.59731045E+02        5.59162987E+02
VESSEL2716DST1       5.58625584E+02 E
*****          FKLOS-T
VESSEL2716FKLOS-T0  R02    .00000000E+00 E
*****          FKLOS-Z
VESSEL2716FKLOS-Z0  R02    .00000000E+00 E
*****          FKLOS-R
VESSEL2716FKLOS-R0  R02    .00000000E+00 E
*****          RKLOS-T
VESSEL2716RKLOS-T0  R02    .00000000E+00 E
*****          RKLOS-Z
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VESSEL2716RKLOS-Z0  R02    .00000000E+00 E
*****          RKLOS-R
VESSEL2716RKLOS-R0  R02    .00000000E+00 E
*****          VOL
VESSEL2716VOL0  R02  1.00000000E+00 E
*****          FA-T
VESSEL2716FA-T0  R02    .00000000E+00 E
*****          FA-Z
VESSEL2716FA-Z0  R02    .00000000E+00 E
*****          FA-R
VESSEL2716FA-R0        1.00000000E+00         .00000000E+00 E
*****          HD-T
VESSEL2716HD-T0  R02  3.95400000E-01 E
*****          HD-Z
VESSEL2716HD-Z0  R02  3.95400000E-01 E
*****          HD-R
VESSEL2716HD-R0  R02  3.95400000E-01 E
*****          EPSD-T
VESSEL2716EPSD-T0  R02    .00000000E+00 E
*****          EPSD-Z
VESSEL2716EPSD-Z0  R02    .00000000E+00 E
*****          EPSD-R
VESSEL2716EPSD-R0  R02    .00000000E+00 E
*****          HSTN
VESSEL2716HSTN0  R02  5.60600000E+02 E
*****          ALPN
VESSEL2716ALPN0  R02  9.99999981E-01 E
*****          VVN-T
VESSEL2716VVN-T0  R02    .00000000E+00 E
*****          VVN-Z
VESSEL2716VVN-Z0  R02    .00000000E+00 E
*****          VVN-R
VESSEL2716VVN-R0        5.78514128E-01         .00000000E+00 E
*****          VLN-T
VESSEL2716VLN-T0  R02    .00000000E+00 E
*****          VLN-Z
VESSEL2716VLN-Z0  R02    .00000000E+00 E
*****          VLN-R
VESSEL2716VLN-R0        1.06622987E-01         .00000000E+00 E
*****          TVN
VESSEL2716TVN0  R02  5.60584919E+02 E
*****          TLN
VESSEL2716TLN0  R02  5.60634127E+02 E
*****          PN
VESSEL2716PN0        7.16937061E+06       7.16921457E+06 E
*****          ILEV
VESSEL2716ILEV0                 -1               0 E
*****          DZLEV
VESSEL2716DZLEV0  R02    .00000000E+00 E
*****          VLEV
VESSEL2716VLEV0  R02    .00000000E+00 E
*****          ALPP
VESSEL2716ALPP0  R02    .00000000E+00 E
*****          ALPM
VESSEL2716ALPM0  R02    .00000000E+00 E
*****          ICCFL
VESSEL2716ICCFL0  R02           0 E
CHECKOUT 5 0 0 0 0   0 7
```

Appendix B

Representative Major Edit for TLTA Test 6423

Appendix B
Representative Major Edit for TLTA Test 6423

This appendix contains a representative major edit taken from a TRAC-BF1/MOD1 output printout for the sample problem, TLTA Test 6423.

```
                         ******************************
                         *                            *
                         *    TRAC MAJOR EDIT     2   *
                         *                            *
                         *    AT TIME STEP =      5   *
                         ******************************

0   TIME = 7.44160E-06 SEC.   DELT = 2.48832E-06 SEC.   TIME STEPS =    5,   NUMBER OF HYDRODYNAMIC SOLUTION ITERATIONS =      2
0    TIME STEP COURANT LIMITED BY COMPONENT   27.FACE  39  TO  2.813E-02 SEC
0    TIME STEP SELECTION MODE =   0
0    TIME STEP DETERMINED BY ITERATION COUNT
0    AVERAGE OUTER ITERATION COUNT OVER THE LAST    5 TIME STEPS WAS  2.00E+00
0    TOTAL NUMBER OF TIMES THAT EACH COMPONENT WAS THE LAST TO CONVERGE SINCE THE LAST EDIT -
     TRAC COMP SEQUENCE NUMBER   1 -  10        0    0    0    0    0    0    0    0    0    0
     TRAC COMP SEQUENCE NUMBER  11 -  20        0    0    0    0    0    5    0    0    0    0
     TRAC COMP SEQUENCE NUMBER  21 -  24        0    0    0    0
0    THE LAST MINIMUM NUMBER OF OUTER ITERATIONS WAS  2 AT STEP    4. LIMITED BY COMPONENT 25. WITH DELTA-P/P =  4.36E-03
0    THE LAST MAXIMUM NUMBER OF OUTER ITERATIONS WAS  2 AT STEP    4. LIMITED BY COMPONENT 25. WITH DELTA-P/P =  4.36E-03
0    JOB TIME = 1.571E+01     TRAC EXECUTION TIME = 1.569E+01

0************   TIME =   0.00001    DELT = 2.48832E-06    NSTEP =      5   ************

  TRIP INFORMATION (SET TRIPS)

                   SET TRIP NO.    TIME SET POINT REACHED    DELAY TIME EXCEEDED
                   ------------    ----------------------    -------------------
                        1              0.000000E+00                 YES
                        3              0.000000E+00                 YES

0************   TIME =   0.00001    DELT = 2.48832E-06    NSTEP =      5   ************

  POWER INFORMATION

    TOTAL REACTOR POWER = 6.461E-06
0# # # # * EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- FILL     14++STEAM FLOW VELOCITY                    NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 =  0

                  CELL  1     LEAK FLOW RATE= -3.381E+00 KG/S       LEAK MASS FLUX= -7.935E+02 KG/M2-S

       PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
 CELL    (PA)                   (M/S)       (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)      (PA)
   1   7.169E+06  1.000000   -21.15      -21.15      560.633     560.600     560.600      737.9       37.51    -0.7169E+07    0 0     0 0

    MASS FLOW RATE =   0.0000E+00          TOTAL MASS IN  =  -2.5160E-05
0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- TEE       1++ LOOP SUCTION PIPE  MASS FLOW          NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 =  4     JUN2 =  5     JUN3 = 22

  PRIMARY TUBE

                  CELL  1     FLOW RATE IN  =  3.636E+00 KG/S       MASS FLUX IN      1.177E+03 KG/M2-S
                  CELL 10     FLOW RATE OUT =  3.631E+00 KG/S       MASS FLUX OUT =  8.522E+02 KG/M2-S

       PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
 CELL    (PA)                   (M/S)       (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)      (PA)
```

1	7.181E+06	0.000000	1.537	1.756	560.742	547.137	560.742	765.8	37.57	2476.	0 0	0 0
2	7.180E+06	0.000000	1.114	1.283	560.732	547.128	560.732	765.8	37.57	974.9	0 0	0 0
3	6.811E+06	0.000000	16.7(?)	17.10	557.159	547.005	557.159	765.6	35.42	0.3689E+06	0-1	0 0
4	6.811E+06	0.000000	1.115	1.270	557.163	546.968	557.163	765.6	35.42	-357.8	0 0	0 0
5	6.811E+06	0.000000	1.115	1.270	557.160	547.027	557.160	765.5	35.42	262.2	0 0	0 0
6	6.811E+06	0.000000	1.115	1.270	557.158	547.087	557.158	765.4	35.42	208.7	0 0	0 0
7	6.814E+06	0.000000	1.115	1.256	557.193	547.153	557.193	765.3	35.44	-3548.	0 0	0 0
8	6.826E+06	0.000000	1.115	1.239	557.305	547.366	557.305	764.9	35.51	-0.1135E+05	0 0	0 0
9	6.837E+06	0.000000	1.115	1.239	557.417	547.493	557.417	764.6	35.57	-0.1134E+05	0 0	0 0
10	6.841E+06	0.000000	1.115	1.249	557.453	547.558	557.453	764.5	35.59	-3586.	0 0	0 0
11			1.115	1.279						1170.	0 0	0 0

0

INTERFACIAL HEAT TRANSFER (+=FLASH.-=CONDENSE) — INTERFACIAL FRICTION

CELL	LIQ HTC*A (W/K)	VAPOR HTC*A (W/K)	WALL MASS TRANSFER RATE (KG/S)	TOTAL MASS TRANSFER RATE (KG/S)	TOT.E/(+LIQ OR-VAP.E) (J/J)	THERMODYNAMIC QUALITY	SHEAR COEFFI (KG/M3-S)	SLIP	REYGAS	REYLIQ
1	0.1492E-03	0.7460E-04	0.0000	-0.1358E-08	-0.5037E-14	-0.048	20.9	1.14	0.138E-03	0.694E+06
2	0.1421E-04	0.7106E-05	0.0000	-0.1294E-09	-0.4411E-15	-0.048	23.7	1.15	0.498E-04	0.317E+07
3	0.1410E-05	0.7051E-06	0.0000	-0.9431E-11	-0.3761E-16	-0.035	10.8	1.02	0.541E-05	0.316E+07
4	0.1928E-06	0.9640E-07	0.0000	-0.1295E-11	-0.5203E-18	-0.035	22.6	1.14	0.164E-07	0.630E+06
5	0.2677E-08	0.1338E-08	0.0000	-0.1787E-13	-0.6340E-20	-0.035	22.6	1.14	0.201E-09	0.630E+06
6	0.3265E-10	0.1632E-10	0.0000	-0.2166E-15	-0.1538E-2[illegible]	-0.035	22.5	1.14	0.488E-11	0.630E+06
7	0.8065E-12	0.4033E-12	0.0000	-0.5334E-17	-0.5053E-2[illegible]	-0.035	22.6	1.1[illegible]	0.159E-12	0.630E+06
8	0.1148E-12	0.5740E-13	0.0000	-0.7531E-18	-0.3558E-24	-0.034	22.8	1.11	0.113E-13	0.630E+06
9	0.2584E-13	0.1292E-13	0.0000	-0.1691E-18	-0.1599E-24	-0.034	22.8	1.11	0.510E-14	0.630E+06
10	0.2360E-13	0.1180E-13	0.0000	-0.1540E-18	-0.2996E-24	-0.034	22.8	1.12	0.974E-14	0.630E+06
11							22.5	1.15		

0

INSIDE WALL CONVECTION HEAT TRANSFER (ADIABATIC OUTSIDE WALL)

CELL	H T MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	QTOT (W)	QTOT/FL.E (J/J)	RADIAL TEMPERATURES <INSIDE
1	7.00	0.900E+04	0.000	-0.825E-01	-0.224E-15	547.137
2	7.00	0.447E+05	0.000	-0.565	-0.153E-14	547.128
3	7.00	0.447E+05	0.000	0.389	0.106E-14	547.005
4	7.00	0.771E+04	0.000	-0.410	-0.112E-14	546.968
5	7.00	0.771E+04	0.000	0.653	0.178E-14	547.027
6	7.00	0.771E+04	0.000	0.676	0.184E-14	547.088
7	7.00	0.771E+04	0.000	0.725	0.197E-14	547.154
8	7.00	0.771E+04	0.000	2.34	0.635E-14	547.3[illegible]
9	7.00	0.771E+04	0.000	1.38	0.375E-14	547.494
10	7.00	0.771E+04	0.000	0.720	0.195E-14	547.559

SIDE TUBE

CELL 1 FLOW RATE OUT = 1.785E-03 KG/S MASS FLUX OUT = 4.190E-01 KG/M2-S

CELL	PRESSURE (PA)	VAPOR FRAC	LIQ VEL (M/S)	VAP VEL (M/S)	T SAT (K)	T LIQ (K)	T VAP (K)	LIQ DEN (KG/M3)	VAP DEN (KG/M3)	DELTA-P TOT (PA)	ICHOKE	ICCFL
1	6.792E+06	0.000000	-0.2424E-05	0.1377E-01	556.971	547.025	556.971	76[illegible].5	35.31	0.193 [illegible]E+05	0 0	0 0
2			0.5473E-03	0.6939E-03						0.9231E+05	0-1	0 0

0

INTERFACIAL HEAT TRANSFER (+=FLASH.-=CONDENSE) — INTERFACIAL FRICTION

CELL	LIQ HTC*A (W/K)	VAPOR HTC*A (W/K)	WALL MASS TRANSFER RATE (KG/S)	TOTAL MASS TRANSFER RATE (KG/S)	TOT.E/(+LIQ OR-VAP.E) (J/J)	THERMODYNAMIC QUALITY	SHEAR COEFFI (KG/M3-S)	SLIP	REYGAS	REYLIQ
1	0.2993E-10	0.1497E-10	0.0000	-0.1959E-15	-0.6929E-22	-0.034	52.3	-0.568E+04	0.127E-13	154.
2							61.7	1.27		

0

INSIDE WALL CONVECTION HEAT TRANSFER (ADIABATIC OUTSIDE WALL)

CELL	H T MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	QTOT (W)	QTOT/FL.E (J/J)	RADIAL TEMPERATURES <INSIDE
1	7.00	32.5	0.000	0.531E-03	0.144E-17	547.025

```
0     TOTAL C\MPONENT WATER MASS =  4.7646E+01 KG.      TOTAL COMPONENT WATER ENERGY =  5.6995E+07 J.
    PERCENT M\SS CONTINUITY ERROR = -1.6099E-08   LOST MASS= -7.6705E-09 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -7.3493E-08

0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # #

 -***- PUMP       2-+LOOP PUMP - MASS FLOW                     NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 =  5      JUN2 =  6
 TRIP    OMEGA       RHO          VOL. FLOW      MASS FLOW      VAPOR FRAC      SMOM      HEAD        DELTA - P      TORQUE       TORQM
  1   3.370E-02  7.644E+02      4.750E-03      3.631E+00      8.547E-20   1.878E+03 1.878E+03   1.4365E+06    5.75[illegible]E+01    0.000E+00

                     CELL  1     FLOW RATE IN  =  3.631E+00 KG/S       MASS FLUX IN  =  8.522E+02 KG/M2-S
                     CELL  6     FLOW RATE OUT =  3.629E+00 KG/S       MASS FLUX OUT =  3.183E+03 KG/M2-S

        PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
 CELL     (PA)                   (M/S)       (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)      (PA)
   1    6.839E+06  0.000000   1.115        1.279     557.441     547.627     557.441      764.4       35.54      0.0000         0 0     0 0
   2    8.276E+06  0.000000   1.115        1.115     570.568     548.096     570.568      765.5       44.18     -0.1436E+07     0 0     0 0
   3    8.259E+06  0.000000   4.160        4.445     570.427     548.186     570.427      765.3       44.08      0.1661E+05     0 0     0 0
   4    8.030E+06  0.000000   12.48        12.90     568.451     548.148     568.451      765.0       43.66      0.2296E+06     0 0     0 0
   5    8.021E+06  0.000000   4.161        4.433     568.376     548.181     568.376      765.0       42.61       8655.         0 0     0 0
   6    8.018E+06  0.000000   4.161        4.409     568.351     548.216     568.351      764.9       42.59       2865.         0 0     0 0
   7                          4.161        4.409                                                                  2645.         [illegible]     0 0
0                    INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                           INTERFACIAL FRICTION

     LIQ HTC*A   VAPOR HTC*A   WALL MASS     TOTAL MASS      TOT.E/(+LIQ      THERMODYNAMIC    SHEAR        SLIP         REYGAS      REYLIQ
 CELL                          TRANSFER RATE TRANSFER RATE   OR-VAP.E)          QUALITY        COEFFI
       (W/K)        (W/K)        (KG/S)        (KG/S)          (J/J)                          (KG/M3-S)
   1   0.3618E-13   0.1809E-13   0.0000       -0.2342E-18    -0.4555E-24         -0.034        0.000        1.15        0.141E-13   0.630E+06
   2   0.2768E-14   0.1384E-14   0.0000       -0.4363E-19    -0.4853E-24         -0.085        0.000        1.00        0.139E-13   0.113E+07
   3   0.2060E-13   0.1030E-13   0.0000       -0.3212E-18    -0.4951E-24         -0.084        17.0         1.07        0.240E-13   0.193E+07
   4   0.2289E-14   0.1144E-14   0.0000       -0.3225E-19    -0.1339E-24         -0.076        13.2         1.03        0.691E-14   0.192E+07
   5   0.1274E-13   0.6371E-14   0.0000       -0.1785E-18    -0.7626E-24         -0.075        16.3         1.07        0.25[illegible]-13   0.122E+07
   6   0.5778E-14   0.2889E-14   0.0000       -0.8872E-19    -3.3448E-24         -0.075        16.4         1.06        0.116E-13   0.122E+07
   7                                                                                            16.3         1.06

 (.........INSIDE WALL CONVECTION HEAT TRANSFER...................) (...........OUTSIDE WALL CONVECTION HEAT TRANSFER.....)
 CELL  CELL     H-LIQ       H-VAP        TSUR        QTOT     QTOT/FL.E     CELL     H-LIQ         H-VAP         TSUR       QTOT
  #  HT-MODE  (W/M2-K)   (W/M2-K)        (K)         (W)       (J/J)      HT-MODE  (W/M2-K)      (W/M2-K)        (K)        (W)
   1   7.00  0.771E+04  0.000          547.640     11.5      0.313E-13    0.00       11.7          11.7        547.653    -10.9
   2   7.00  0.163E+05  0.000          548.102    6.15       0.167E-13    0.00       11.7          11.7        548.113     5.76
   3   7.00  0.461E+05  [illegible]    548.187     43.4      0.118E-12    0.00       11.7          11.7        548.199     40.3
   4   7.00  0.461E-05  [illegible]    548.150     16.5      0.447E-13    0.00       11.7          11.7        548.162    -15.3
   5   7.00  0.253E+05  0.000          548.184     15.9      0.430E-13    0.00       11.7          11.7        548.195    -14.7
   6   7.00  0.252E+05  0.000          548.219     15.7      0.426E-13    0.00       11.7          11.7        548.230    -14.6
0     TOTAL COMPONENT WATER MASS =  5.9240E+00 KG.      TOTAL COMPONENT WATER ENERGY =  7.1045E+06 J.
    PERCENT MASS CONTINUITY ERROR = -8.1561E-12   LOST MASS= -4.8317E-13 KG.  PERCENT MASS FLOW THR' TURNOVER)  = -3.1204E-07

0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # #

 -***- VALVE      3-+LOOP BLOCK VALVE                          NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 =  6      JUN2 =  7

                     CELL  1     FLOW RATE IN  =  3.629E+00 KG/S       MASS FLUX IN  =  3.183E+03 KG/M2-S
                     CELL  2     FLOW RATE OUT =  3.628E+00 KG/S       MASS FLUX OUT =  3.183E+03 KG/M2-S
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       PRESSURE    VAPOR FRAC  LIQ VEL    VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN    VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
CELL     (PA)                   (M/S)      (M/S)        (K)         (K)         (K)      (KG/M3)    (KG/M3)       (PA)
  1    8.015E+06  0.000000   4.161       4.409      568.328     548.244     568.328      764.8      42.58      0.0000         0 0     0 0
  2    7.659E+06  0.000000   10.03       10.37      566.954     548.223     566.954      764.7      41.62      0.1564E+06     0 0     0 0
  3                          4.162       4.412                                                                 1758.          0 0     0 0

0                   INTERFACIAL HEAT  RANSFER (+=FLASH,-=CONDENSE)                              INTERFACIAL FRICTION

      LIQ HTC*A  VAPOR HTC*A   WALL MASS     TOTAL MASS     TOT.E/(+LIQ     THERMODYNAMIC   SHEAR        SLIP        REYGAS     REYLIQ
CELL                          TRANSFER RATE  TRANSFER RATE  OR-VAP.E)        QUALITY        COEFFI
        (W/K)        (W/K)       (KG/S)         (KG/S)        (J/J)                         (KG/M3-S)
  1   0.6158E-14   0.3879E-14   0.0000       -0.8578E-19   -0.4325E-24       -0.075          0.000       1.06      0.200E-13  0.171E+07
  2   0.5341E-14   0.2670E-14   0.0000       -0.6892E-19   -0.3499E-24       -0.069          12.7        1.03      0.170E-13  0.171E+07
  3                                                                                          15.9        1.06

  VALVE AREA =   4.730949E-04      PERCENT OPEN =  99.99893

0     TOTAL COMPONENT WATER MASS =  1.1857E+00 KG.      TOTAL COMPONENT WATER ENERGY =  1.4229E+06 J.
    PERCENT MASS CONTINUITY ERROR =  3.5957E-12   LOST MASS=  4.2633E-14 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -3.4043E-07

0# # # # # EDIT=      2 # # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- TEE      16++ PUMP DISCHARGE                              NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 =  7      JUN2 =  8      JUN3 = 23

 PRIMARY TUBE

                    CELL  1     FLOW RATE IN   =  3.628E+00 KG/S        MASS FLUX IN   =  3.183E+03 KG/M2-S
                    CELL  4     FLOW RATE OUT  =  3.627E+00 KG/S        MASS FLUX OUT  =  8.136E+03 KG/M2-S

       PRESSURE    VAPOR FRAC  LIQ VEL    VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN    VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
CELL     (PA)                   (M/S)      (M/S)        (K)         (K)         (K)      (KG/M3)    (KG/M3)       (PA)
  1    7.957E+06  0.000000   4.162       4.412      566.939     548.236     566.939      764.6      41.61      0.0000         0 0     0 0
  2    7.850E+06  0.000000   4.162       4.425      566.877     548.285     566.877      764.5      41.57      7018.          0 0     0 0
  3    7.846E+06  0.000000   4.162       4.411      566.841     548.336     566.841      764.4      41.55      4065.          0 0     0 0
  4    7.805E+06  0.000000   4.162       4.541      566.474     548.336     566.474      764.4      41.30      0.4131E+05     0 0     0 0
  5                          10.64       11.05                                                                 0.1763E+05     0 0     0 0

0                   INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                              INTERFACIAL FRICTION

      LIQ HTC*A  VAPOR HTC*A   WALL MASS     TOTAL MASS     TOT.E/(+LIQ     THERMODYNAMIC   SHEAR        SLIP        REYGAS     REYLIQ
CELL                          TRANSFER RATE  TRANSFER RATE  OR-VAP.E)        QUALITY        COEFFI
        (W/K)        (W/K)       (KG/S)         (KG/S)        (J/J)                         (KG/M3-S)
  1   0.3234E-14   0.1617E-14   0.0000       -0.4166E-19   -0.4719E-24       -0.069          0.000       1.06      0.167E-13  0.123E+07
  2   0.1273E-13   0.6363E-14   0.0000       -0.1629E-18   -0.4934E-24       -0.068          15.9        1.06      0.176E-13  0.122E+07
  3   0.1364E-13   0.6820E-14   0.0000       -0.1738E-18   -0.5263E-24       -0.068          15.9        1.06      0.191E-13  0.122E+07
  4   0.2867E-14   0.1433E-14   0.0000       -0.3574E-19   -0.8893E-24       -0.067          34.9        1.09      0.463E-13  0.176E+07
  5                                                                                          12.2        1.04
0            INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

        H T     H-LIQ       H-VAP       QTOT       QTOT/FL.E                RADIAL TEMPERATURES
 CELL  MODE   (W/M2-K)    (W/M2-K)      (W)         (J/J)                   <INSIDE
   1   7.00   0.253E+05   0.000        0.204      0.552E-15                 548.236
   2   7.00   0.253E+05   0.000        0.769      0.209E-14                 548.285
   3   7.00   0.253E+05   0.000        0.783      0.212E-14                 548.336
   4   7.00   0.417E+05   0.000        0.407      0.110E-14                 548.336


 SIDE TUBE
                    CELL  2     FLOW RATE OUT  =  2.122E-05 KG/S        MASS FLUX OUT  =  4.080E-01 KG/M2-S

       PRESSURE    VAPOR FRAC  LIQ VEL    VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN    VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
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CELL    (PA)                        (M/S)        (M/S)        (K)         (K)          (K)         (KG/M3)     (KG/M3)       (PA)
  1    7.851E+06  0.000000  0.1024E-04  0.1175E-01 566.882    546.855    566.882      767.3       41.57       6409.        0 0     0 0
  2    7.840E+06  0.000000  0.5918E-05  0.1177E-01 566.789    54 .831    566.789      767.3       41.51      0.1053E+05    0 0     0 0
  3                         0.5317E-03  0.6569E-03                                                           0.4090E+05    0-1     0 0
0                  INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                           INTERFACIAL FRICTION

     LIQ HTC*A   VAPOR HTC*A   WALL MASS     TOTAL MASS     TOT.E/(+LIQ    THERMODYNAMIC   SHEAR        SLIP        REYGAS     REYLIQ
CELL                           TRANSFER RATE TRANSFER RATE  OR-VAP E)      QUALITY         COEFFI
       (W/K)        (W/K)       (KG/S)         (KG/S)        (J/J)                         (KG/M3-S)
  1    0.7433E-21   0.3716E-21  0.0000        -0.1023E-25   -0.2587E-31      -0.074        60.8       0.115E-04  0.350E-23   2.70
  2    0.1182E-20   0.5909E-21  0.0000        -0.1624E-25   -0.2466E-31      -0.073        60.7       0.199E+04  0.860E-24   59.0
  3                                                                                        233.       1.24
0            INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

      H T     H-LIQ       H-VAP       QTOT       QTOT/FL.E              RADIAL TEMPERATURES
 CELL MODE  (W/M2-K)    (W/M2-K)      (W)         (J/J)                 <INSIDE
   1  7.00    55.0        0.000    -0.944E-03 -0.257E-17                546.855
   2  7.00    83.8        0.000    -0.158E-02 -0.430E-17                546.831

0     TOTAL COMPONENT WATER MASS =  5.5696E+00 KG.     TOTAL  PONENT WATER ENERGY =  6.6629E+06 J.
     PERCENT MASS CONTINUITY ERROR = -5.2051E-10   LOST MASS= -2.8990E-11 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -1.5845E-07

0# # # # # EDIT=      2 # # # # # # # # # # # # # # # # # # # # # # # # # #


-***- TEE        4++LOOP JET PUMP                               NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 *****
0    JUN1 = 28     JUN2 =  9     JUN3 =  8
0    * THIS TEE IS A JET PUMP *

          EFFECTIVE  VALUES                          APPLICABLE VALUES
     M RATIO      N RATIO       ETA        M RATIO     N RATIO       ETA
  1.4768E+00  3.3304E-01  4.9184E-01  1.4768E+00  3.3250E-01  4.9104E-01

PRIMARY TUBE

                   CELL  1     FLOW RATE IN  =  5.357E+00 KG/S        MASS FLUX IN  =  1.678E+04 KG/M2-S
                   CELL  3     FLOW RATE OUT =  8.983E+00 KG/S        MASS FLUX OUT =  3.926E+03 KG/M2-S

      PRESSURE     VAPOR FRAC  LIQ VEL      VAP VEL       T SAT        T LIQ        T VAP      LIQ DEN     VAP DEN   DELTA-P TOT     ICHOKE  ICCFL
CELL    (PA)                    (M/S)        (M/S)         (K)          (K)          (K)       (KG/M3)     (KG/M3)      (PA)
  1    6.937E+06  0.000000   21.92         22.60       558.397      547.575      558.397      764.6       36.15      0.2394E+06     0-1     0-1
  2    7.313E+06  0.000000   27.76         28.00       561.993      547.697      561.993      764.9       38.36     -0.3766E+06     0 0     0 0
  3    7.341E+06  0.000000   5.133         5.295       562.247      547.714      562.247      764.9       38.52     -0.2722E+05     0 0     0 0
  4                          5.133         5.320                                                                     -3351.        0 0     0 0
0                  INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                           INTERFACIAL FRICTION

     LIQ HTC*A   VAPOR HTC*A   WALL MASS     TOTAL MASS     TOT.E/(+LIQ    THERMODYNAMIC   SHEAR        SLIP        REYGAS     REYLIQ
CELL                           TRANSFER RATE TRANSFER RATE  OR-VAP E)      QUALITY         COEFFI
       (W/K)        (W/K)       (KG/S)         (KG/S)        (J/J)                         (KG/M3-S)
  1    0.2205E-07   0.1102E-07  0.0000        -0.1580E-12   -0.5281E-17      -0.038        72.9       1.03       0.937E-06  0.414E 07
  2    0.2616E-07   0.1308E-07  0.0000        -0.2517E-12   -0.2355E-17      -0.051        389.       1.01       0.389E-06  0.488E+07
  3    0.1267E-07   0.6308E-08  0.0000        -0.1235E-12   -0.2995E-18      -0.052        35.3       1.03       0.218E-07  0.213E+07
  4                                                                                        19.5       1.04
0            INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

      H T     H-LIQ       H-VAP       QTOT       QTOT/FL.E              RADIAL TEMPERATURES
 CELL MODE  (W/M2-K)    (W/M2-K)      (W)         (J/J)                 <INSIDE
   1  7.00  0.118E+06   0.000      0.341E-01  0.927E-16                 547.575   547.575   547.575
   2  7.00  0.756E+05   0.000      0.693E-01  0.188E-15                 547.697   547.697   547.697
   3  7.00  0.279E+05   0.000      0.194      0.526E-15                 547.714   547.714   547.714
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SIDE TUBE
                   CELL  2     FLOW RATE OUT = -3.627E+00 KG/S       MASS FLUX OUT = -8.136E+03 KG/M2-S

       PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN  DELTA-P TOT     ICHOKE  ICCFL
CELL     (PA)                   (M/S)       (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)     (PA)
  1    7.688E+06  0.000000  -45.63       -46.19      565.432     548.305     565.432      764.3       40.59     -0.7514E+06     0 0     0 0
  2    7.787E+06  0.000000  -10.64       -11.21      566.317     548.332     566.317      764.3       41.19     -0.9888E+05     0 0     0 0
  3                         -10.64       -11.05                                                                  0.0000        3 0     0 0
0                   INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                            INTERFACIAL FRICTION

     LIQ HTC*A  VAPOR HTC*A   WALL MASS     TOTAL MASS    TOT.E/(+LIQ    THERMODYNAMIC    SHEAR       SLIP        REYGAS     REYLIQ
CELL                        TRANSFER RATE  TRANSFER RATE  OR-VAP.E)        QUALITY       COEFFI
       (W/K)        (W/K)        (KG/S)         (KG/S)       (J/J)                       (KG/M3-S)
  1   0.1650E-14   0.8249E-15   0.0000       -0.1932E-19   -0.8522E-24       -0.063        140.        1.01       0.131E-12  0.516E+07
  2   0.3201E-14   0.1601E-14   0.0000       -0.3955E-19   -0.8890E-24       -0.066        110.        1.05       0.512E-13  0.195E+07
  3                                                                                        0.003       1.04
0             INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

       H T     H-LIQ        H-VAP         QTOT       QTOT/FL.E              RADIAL TEMPERATURES
CELL  MODE  (W/M2-K)     (W/M2-K)         (W)         (J/J)                 <INSIDE
  1   7.00   0.128E+06    0.000        0.799E-01   0.217E-15               548.305    548.305    548.305
  2   7.00   0.588E+05    0.000        0.110       0.208E-15               548.332    548.332    548.332

0     TOTAL COMPONENT WATER MASS =  1.8978E+00 KG.     TOTAL COMPONENT WATER ENERGY =  2.2748E+06 J.
     PERCENT MASS CONTINUITY ERROR =  1.0858E-11   LOST MASS=  2.0606E-13 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -1.2611E-07

0# # # # # EDIT=      2 # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- BREAK      5++ BREAK SUCTION SIDE                            NSTEP=      5 TIME=   0.00001     DELT= 2.48832E-06 ******
0     JUN1 = 22

      PRESSURE    VAPOR FRAC  LIQ VEL      VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN  DELTA-P TOT     ICHOKE  ICCFL
CELL    (PA)                   (M/S)        (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)     (PA)
  1   6.700E+06  1.000000  0.5473E-03  0.6939E-03  556.052     556.052     556.052      746.9       34.78      0.0000         0 0     0 0
0  MASS FLOW RATE =    1.7853E-03            TOTAL MASS OUT =   8.0518E-09
0# # # # # EDIT=      2 # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- BREAK     13++ BREAK DISCHARGE SIDE                          NSTEP=      5 TIME=   0.00001     DELT= 2.48832E-06 ******
0     JUN1 = 23

      PRESSURE    VAPOR FRAC  LIQ VEL      VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN  DELTA-P TOT     ICHOKE  ICCFL
CELL    (PA)                   (M/S)        (M/S)        (K)         (K)         (K)       (KG/M3)     (KG/M3)     (PA)
  1   7.799E+06  1.000000  0.5317E-03  0.6569E-03  566.426     566.426     566.426      726.0       41.26      0.0000         0 0     0 0
0  MASS FLOW RATE =    2.1216E-05            TOTAL MASS OUT =   9.5169E-11
0# # # # # EDIT=      2 # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- PIPE       6++  GUIDETUBE PIPE                               NSTEP=      5 TIME=   0.00001     DELT= 2.48832E-06 ******
0     JUN1 = 32      JUN2 = 33

                   CELL  1     FLOW RATE IN  =  0.000E+00 KG/S        MASS FLUX IN  =  0.000E+00 KG/M2-S
                   CELL  5     FLOW RATE OUT =  3.349E-01 KG/S        MASS FLUX OUT =  7.345E+01 KG/M2-S

                   CELL  5     LEAK FLOW RATE= -3.346E-01 KG/S        LEAK MASS FLUX= -5.713E+03 KG/M2-S

      PRESSURE    VAPOR FRAC  LIQ VEL      VAP VEL      T SAT       T LIQ       T VAP      LIQ DEN     VAP DEN  DELTA-P TOT     ICHOKE  ICCFL
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CELL   (PA)                         (M/S)         (M/S)        (K)       (K)       (K)       (KG/M3)   (KG/M3)     (PA)
  1   7.239E+06  0.000000  0.0000        0.0000       561.292   547.161   561.292   765.9     37.91     -0.6143E+05   0 0   0 0
  2   7.237E+06  0.000000 -0.1706E-04    0.1293E-01   561.276   547.161   561.276   765.9     37.91      1635.        0 0   0 0
  3   7.236E+06  0.000000 -0.3560E-04    0.1288E-01   561.261   547.143   561.261   765.9     37.90      1636.        0 0   0 0
  4   7.234E+06  0.000000 -0.9529E-05    0.1295E-01   561.245   547.143   561.245   765.9     37.89      1637.        0 0   0 0
  5   7.232E+06  0.000000  0.1120E-03    0.1330E-01   561.225   547.776   561.225   764.6     37.87      2094.        0 0   0 0
  6                        0.9606E-01    0.1439                                                          2119.
0                     INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                              INTERFACIAL FRICTION

       LIQ HTC*A    VAPOR HTC*A   WALL MASS       TOTAL MASS      TOT.E/(+LIQ     THERMODYNAMIC   SHEAR       SLIP        REYGAS      REYLIQ
CELL                              TRANSFER RATE   TRANSFER RATE   OR-VAP.E)       QUALITY         COEFFI
       (W/K)        (W/K)         (KG/S)          (KG/S)          (J/J)                           (KG/M3-S)
  1    0.6419E-15   0.3210E-15    0.0000          -0.6085E-20     -0.2332E-26     -0.050          0.000       1.00        0.483E-18   8.14
  2    0.5414E-20   0.2707E-20    0.0000          -0.5126E-25     -0.1964E-31     -0.050          55.2        -758.       0.456E-23   25.1
  3    0.0000       0.0000        0.0000           0.0000          0.0000         -0.050          55.2        -162.       0.184E-23   21.5
  4    0.2479E-15   0.1239E-15    0.0000          -0.2344E-20     -0.8986E-27     -0.050          55.2        -0.136E+04  0.378E-18   48.9
  5    0.4863E-38   0.2431E-08    0.0000          -0.4386E-13     -0.1368E-19     -0.048          55.1        119.        0.236E-10   0.300E+05
  6                                                                                               45.7        1.50

(..........INSIDE WALL CONVECTION HEAT TRANSFER.....................) (...........OUTSIDE WALL CONVECTION HEAT TRANSFER.....)
CELL  CELL      H-LIQ       H-VAP         TSUR       QTOT     QTOT/FL.E     CELL      H-LIQ        H-VAP        TSUR      QTOT
 #   HT-MODE  (W/M2-K)    (W/M2-K)        (K)        (W)      (J/J)         HT-MODE   (W/M2-K)     (W/M2-K)     (K)       (W)
 1    7.00     595.        0.000         547.529    23.7     0.833E-13     7.00       269.         0.000        547.774   0.226
 2    7.00     595.        0.000         547.520    169.     0.459E-12     7.00       0.209E+04    0.000        547.774   -167.
 3    7.00     569.        0.000         547.458    118.     0.322E-12     7.00       877.         0.000        547.672   -118.
 4    7.00     569.        0.000         547.458    33.5     0.911E-13     7.00       0.166E+04    0.000        547.672   -43.2
 5    7.00     611.        0.000         547.788    1.21     0.328E-14     7.00       632.         0.000        547.796   7.42
0     TOTAL COMPONENT WATER MASS =  4.2306E+01 KG.    TOTAL COMPONENT WATER ENERGY =  5.0616E+07 J.
      PERCENT MASS CONTINUITY ERROR = -8.5992E-12   LOST MASS= -3.6380E-12 KG.  PERCENT MASS FLOW THRU(TURNOVER)  =  4.1830E-09

0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # #


_***_ FILL      7++  ZERO VELOCITY FILL                          NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0     JUN1 = 32
       PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT      T LIQ      T VAP      LIQ DEN    VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
CELL    (PA)                   (M/S)       (M/S)        (K)        (K)        (K)        (KG/M3)    (KG/M3)   (PA)
  1    7.177E+06  0.000000  0.0000      0.0000       560.710    554.820    560.710    750.3      37.55     0.0000         0 0     0 0

      MASS FLOW RATE =   0.0000E+00          TOTAL MASS IN   =   0.0000E+00
0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # #


_***_ VALVE     8++INT SUCTN LINE , PIPE AND VALVE               NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0     JUN1 = 26     JUN2 =  2
                 CELL  1     FLOW RATE IN   =  3.352E+00 KG/S        MASS FLUX IN   =  1.085E+03 KG/M2-S
                 CELL  9     FLOW RATE OUT  =  3.347E+00 KG/S        MASS FLUX OUT  =  7.855E+02 KG/M2-S
       PRESSURE    VAPOR FRAC  LIQ VEL     VAP VEL      T SAT      T LIQ      T VAP      LIQ DEN    VAP DEN   DELTA-P TOT    ICHOKE  ICCFL
CELL    (PA)                   (M/S)       (M/S)        (K)        (K)        (K)        (KG/M3)    (KG/M3)   (PA)
  1    7.140E+06  0.000000  1.417       1.760        560.354    547.130    560.354    765.8      37.33     0.4324E+05     0 0     0 0
  2    7.179E+06  0.000000  1.027       1.048        560.723    547.117    560.723    765.9      37.56     -0.3881E+05    0 0     0 0
  3    7.179E+06  0.000000  1.027       1.175        560.722    547.094    560.722    765.9      37.56     147.1          0 0     0 0
  4    7.063E+06  0.000000  4.109       4.357        559.620    547.063    559.620    765.8      36.89     0.1154E+06     0 0     0 0
  5    7.067E+06  0.000000  1.028       1.161        559.659    547.094    559.659    765.7      36.91     -4108.         0 0     0 0
  6    7.080E+06  0.000000  1.028       1.146        559.783    547.274    559.783    765.4      36.98     -0.1289E+05    0 0     0 0
  7    7.097E+06  0.000000  1.027       1.146        559.948    547.561    559.948    764.9      37.08     -0.1718E+05    0 0     0 0
```

8	7.110E+06	0.000000	1.027	1.146	560.071	547.728	560.071	764.6	37.16	-0.1288E-05	0 0	0 0
9	7.114E+06	0.000000	1.027	1.154	560.110	547.786	560.110	764.5	37.18	-4134.	0 0	0 0
10			1.027	1.231						2496.	0 0	0 0

0 INTERFACIAL HEAT TRANSFER (+=FLASH -=CONDENSE) INTERFACIAL FRICTION

CELL	LIQ HTC*A (W/K)	VAPOR HTC*A (W/K)	WALL MASS TRANSFER RATE (KG/S)	TOTAL MASS TRANSFER RATE (KG/S)	TOT.E/(+LIQ OR-VAP.E) (J/J)	THERMODYNAMIC QUALITY	LINEAR COEFFI (KG/M3-S)	SLIP	REYGAS	REYLIQ
1	0.9153E-04	0.4577E-04	0.0000	-0.8985E-09	-0.2963E-13	-0.047	113.	1.24	0.771E-03	0.640E+06
2	0.7376E-04	0.3688E-04	0.0000	-0.6715E-09	-0.7650E-15	-0.048	52.3	1.02	0.166E-04	0.581E+06
3	0.2122E-05	0.1061E-05	0.0000	-0.1935E-10	-0.7157E-17	-0.048	24.6	1.14	0.290E-06	0.109E+07
4	0.1965E-07	0.9823E-08	0.0000	-0.1642E-12	-0.1460E-18	-0.044	14.5	1.06	0.630E-08	0.109E+07
5	0.4583E-09	0.2291E-09	0.0000	-0.3834E-14	-0.3172E-20	-0.044	24.3	1.13	0.763E-10	0.581E+06
6	0.1002E-10	0.5010E-11	0.0000	-0.8351E-16	-0.3451E-22	-0.044	24.4	1.12	0.831E-12	0.581E+06
7	0.1644E-12	0.8222E-13	0.0000	-0.1358E-17	-0.5605E-24	-0.044	24.5	1.12	0.137E-13	0.581E+06
8	0.4360E-18	0.2180E-18	0.0000	-0.3590E-23	-0.2961E-29	-0.044	24.5	1.12	0.101E-18	0.581E+06
9	0.1450E-14	0.7251E-15	0.0000	-0.1193E-19	-0.2964E-25	-0.043	24.5	1.12	0.747E-15	0.581E+06
10							24.1	1.17		

(..........INSIDE WALL CONVECTION HEAT TRANSFER..................) (............OUTSIDE WALL CONVECTION HEAT TRANSFER.....)

CELL #	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)	QTOT/FL.E (J/J)	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)
1	7.00	0.844E+04	0.000	547.130	-0.286	-0.777E-15	0.00	11.7	11.7	547.130	0.221
2	7.00	0.723E+04	0.000	547.116	-0.847	-0.230E-14	0.00	11.7	11.7	547.116	0.633
3	7.00	0.159E+05	0.000	547.094	-1.76	-0.478E-14	0.00	11.7	11.7	547.094	1.58
4	7.00	0.159E+05	0.000	547.063	-0.397	-0.108E-14	0.00	11.7	11.7	547.063	0.445
5	7.00	0.723E+04	0.000	547.094	-0.459	-0.125E-14	0.00	11.7	11.7	547.094	0.702
6	7.00	0.723E 04	0.000	547.273	-2.63	-0.715E-14	0.00	11.7	11.7	547.273	4.12
7	7.00	0.723E+04	0.000	547.559	-6.04	-0.164E-13	0.00	11.7	11.7	547.559	8.45
8	7.00	0.722E+04	0.000	547.726	-4.08	-0.111E-13	0.00	11.7	11.7	547.726	5.49
9	7.00	0.722E+04	0.000	547.784	-1.48	-0.402E-14	0.00	11.7	11.7	547.784	1.97

VALVE AREA = 1.065300E-03 PERCENT OPEN = 100.00000

0 TOTAL COMPONENT WATER MASS = 3.8644E+01 KG. TOTAL COMPONENT WATER ENERGY = 4.6243E+07 J.
PERCENT MASS CONTINUITY ERROR = 9.4142E-12 LOST MASS= 3.6380E-12 KG. PERCENT MASS FLOW THRU(TURNOVER) = -1.0932E-07

0# # # # # EDIT= 2 #

-***- PUMP 9--INT LOOP PMP AND DRIVE NSTEP= 5 TIME= 0.00001 DELT= 2.48832E-06 ******
0 JUN1 = 2 JUN2 = 50

TRIP	OMEGA	RHO	VOL. FLOW	MASS FLOW	VAPOR FRAC	SMOM	HEAD	DELTA - P	TORQUE	TORQM
1	3.290E+02	7.643E+02	4.378E-03	3.346E+00	4.989E-20	1.767E+03	1.767E+03	1.3516E+06	5.130E+01	0.000E+00

CELL 1 FLOW RATE IN = 3.347E+00 KG/S MASS FLUX IN = 7.855E+02 KG/M2-S
CELL 8 FLOW RATE OUT = 3.343E+00 KG/S MASS FLUX OUT = 2.932E+03 KG/M2-S

CELL	PRESSURE (PA)	VAPOR FRAC	LIQ VEL (M/S)	VAP VEL (M/S)	T SAT (K)	T LIQ (K)	T VAP (K)	LIQ DEN (KG/M3)	VAP DEN (KG/M3)	DELTA-P TOT (PA)	ICHOKE	ICCFL
1	7.112E+06	0.000000	1.027	1.201	560.087	547.843	560.087	764.3	37.17	0.0000	0 0	0 0
2	8.464E+06	0.000000	1.027	1.027	572.149	548.303	572.149	765.4	45.36	-0.1352E+07	0 0	0 0
3	8.444E+06	0.000000	3.835	4.107	571.987	548.397	571.987	765.1	45.23	0.1938E+05	0 0	0 0
4	8.207E+06	0.000000	11.51	11.91	569.982	548.424	569.982	764.8	43.76	0.2371E+06	0 0	0 0
5	8.191E+06	0.000000	3.836	4.114	569.844	548.455	569.844	764.7	43.66	0.1502E+05	0 0	0 0
6	8.184E+06	0.000000	3.836	4.095	569.781	548.484	569.781	764.6	43.61	7462.	0 0	0 0
7	8.179E+06	0.000000	3.836	4.073	569.738	548.602	569.738	764.4	43.58	4993.	0 0	0 0
8	8.174E+06	0.000000	3.836	4.073	569.695	548.632	569.695	764.3	43.55	4992.	0 0	0 0
9			3.836	4.096						4529.	0 0	0 0

0 INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE) — INTERFACIAL FRICTION

CELL	LIQ HTC*A (W/K)	VAPOR HTC*A (W/K)	WALL MASS TRANSFER RATE (KG/S)	TOTAL MASS TRANSFER RATE (KG/S)	TOT.E/(+LIQ OR-VAP.E) (J/J)	THERMODYNAMIC QUALITY	SHEAR COEFFI (KG/M3-S)	SLIP	REYGAS	REYLIQ
1	0.1606E-13	0.8030E-14	0.0000	-0.1312E-18	-0.3315E-24	-0.043	0.000	1.17	0.796E-14	0.582E+06
2	0.7522E-15	0.3761E-15	0.0000	-0.1269E-19	-0.6426E-25	-0.091	0.000	1.00	0.164E-14	0.105E+07
3	0.2117E-13	0.1059E-13	0.0000	-0.3530E-18	-0.5277E-24	-0.090	18.1	1.07	0.227E-13	0.178E+07
4	0.2303E-13	0.1152E-13	0.0000	-0.3473E-18	-0.5246E-24	-0.081	13.8	1.04	0.241E-13	0.178E+07
5	0.5270E-14	0.2635E-14	0.0000	-0.7879E-19	-0.3378E-24	-0.080	17.4	1.07	0.101E-13	0.113E+07
6	0.5820E-14	0.2910E-14	0.0000	-0.8660E-19	-0.4302E-24	-0.080	17.4	1.07	0.129E-13	0.113D+07
7	0.2410E-13	0.1205E-13	0.0000	-0.3559E-18	-0.4638E-24	-0.079	17.4	1.06	0.139E-13	0.113E+07
8	0.1076E-13	0.5380E-14	0.0000	-0.1583E-18	-0.7864E-24	-0.079	17.4	1.06	0.238E-13	0.113E+07
9							17.4	1.07		

(..........INSIDE WALL CONVECTION HEAT TRANSFER.....................) (........... OUTSIDE WALL CONVECTION HEAT TRANSFER.....)

CELL #	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)	QTOT/FL.E (J/J)	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)
1	7.00	0.722E+04	0.000	547.840	-0.945	-0.256E-14	0.00	11.7	11.7	547.840	1.12
2	7.00	0.152E+05	0.000	548.301	-2.74	-0.742E-14	0.00	11.7	11.7	548.301	3.06
3	7.00	0.432E+05	0.000	548.396	-9.98	-0.271E-13	0.00	11.7	11.7	548.396	11.1
4	7.00	0.432E+05	0.000	548.423	-10.2	-0.275E-13	0.00	11.7	11.7	548.423	11.3
5	7.00	0.237E+05	0.000	548.453	-3.67	-0.994E-14	0.00	11.7	11.7	548.453	4.08
6	7.00	0.237E+05	0.000	548.482	-3.23	-0.877E-14	0.00	11.7	11.7	548.482	3.60
7	7.00	0.237E+05	0.000	548.601	-13.4	-0.364E-13	0.00	11.7	11.7	548.601	14.9
8	7.00	0.237E+05	0.000	548.631	-3.59	-0.974E-14	0.00	11.7	11.7	548.631	3.95

0 TOTAL COMPONENT WATER MASS = 9.8935E+00 KG. TOTAL COMPONENT WATER ENERGY = 1.1878E+07 J.
PERCENT MASS CONTINUITY ERROR = 2.8728E-12 LOST MASS= 2.8422E-13 KG. PERCENT MASS FLOW THRU(TUPNOVER) = -3.2342E-07

0# # # # # EDIT= 2 #

-***- VALVE 10--INTACT LOOP VALVE NSTEP= 5 TIME= 0.00001 DELT= 2.48832E-06 ******
0 JUN1 = 50 JUN2 = 3

CELL 1 FLOW RATE IN = 3.343E+00 KG/S MASS FLUX IN = 2.932E+03 KG/M2-S
CELL 4 FLOW RATE OUT = 3.341E+00 KG/S MASS FLUX OUT = 7.495E+03 KG/M2-S

CELL	PRESSURE (PA)	VAPOR FRAC	LIQ VEL (M/S)	VAP VEL (M/S)	T SAT (K)	T LIQ (K)	T VAP (K)	LIQ DEN (KG/M3)	VAP DEN (KG/M3)	DELTA-P TOT (PA)	ICHOKE	ICCFL
1	8.169E+06	0.000000	3.836	4.096	569.656	548.656	569.656	764.2	43.52	0.0000	0 0	0 0
2	8.165E+06	0.000000	3.836	4.093	569.625	548.680	569.625	764.2	43.50	3666.	0 0	0 0
3	7.788E+06	0.000000	11.63	11.98	566.327	548.659	566.327	763.7	41.20	0.3771E+06	0 0	0 0
4	7.753E+06	0.000000	3.838	4.184	566.011	548.659	566.011	763.6	40.98	0.3534E+05	0 0	0 0
5			9.814	10.19						0.1844E+05	0 0	0 0

0 INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE) — INTERFACIAL FRICTION

CELL	LIQ HTC*A (W/K)	VAPOR HTC*A (W/K)	WALL MASS TRANSFER RATE (KG/S)	TOTAL MASS TRANSFER RATE (KG/S)	TOT.E/(+LIQ OR-VAP.E) (J/J)	THERMODYNAMIC QUALITY	SHEAR COEFFI (KG/M3-S)	SLIP	REYGAS	REYLIQ
1	0.5510E-14	0.2755E-14	0.0000	-0.8080E-19	-0.3124E-24	-0.079	0.000	1.07	0.156E-13	0.113E+07
2	0.5984E-14	0.2992E-14	0.0000	-0.8751E-19	-0.5344E-24	-0.079	17.3	1.07	0.252E-13	0.179E+07
3	0.1331E-13	0.6657E-14	0.0000	-0.1616E-18	-0.2508E-24	-0.065	12.8	1.03	0.135E-13	0.179E+07
4	0.9899E-15	0.4949E-15	0.0000	-0.1178E-19	-0.1957E-24	-0.064	13.7	1.09	0.977E-14	0.163E+07
5							12.3	1.04		

(..........INSIDE WALL CONVECTION HEAT TRANSFER.....................) (...........OUTSIDE WALL CONVECTION HEAT TRANSFER.....)

CELL #	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)	QTOT/FL.E (J/J)	CELL HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TSUR (K)	QTOT (W)
1	7.00	0.237E+05	0.000	548.654	-2.86	-0.775E-14	0.00	11.7	11.7	548.654	3.14

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  2  7.00  0.435E+05  0.000        548.579  -3.02     -0.818E-14   0.00        11.7        11.7      548.679     3.31
  3  7.00  0.435E+05  0.000        548.658  -11.9     -0.324E-13   0.00        11.7        11.7      548.658     13.1
  4  7.00  0.391E+05  0.000        548.658  -2.57     -0.697E-14   0.00        11.7        11.7      548.658     3.13
 VALVE AREA =   3.762000E-04     PERCENT OPEN = 100.00000

0     TOTAL COMPONENT WATER MASS =  7.0751E+00 KG.     TOTAL COMPONENT WATER ENERGY =  3.6973E+06 J.
     PERCENT MASS CONTINUITY ERROR = -1.8485E-12   LOST MASS= -5.6843E-14 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -3.3015E-07

0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- TEE      11++INTACT LOOP JET PUMP - 7.711              NSTEP=     5 TIME=   0.00001    DELT= 2.48832E-06 ******
0    JUN1 = 29     JUN2 = 30     JUN3 =  3
0    * THIS TEE IS A JET PUMP *

          EFFECTIVE  VALUE                            APPLICABLE VALUES
    M RATIO     N RATIO       ETA        M RATIO     N RATIO       ETA
  1.3339E+00  3.7119E-01  4.9515E-01  1.3339E+00  3.7838E-01  5.0473E-01

 PRIMARY TUBE

                  CELL  1     FLOW RATE IN  =  4.457E+00 KG/S       MASS FLUX IN  =  1.396E+04 KG/M2-S
                  CELL  3     FLOW RATE OUT =  7.798E+00 KG/S       MASS FLUX OUT =  3.408E+03 KG/M2-S

      PRESSURE     VAPOR FRAC  LIQ VEL     VAP VEL      T SAT      T LIQ       T VAP      LIQ DEN    VAP DEN  DELTA-P TOT    ICHOKE  ICCFL
 CELL   (PA)                    (M/S)       (M/S)        (K)        (K)         (K)       (KG/M3)    (KG/M3)     (PA)
   1   7.011E+06  0.000000   18.24       18.86      559.118    547.765     559.118      764.4      36.58     0.1652E+06     0-1     0-1
   2   7.319E+06  0.000000   24.10       24.32      562.044    547.866     562.044      764.6      38.39    -0.3078E+06     0 0     0 0
   3   7.349E+06  0.000000   4.453       4.610      562.244    547.883     562.244      764.6      38.51    -0.2149E+05     0 0     0 0
   4                         4.457       4.632                                                                  -3619.         0 0     0 0
0                INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                             INTERFACIAL FRICTION

      LIQ HTC*A   VAPOR HTC*A   WALL MASS      TOTAL MASS      TOT.E/(+LIQ     THERMODYNAMIC   SHEAR       SLIP        REYGAS    REYLIQ
 CELL                          TRANSFER RATE  TRANSFER RATE    OR-VAP.E)        QUALITY       COEFFI
       (W/K)        (W/K)        (KG/S)         (KG/S)          (J/J)                         (KG/M3-S)
   1  0.1987E-07   0.9931E-08   0.0000       -0.1498E-12    -0.4990E-17       -0.040          53.3        1.03       0.728E-06  0.353E+07
   2  0.2177E-07   0.1088E-07   0.0000       -0.2077E-12    -0.1943E-17       -0.051          329.        1.01       0.282E-06  0.424E+07
   3  0.9315E-08   0.4698E-08   0.0000       -0.9091E-13    -0.2203E-18       -0.051          30.2        1.03       0.141E-07  0.185E+07
   4                                                                                          17.3        1.04
0           INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

      H T     H-LIQ       H-VAF         QTOT       QTOT/FL.E             RADIAL TEMPERATURES
 CELL MODE  (W/M2-K)    (W/M2-K)        (W)          (J/J)               <INSIDE
   1  7.00  0.104E+06   0.000       0.343E-01   0.931E-16              547.766   547.766   547.766
   2  7.00  0.675E+05   0.000       0.646E-01   0.175E-15              547.866   547.866   547.866
   3  7.00  0.249E+05   0.000       0.179       0.486E-15              547.883   547.883   547.883


 SIDE TUBE
                  CELL  2     FLOW RATE OUT = -3.341E+00 KG/S       MASS FLUX OUT = -7.495E+03 KG/M2-S

      PRESSURE     VAPOR FRAC  LIQ VEL     VAP VEL      T SAT      T LIQ       T VAP      LIQ DEN    VAP DEN  DELTA-P TOT    ICHOKE  ICCFL
 CELL   (PA)                    (M/S)       (M/S)        (K)        (K)         (K)       (KG/M3)    (KG/M3)     (PA)
   1   7.650E+06  0.000000  -42.07      -42.60      565.087    548.636     565.087      763.5      40.36    -0.6389E+06     0 0     0 0
   2   7.735E+06  0.000000  -9.815      -10.35      565.846    548.659     565.846      763.3      40.87    -0.8448E+05     0 0     0 0
   3                        -9.814      -10.19                                                               0.0000         0 0     0 0
0                INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                             INTERFACIAL FRICTION

      LIQ HTC*A   VAPOR HTC*A   WALL MASS      TOTAL MASS      TOT.E/(+LIQ     THERMODYNAMIC   SHEAR       SLIP        REYGAS    REYLIQ
 CELL                          TRANSFER RATE  TRANSFER RATE    OR-VAP.E)        QUALITY       COEFFI
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         (W/K)          (W/K)         (KG/S)              (KG/S)        (J/J)                              (KG/M3-S)
  1    0.1699E-14    0.8493E-15    0.0000          -0.1908E-19   -0.8423E-24         -0.060            119.        1.01        0.124E-12   0.476E+07
  2    0.2427E-14    0.1214E-14    0.0000          -0.2859E-19   -0.6437E-24         -0.063            97.8        1.06        0.356E-13   0.180E+07
  3                                                                                                    0.900        1.04
0               INSIDE WALL CONVECTION HEAT TRANSFER  (ADIABATIC OUTSIDE WALL)

      H T     H-LIQ       H-VAP        QTOT      QTOT/FL.E               RADIAL TEMPERATURES
 CELL MODE  (W/M2-K)    (W/M2-K)       (W)        (J/J)                  <INSIDE
   1  7.00  0.120E+06   0.000      0.696E-01  0.189E-15                 548.636   548.636   548.636
   2  7.00  0.551E+05   0.000      0.992E-01  0.269E-15                 548.659   548.659   548.659

7     TOTAL COMPONENT WATER MASS =  1.8969E+00 KG.      TOTAL COMPONENT WATER ENERGY =  2.2755E+06 J.
    PERCENT MASS CONTINUITY ERROR =  2.4723E-11   LOST MASS=  4.6856E-13 KG.  PERCENT MASS FLOW THRU(TURNOVER)  = -1.3305E-0

0# # # # # EDIT=     2 # # # # # # # # # # # # # # # # # # # # # # # # # # # # #


 -***- CHAN     12--  64 ROD BUNDLE                            NSTEP=     5 TIME=   0.00001    DELT= 2. 8832E-06 ******
0         MAXIMUM SURFACE TEMPERATURE = 5.815911E+02, WHICH IS IN ROD GROUP   1, CELL    4
0     JUN1 = 20      JUN2 = 21

                  CELL  1     FLOW RATE IN   =  1.644E+01 KG/S       MASS FLUX IN   =  5.495E+03 KG/M2-S
                  CELL  9     FLOW RATE OUT  =  1.540E+01 KG/S       MASS FLUX OUT  =  2.099E+03 KG/M2-S

                  CELL  2     LEAK FLOW RATE=  1.042E+00 KG/S       LEAK MASS FLUX=  5.888E+03 KG/M2-S

      PRESSURE      VAPOR FRAC  LIQ VEL     VAP VEL      T SAT        T LIQ        T VAP      LIQ DEN     VAP DEN   DELTA-P TOT     ICHOKE   ICCFL
 CELL   (PA)                    (M/S)       (M/S)        (K)          (K)          (K)       (KG/M3)     (KG/M3)      (PA)
   1   7.310E+06  0.000000    7.187       7.684      561.950      547.851      561.958      764.6       38.33    0.3064E+05     0 0      0-2
   2   7.314E+06  0.000000    1.229       1.293      562.000      547.911      562.000      764.5       38.36    -4472.         0 0      0 0
   3   7.296E+06  0.029578    3.764       4.298      561.831      554.712      561.831      750.7       38.25    0.1808E+05     0 0      0 0
   4   7.289E+06  0.402957    2.141       1.370      561.762      560.249      561.762      738.9       38.21     7338.         0 0      0 0
   5   7.278E+06  0.579660    3.408       3.760      561.665      561.342      561.663      736.5       38.15    0.1038E+05     0 0      0 0
   6   7.268E+06  0.638726    4.638       5.662      561.567      561.502      561.559      736.1       38.09    0.1040E+05     0 0      0 0
   7   7.258E+06  0.715207    5.252       6.753      561.470      561.596      561.462      735.9       38.03    0.1036E+05     0 0      0 0
   8   7.242E+06  0.772670    6.316       8.731      561.324      561.536      561.313      736.0       37.94    0.1545E+05     0 0      0 0
   9   7.224E+06  0.816408    7.483       10.59      561.141      561.413      561.122      736.2       37.83    0.1853E+05     0 0      0 0
  10                          11.97       15.56                                                                  0.2304E+05     0 0      0-1

0                       INTERFACIAL HEAT TRANSFER (+=FLASH,-=CONDENSE)                                INTERFACIAL FRICTION

      LIQ HTC*A    VAPOR HTC*A    WALL MASS       TOTAL MASS       TOT.E/(+LIQ      THERMODYNAMIC    SHEAR          SLIP        REYGAS      REYLIQ
 CELL                           TRANSFER RATE   TRANSFER RATE     OR-VAP.E)          QUALITY       COEFFI
        (W/K)         (W/K)        (KG/S)          (KG/S)          J/J)                            (KG/M3-S)
   1  0.4856E-06   0.2428E-06   0.0000         -0.4610E-11     -0.1469E-16          -0.050          18.6          1.07      0.124E-05   0.233E+07
   2  0.1591E-06   0.7957E-07   0.0000         -0.1509E-11     -0.1298E-17          -0.050          24.5          1.05      0.453E-07   0.918E+06
   3   6560.        1621.       0.4644E-01      0.1524E-01      0.3856E-05          -0.024          282.          1.14      0.219E+04   0.291E+06
   4  0.2049E+06   0.4230E+05   0.7640          0.5556          0.6891E-05           0.025        0.203E+04      0.640     0.269E+05   0.169E+06
   5  0.2441E+06   0.1221E+06   0.7171          0.6640          0.8605E-05           0.076          708.          1.10      0.711E+05   0.173E+06
   6  0.1156E+06   0.5791E+05   0.3543          0.3489          0.8223E-05           0.103          830.          1.22      0.103E+06   0.183E+06
   7  0.2837E+06   0.1022E+06   0.3552          0.3788          0.3994E-05           0.148        0.101E+04      1.29      0.144E+06   0.169E+06
   8  0.5366E+06   0.1324E+06   0.1458          0.2210          0.1442E-05           0.198          842.          1.38      0.193E+06   0.161E+06
   9  0.3812E+06   0.4519E+05   0.8586E-02      0.7509E-01      0.6982E-06           0.236        0.135E+08      1.42      0.229E+06   0.151E+06
  10                                                                                             0.240E+08      1.30
0     CONVECTIVE CELL AVERAGE QUANTITIES FOR INNER CHAN WALL USED FOR WALL ENERGY  TRANSFER TO CHAN FLUID (A NEG. HTC IS OK; SEE MANUEL)
       .SURF     H-LIQ(CONV)        H-VAP(CONV)       QTOT(CONV)     H-LIQ(RAD)    H-VAP(RAD)   QTOT(CONV+RAD)    QTOT/FLUID ENERGY
 CELL   (K)     (W/M**2-K)         (W/M**2-K)          (W)         (W/M**2-K)    (W/M**2-K)        (W)              (J/J)
   1  547.861     8582.              0.0000           10.63          0.0000        0.0000          10.63            0.2279E-10
   2  550.665   0.2899E+05           0.0000           4636.          0.0000        0.0000          4636.            0.2683E-08
   3  555.566   0.1035E+05           0.0000           2380.          0.0000        0.0000          2380.            0.1310E-08
   4  559.153   0.1053E+05           0.0000          -4663.          0.0000        0.0000         -4663.           -0.2584E-08
   5  561.011   0.2042E+05           0.0000          -1321.          0.0000        0.0000         -1321.           -0.2009E-08
   6  561.477   0.2259E+05           0.0000          -80.72          0.0000        0.0000         -80.72           -0.2001E-09
   7  561.556   0.3463E+05           0.0000          -372.3          0.0000        0.0000         -372.3           -0.5493E-09
```

8	561.505	0.4433E+05	0.0000	-557.2	0.0000	0.0000	-557.2	-0.6398E-09
9	561.436	0.4156E+05	0.0000	256.5	0.0000	0.0000	256.5	0.5067E-09

0 WALL COARSE MESH CONDUCTION INFORMATION (MODES USE ABOVE CELL FLUID PROPERTIES EXCEPT LAST ONE; HT-COEFF. ARE AVERAGES)

(........ INSIDE WALL CONDUCTION DATA......)(..... OUTSIDE WALL CONDUCTION DATA.....) WALL RADIAL NODE TEMPERATURES (K)

MESH #	MESH HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	MESH HT-MODE	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	<INSIDE		
1	1.20	0.355E+05	0.000	0.00	0.000	0.000	547.851	547.851	547.851
2	1.20	0.815E+04	0.000	0.00	0.000	0.000	547.870	547.870	547.870
3	1.20	0.281E+05	0.000	0.00	0.000	0.000	553.459	553.459	553.459
4	1.20	0.143E+05	0.000	0.00	0.000	0.000	557.674	557.674	557.674
5	0.20	0.205E+05	0.000	0.00	0.000	0.000	560.631	560.631	560.631
6	0.2	0.279E+05	0.000	0.00	0.000	0.000	561.391	561.391	561.391
7	1.20	0.312E+05	0.000	0.00	0.000	0.000	561.562	561.562	561.562
8	2.42	0.368E+05	0.000	0.00	0.000	0.000	561.550	561.550	561.550
9	2.42	0.425E+05	0.000	0.00	0.000	0.000	561.459	561.459	561.459
10	1.20	0.631E+05	0.000	0.00	0.000	0.000	561.412	561.412	561.412

ROD HEAT TRANSFER FOR GROUP NUM= 1

CONVECTIVE CELL AVERAGE QUANTITIES USED FOR ROD ENERGY TRANSFER TO CHAN FLUID

CELL	TSUR-LIQ (K)	TSUR-VAP (K)	H-LIQ(CONV) (W/M**2-K)	H-VAP(CONV) (W/M**2-K)	QTOT(CONV) (W)	H-LIQ(RAD) (W/M**2-K)	H-VAP(RAD) (W/M**2-K)	QTOT(CONV+RAD) (W)	QTOT/FLUID ENERGY (J/J)
1	570.072	570.157	0.318E+05	0.100E-09	0.489E+06	0.000	0.000	0.489E+06	0.269E-06
2	576.235	576.330	0.469E+05	0.100E-09	0.750E+06	0.000	0.000	0.750E+06	0.415E-06
3	580.379	580.358	0.492E+05	0.100E-09	0.937E+06	0.000	0.000	[illegible]	0.103E-05
4	581.581	581.581	0.507E+05	0.100E-09	0.102E+07	0.000	0.000	0.102E+07	0.252E-05
5	580.095	580.124	0.508E+05	0.100E-09	0.939E+06	0.000	0.000	0.939E+06	0.139E-05
6	576.110	576.173	0.504E+05	0.100E-09	0.735E+06	0.000	0.000	0.735E+06	0.844E-06
7	569.953	570.466	0.579E+05	0.100E-09	0.495E+06	0.000	0.000	0.495E+06	0.977E-06

0 ROD COARSE MESH CONDUCTION INFORMATION (MODE, TRIP AND TCHF USED ABOVE MESH FLUID PROPERTIES FOR ALL BUT TOP MESH)

MESH #	MESH HT-MODE	CHF TRIP	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TCHF:TMIN (K)	RADIAL NODE TEMPERATURES (K) <CENTER					
1	2.02	0	0.326E+05	0.000	600.303	573.991	573.991	573.991	573.991	573.991	566.779
2	2.42	0	0.415E+05	0.000	597.688	584.794	584.794	584.794	584.794	584.794	573.534
3	2.42	0	0.467E+05	0.000	604.358	594.624	594.624	594.623	594.623	594.623	579.125
4	2.42	0	0.498E+05	0.000	605.502	599.659	599.659	599.659	599.659	599.659	581.591
5	2.42	0	0.503E+05	0.000	604.893	599.640	599.640	599.640	599.640	599.640	581.571
6	2.42	0	0.502E+05	0.000	602.225	594.183	594.183	594.183	594.183	594.183	576.677
7	2.42	0	0.505E+05	0.000	598.715	584.937	584.937	584.937	584.937	584.937	573.668
8	2.42	0	0.672E+05	0.000	595.421	574.498	574.498	574.493	574.498	5 4.498	567.263

ROD HEAT TRANSFER FOR GROUP NUM= 2

CONVECTIVE CELL AVERAGE QUANTITIES USED FOR ROD ENERGY TRANSFER TO CHAN FLUID

CELL	TSUR-LIQ (K)	TSUR-VAP (K)	H-LIQ(CONV) (W/M**2-K)	H-VAP(CONV) (W/M**2-K)	QTOT(CONV) (W)	H-LIQ(RAD) (W/M**2-K)	H-VAP(RAD) (W/M**2-K)	QTOT(CONV+RAD) (W)	QTOT/FLUID ENERGY (J/J)
1	569.791	569.886	0.315E+05	0.100E-09	0.475E+06	0.000	0.000	0.475E+06	0.261E-06
2	575.946	576.032	0.462E+05	0.100E-09	0.725E+06	0.000	0.000	0.725E+06	0.402E-06
3	579.979	579.966	0.486E+05	0.100E-09	0.906E+06	0.000	0.000	0.906E+06	0.100E-05
4	581.140	581.140	0.502E+05	0.100E-09	0.986E+06	0.000	0.000	0.986E+06	0.244E-05
5	579.657	579.6[illegible]	0.503E+05	0.100E-09	0.909E+06	0.000	0.000	0.909E+06	0.134E-05
6	575.730	575.794	0.501E+05	0.100E-09	0.712E+06	0.000	0.000	0.712E+06	0.817E-06
7	569.70[illegible]	570.212	0.577E+05	0.100E-09	0.479E+06	0.000	0.000	0.479E+06	0.946E-06

0 ROD COARSE MESH CONDUCTION INFORMATION (MODE, TRIP AND TCHF USED ABOVE MESH FLUID PROPERTIES FOR ALL BUT TOP MESH)

MESH #	MESH HT-MODE	CHF TRIP	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TCHF:TMIN (K)	RADIAL NODE TEMPERATURES (K) <CENTER					
1	2.02	0	0.324E+05	0.000	600.105	573.467	573.467	573.466	573.466	573.466	566.482
2	2.42	0	0.408E+05	0.000	597.685	584.200	584.200	584.200	584.200	584.200	573.291
3	2.42	0	0.461E+05	0.000	604.356	593.788	593.788	593.788	593.788	593.788	578.773
4	2.42	0	0.493E+05	0.000	606.501	598.664	598.664	598.664	598.664	598.664	581.156

5	2.42	0	0.498E+05	0.000	604.893	598.632	598.632	598.631	598.631	598.631	581.122
6	2.42	0	0.499E 05	0.000	602.330	593.276	593.276	593.276	593.276	593.276	578.254
7	2.42	0	0.502E+05	0.000	598.730	584.251	584.251	584.251	584.251	584.251	573.335
8	2.42	0	0.670E+05	0.000	595.443	574.095	574.095	574.095	574.095	574.095	567.088

ROD HEAT TRANSFER FOR GROUP NUM= 3

CONVECTIVE CELL AVERAGE QUANTITIES USED FOR ROD ENERGY TRANSFER TO CHAN FLUID

CELL	TSUR-LIQ (K)	TSUR-VAP (K)	H-LIQ(CONV) (W/M**2-K)	H-VAP(CONV) (W/M**2-K)	QTOT(CONV) (W)	H-LIQ(RAD) (W/M**2-K)	H-VAP(RAD) (W/M**2-K)	QTOT(CONV+RAD) (W)	QTOT/FLUID ENERGY (J/J)
1	569.280	569.295	0.309E+05	0.100E-09	0.451E+06	0.000	0.000	0.451E+06	0.248E-06
2	575.420	575.490	0.449E+05	0.100E-09	0.681E+06	0.000	0.000	0.681E+06	0.377E-06
3	579.268	579.252	0.476E+05	0.100E-09	0.853E+06	0.000	0.000	0.853E+06	0.947E-06
4	580.338	580.339	0.493E+05	0.100E-09	0.928E+06	0.000	0.000	0.929E+06	0.230E-05
5	578.864	578.897	0.496E+05	0.100E-09	0.856E+06	0.000	0.000	0.856E+06	0.126E-05
6	575.045	575.111	0.496E+05	0.100E-09	0.670E+06	0.000	0.000	0.670E+06	0.769E-06
7	569.270	569.755	0.574E+05	0.100E-09	0.451E+06	0.000	0.000	0.451E+06	0.892E-06

0 ROD COARSE MESH CONDUCTION INFORMATION (MODE, TRIP AND TCHF USED ABOVE MESH FLUID PROPERTIES FOR ALL BUT TOP MESH)

MESH #	MESH HT-MODE	CHF TRIP	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TCHF:TMIN (K)	RADIAL NODE TEMPERATURES (K) <CENTER					
1	2.02	0	0.320E+05	0.000	599.712	572.527	572.527	572.527	572.527	572.527	565.942
2	2.42	0	0.396E+05	0.000	597.677	583.124	583.124	583.124	583.124	583.124	572.847
3	2.42	0	0.450E+05	0.000	604.352	592.287	592.287	592.286	592.286	592.286	578.134
4	2.42	0	0.483E+05	0.000	606.500	596.879	596.879	596.878	596.878	596.878	580.371
5	2.42	0	[illegible]	0.000	604.899	596.812	596.812	596.812	596.812	596.812	580.306
6	2.42	0	[illegible]	0.000	602.239	591.649	591.649	591.649	591.649	591.649	577.487
7	2.42	0	0.498E+05	0.000	598.752	583.023	583.023	583.023	583.023	583.023	572.735
8	2.42	0	0.668E+05	0.000	595.487	573.377	573.377	573.377	573.377	573.377	566.776

ROD HEAT TRANSFER FOR GROUP NUM= 4

CONVECTIVE CELL AVERAGE QUANTITIES USED FOR ROD ENERGY TRANSFER TO CHAN FLUID

CELL	TSUR-LIQ (K)	TSUR-VAP (K)	H-LIQ(CONV) (W/M**2-K)	H-VAP(CONV) (W/M**2-K)	QTOT(CONV) (W)	H-LIQ(RAD) (W/M**2-K)	H-VAP(RAD) (W/M**2-K)	QTOT(CONV+RAD) (W)	QTOT/FLUID ENERGY (J/J)
1	555.855	556.182	0.229E+05	0.100E-09	0.261E+05	0.000	0.000	0.261E+05	0.144E-07
2	559.523	559.141	0.161E+05	0.100E-09	-0.117E+05	0.000	0.000	-0.117E+05	-0.649E-08
3	561.062	561.008	0.244E+05	0.100E-09	-0.684E+04	0.000	0.000	-0.684E+04	-0.754E-08
4	561.483	561.478	0.297E+05	0.100E-09	-563.	0.000	0.000	-563.	-0.139E-08
5	561.562	561.562	0.341E+05	0.100E-09	-0.116E+04	0.000	0.000	-0.116E+04	-0.172E-08
6	561.505	561.509	0.397E+05	0.100E-09	-0.122E+04	0.000	0.000	-0.122E+04	-0.140E-08
7	561.430	561.435	0.525E+05	0.100E-09	929.	0.000	0.000	929.	0.187E-08

0 ROD COARSE MESH CONDUCTION INFORMATION (MODE, TRIP AND TCHF USED ABOVE MESH FLUID PROPERTIES FOR ALL BUT TOP MESH)

MESH #	MESH HT-MODE	CHF TRIP	H-LIQ (W/M2-K)	H-VAP (W/M2-K)	TCHF:TMIN (K)	RADIAL NODE TEMPERATURES (K) <CENTER					
1	1.20	0	0.279E+05	0.000	0.000	554.709	554.709	554.709	554.709	554.709	554.709
2	1.20	0	0.143E+05	0.000	0.000	557.656	557.656	557.656	557.656	557.656	557.656
3	0.20	0	0.205E+05	0.000	0.000	560.626	560.626	560.626	560.626	560.626	560.626
4	0.20	0	0.279E+05	0.000	0.000	561.391	561.391	561.391	561.391	561.391	561.391
5	1.20	0	0.312E+05	0.000	0.000	561.565	561.565	561.565	561.565	561.565	561.565
6	1.20	0	0.369E+05	0.000	0.000	561.565	561.565	561.565	561.559	561.559	561.559
7	2.42	0	0.424E+05	0.000	614.281	561.459	561.459	561.459	561.459	561.459	561.459
8	1.20	0	0.631E+05	0.000	0.000	561.412	561.412	561.411	561.411	561.411	561.411

0 TOTAL COMPONENT WATER MASS = 1.7523E+01 KG. TOTAL COMPONENT WATER ENERGY = 2.2844E+07 J.
PERCENT MASS CONTINUITY ERROR = -3.8753E-06 LOST MASS= -6.7908E-07 KG. PERCENT MASS FLOW THRU(TURNOVER) = -4.0495E-06

0# # # # # EDIT= 2 #

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The TRAC-BWR code development program at the Idaho National Engineering Laboratory has developed versions of the Transient Reactor Analysis Code (TRAC) for the U.S. Nuclear Regulatory Commission and the public. The TRAC-BF1/MOD1 version of the computer code provides a best-estimate analysis capability for analyzing the full range of postulated accidents in boiling water reactor (BWR) systems and related facilities. This version provides a consistent and unified analysis capability for analyzing all areas of a large- or small-break loss-of-coolant accident (LOCA), beginning with the blowdown phase and continuing through heatup, reflood with quenching, and, finally, the refill phase of the accident. Also provided is a basic capability for the analysis of operational transients up to and including anticipated transients without scram (ATWS). The TRAC-BF1/MOD1 version produces results consistent with previous versions. Assessment calculations using the two TRAC-BF1 versions show overall improvements in agreement with data and computation times as compared to earlier versions of the TRAC-BWR series of computer codes.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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TRAC-BF1/MOD1
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13. AVAILABILITY STATEMENT

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